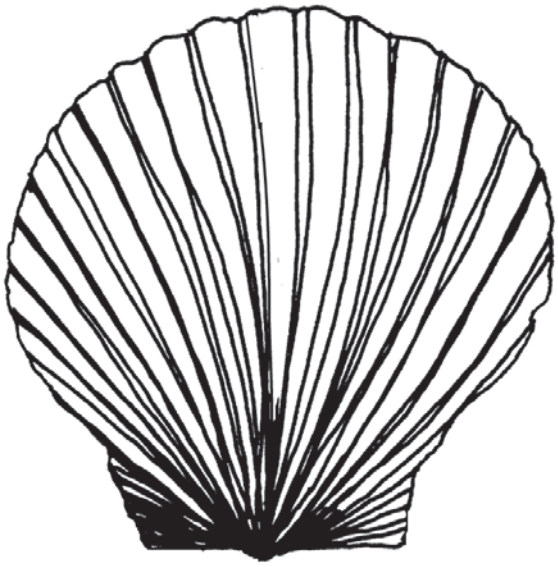
North Carolina
Fishery Management Plan

Bay Scallops



November 2007

North Carolina
Bay Scallop
Fishery Management Plan

By

North Carolina Division of Marine Fisheries

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1.0 ACKNOWLEDGEMENTS

The 2007 North Carolina Bay Scallop Fishery Management Plan (FMP) was developed by the North Carolina Department of Environment and Natural Resources Division of Marine Fisheries (DMF) under the direction of the North Carolina Marine Fisheries Commission (MFC) with advice from the Bay Scallop Advisory Committee, the Plan Development Team (PDT), and the Rules Subcommittee who contributed their time and knowledge to this document.

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2.0 TABLE OF CONTENTS

2.1. LIST OF ACRONYMS

AC – Advisory Committee

ASMFC – Atlantic States Marine Fisheries Commission

BMP – Best Management Practice

CHPP – Coastal Habitat Protection Plan

COE – United States Army Corp of Engineers

CPI – Consumer Price Index

CPUE – Catch Per Unit Effort

CRC – North Carolina Coastal Resources Commission

CRFL – Coastal Recreational Fishing License

DCM – North Carolina Division of Coastal Management

DEH - North Carolina Department of Environmental Health

DEHNR - North Carolina Department of Environment, Health and Natural Resources

DENR – North Carolina Department of Environment and Natural Resources

DMF – North Carolina Division of Marine Fisheries

DO – Dissolved Oxygen

DWQ- North Carolina Division of Water Quality

EFH – Essential Fish Habitat

EMC – North Carolina Environmental Management Commission

EPA – United States Environmental Protection Administration

FDA – United States Food and Drug Administration

FMP – Fishery Management Plan

FRA – Fishery Reform Act

FRG – Fishery Resource Grant

GS – General Statute

HQW- High Quality Waters

ICW – Intercoastal Waterway

ISSC – Interstate Shellfish Sanitation Conference

MFC – North Carolina Marine Fisheries Commission

MRFSS- Marine Recreational Fisheries Statistical Survey

MSC – Moratorium Steering Committee

NMFS – National Marine Fisheries Service

NOAA – National Oceanic and Atmospheric Administration

NPDES - National Pollution Discharge Elimination System

NSSP – National Shellfish Sanitation Program

NSW – Nutrient Sensitive Waters

ORW – Outstanding Resource Waters

PDT – Plan Development Team

PNA – Primary Nursery Area

PPT – Parts Per Thousand

RCGL – Recreational Commercial Gear License

RAT – Rules Advisory Team

SAFMC – South Atlantic Fishery Management Council

SAV – Submerged Aquatic Vegetation

SCFL – Standard Commercial Fishing License

SHA – Strategic Habitat Area

TSS – Total Suspended Solids

USFWS – United States Fish and Wildlife Service

WRC – North Carolina Wildlife Resources Commission

WS – Water Supply

3.0 EXECUTIVE SUMMARY

The goals of the 2007 North Carolina Bay Scallop Fishery Management Plan (FMP) are to implement a management strategy that restore the stock, maintain sustainable harvest, maximize the social and economic value, and consider the needs of all user groups. Plan objectives include: develop an objective management program that restores and maintains sustainable harvest; promote the protection, restoration, and enhancement of habitats and water quality necessary for enhancing the fishery resource; identify, enhance, and initiate studies to increase our understanding of bay scallop biology, predator/prey relationships, and population dynamics in North Carolina; investigate methods for protecting and enhancing the spawning stock; address social and economic concerns of all user groups; and promote public awareness regarding the status and management of the North Carolina bay scallop stock.

Bay scallops are considered an annual crop because of their short life span. Their populations are more affected by environmental conditions such as temperature, salinity, habitat, and water quality. Although fishing does reduce the population size over a fishing season, fishing would not normally reduce year class strength for the following year unless the spawning stock has been reduced below some minimum threshold. Maintenance and improvement of suitable estuarine habitat and water quality are probably the most important factors in providing a sustainable bay scallop stock.

The commercial supply of bay scallops in North Carolina has never been able to keep up with the increasing demand. When bay scallops are available, commercial fishermen can get a good price for them, regardless of the number of pounds they are able to land. Since the fishery occurs in the winter months when other fisheries are slow and is confined to only a small area (Core and Bogue sounds) of the state, limitations in the population are felt strongly in this region. Recreational harvest is allowed at the same time as the commercial season. In recent years, harvest has decreased to essentially no landings because of recruitment failure resulting from a red tide event in 1987, several hurricanes in the 1990's, and cownose ray predation.

Management options such as area and season closures, size and trip limits, gear restrictions, and prohibited take are considered. Research needs on spawning sanctuaries, stock enhancement, genetics, and abundance indicators are addressed. Issues on predation by cownose rays and impacts from weather events are explored. Other

management issues include fishing gear and their impacts to habitat used by bay scallops and commercial and recreational socioeconomic and fishery data limitations.

The proposed management strategy for the bay scallop fishery is to prohibit take until an independent sampling indicator can determine re-opening with further measures in place before re-opening to ensure spawning is complete and the economic yield is at an optimum for fishermen. Improving data collection on the biology, harvest, environment, and socioeconomic aspects relative to bay scallops is recommended throughout the FMP to provide more comprehensive information for assisting in future management decisions.

Issues addressed in formulating the FMP for North Carolina's bay scallop population encompassed the following general categories: 1) insufficient data; 2) environmental concerns; 3) harvest concerns; and 4) stock enhancement. Specific issues and recommendations are as follows:

1) Insufficient data: The statutory obligation to manage bay scallops according to sustainable harvest cannot be met until the appropriate data are collected. Data on bay scallops are limited to landings from the commercial fishery and an independent survey that has not been sampled consistently until recently. Individual trip information has been available since the initiation of the trip ticket program in 1994. A long-term fishery-independent monitoring program is necessary to provide an annual abundance indicator. Recreational harvest data does not exist and funding is unavailable to collect information on the recreational harvest of bay scallops at this time. Socioeconomic surveys of commercial and recreational participants need to be performed to determine specific characteristics of each user group, which issues are important to them, attitudes towards management of the fishery, as well as general demographic information.

2) Environmental issues: The bay scallop, unlike many estuarine species, is very habitat specific in its distribution, occurring almost exclusively in high salinity beds of submerged aquatic vegetation (SAV). Suitable and adequate habitat is a critical element in the ecology and productivity of bay scallops. The use of bottom disturbing fishing gears have the potential to destroy or damage SAV. The Coastal Habitat Protection Plan (CHHP) implementation plan calls for protective buffers and further restrictions on mechanical shellfish harvest. The extent to which habitat alterations and water quality impacts bay scallop survival is still poorly understood.

3) Harvest concerns: Low landings in recent years due to a red tide event in 1987, numerous hurricanes and predation by cownose rays are both biological and socioeconomic concerns because of the large number of bay scallops lost to the fishery as well as limiting recruitment of the bay scallop population. Other issues of concern include the harvest of whole scallops from polluted areas and the prohibition of soaking scallop meats.

4) Stock enhancement: Bay scallops are often absent in the rules and planning procedures for hatcheries and sanctuaries. Recommendations were made to consider bay

scallops in the allocation of enhancement resources. Productive bay scallop areas need to be identified for potential spawning sanctuaries or for enhancement activities.

3.1 GOALS AND OBJECTIVES

The goals of the 2007 North Carolina Bay Scallop Fishery Management Plan (FMP) are to implement a management strategy that restore the stock, maintain sustainable harvest, maximize the social and economic value, and consider the needs of all user groups. To achieve these goals, it is recommended that the following objectives be met:

1. Develop an objective management program that restores and maintains sustainable harvest.

2. Promote the protection, restoration, and enhancement of habitats and water quality necessary for enhancing the fishery resource.

3. Identify, enhance, and initiate studies to increase our understanding of bay scallop biology, predator/prey relationships, and population dynamics in North Carolina.

4. Investigate methods for protecting and enhancing the spawning stock.

5. Address social and economic concerns of all user groups.

6. Promote public awareness regarding the status and management of the North Carolina bay scallop stock.

3.2 MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGIES

The proposed management strategy for the bay scallop fishery in North Carolina is prohibit take until an independent sampling indicator can determine re-opening with further measures in place to ensure spawning is complete and the economic yield is at an optimum for fishermen. Improving data collection on population dynamics, harvest, environment, and socioeconomic aspects relative to bay scallops is recommended throughout the FMP to provide more comprehensive information for assisting in future management decisions. Proposed rule changes to implement the management strategies are found in Appendix 12.7.

3.2.1 SUSTAINABLE HARVEST STRATEGY

The statutory obligation to manage bay scallops according to sustainable harvest cannot be met until the appropriate data are collected. Since commercial harvest levels are at an all time low, prohibited take of bay scallops is recommended until sampling can define an independent indicator for re-opening a harvest season. When a harvest season can be re-opened further measures are recommended in rule to ensure spawning is complete and the economic yield is at an optimum for the fishermen.

3.2.2 MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGIES AND REQUIRED ACTIONS

The management strategies listed below are identified under each general problem statement as found in Section 4.2. (Table 3.1). The Marine Fisheries Commission (MFC) early in the FMP process requested DMF staff provide estimated costs on the selected management and research recommendations. A specific overview on the estimated costs is found in Appendix 12.5 and the research recommendations are summarized in Section 10.2. An overview of the MFC Shellfish and Regional Advisory Committees selected management and research recommendations are provided in Appendix 12.6. Improving bay scallop management in North Carolina includes all strategies required to produce the best management plan possible, which includes estimating annual abundance and comprehensive habitat enhancement.

Table 3.1. The Marine Fisheries Commission selected management strategy, objectives followed, and required actions.

MANAGEMENT STRATEGY	**OBJECTIVES**	**REQUIRED ACTION**
INSUFFICIENT DATA		
1. Recommend produce a mechanism to obtain data on the recreational scallop harvest.	1, 3, 5, and 6	Existing authority
2. Recommend continue prohibited take (started in January 2006) and evaluate the population status annually.	1 and 3	Existing proclamation authority
3. Recommend sampling during the prohibited take period to define an independent sampling indicator for re-opening a harvest season.	1, 3, and 4	Existing authority
4. Recommend eliminating the December opening and compress the main season by beginning the last Monday in January.	1, 4, and 6	Requires rule change to 15A NCAC 03K .0501
ENVIRONMENTAL CONCERNS		
1. Identify and delineate Strategic Habitat Areas that will enhance protection of bay scallop.	1, 2, and 4	Existing authority though the CHPP implementation plan
2. Completely map all SAV habitat in North Carolina.	1 and 2	Existing authority though the CHPP implementation plan
3. Remap SAV habitat in Core and Bogue sounds and assess change in distribution and abundance over time.	1 and 2	Existing authority though the CHPP implementation plan
4. Restore historical distribution and acreage of SAV wherever necessary.	1, 2, and 4	Existing authority though the CHPP implementation plan
5. Aggressively reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV habitat, using regulatory and non-regulatory actions.	2 and 4	Existing authority though the CHPP implementation plan

Table 3.1. The Marine Fisheries Commission selected management strategy, objectives followed, and required actions.

MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
ENVIRONMENTAL CONCERNS		
6. Evaluate dock criteria to determine if existing requirements are adequate for SAV survival and growth and modify if necessary.	2 and 4	Existing authority though the CHPP implementation plan
7. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV and other habitats.	2, 4, and 6	Existing authority though the CHPP implementation plan
8. Evaluate and adjust as necessary dredging and trawling boundaries in Core and Bogue sounds to protect and enhance SAV habitat.	1, 2, 4, and 6	Existing authority though the CHPP implementation plan
9. Seek additional resources to enhance enforcement of and compliance with bottom disturbing fishing gear restrictions that protect SAV and other habitats.	1, 2, 3, 4, and 6	Existing authority though the CHPP implementation plan
10. Work with NOAA and DWQ to determine appropriate levels of TSS, turbidity, chlorophyll a, and other water clarity parameters to achieve adequate water quality conditions for SAV growth.	2	Existing authority though the CHPP implementation plan
11. Conduct research to evaluate the role of shell hash and shell bottom in bay scallop recruitment and survival, particularly where SAV is absent.	2	Existing authority though the CHPP implementation plan
12. Accelerate and complete mapping of all shell bottom in North Carolina.	2	Existing authority though the CHPP implementation plan
13. Protect shallow soft bottom habitat through proper siting of docks, marinas, and shoreline stabilization structures.	2	Existing authority though the CHPP implementation plan
14. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.	2	Existing authority though the CHPP implementation plan
15. Evaluate the effects of clam kicking and trawling on soft bottom habitat and bay scallops.	2, 3, and 4	Existing authority
16. Prevent loss of additional riparian wetlands through the permitting process, land acquisition, or land use planning.	2 and 6	Existing authority though the CHPP implementation plan
17. Restore coastal wetlands to enhance water quality conditions for bay scallops.	2 and 6	Existing authority though the CHPP implementation plan
18. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.	2 and 6	Existing authority though the CHPP implementation plan

Table 3.1. The Marine Fisheries Commission selected management strategy, objectives followed, and required actions.

MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
ENVIRONMENTAL CONCERNS		
19. Increase on-site infiltration of stormwater through voluntary or regulatory measures.	2	Existing authority though the CHPP implementation plan
20. Provide more incentives for low-impact development.	2 and 6	Existing authority though the CHPP implementation plan
21. Work with DWQ and EMC to modify stormwater rules to more effectively reduce runoff volume and pollutant loading to coastal waters to levels that protect and enhance fish habitats vital to bay scallops.	2	Existing authority though the CHPP implementation plan
22. Reduce impervious surfaces associated with new development as much as possible and reduce the maximum amount of impervious surfaces allowed in the absence of engineered stormwater controls.	2	Existing authority though the CHPP implementation plan
23. Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading.	2	Existing authority though the CHPP implementation plan
24. Recommend modifying, if needed, the trawl closure area in Bogue Sound to protect bay scallop habitat based on all available information.	2	Existing proclamation authority
25. Recommend rule change to clarify wording to protect bay scallop habitat from bull rakes and hand tongs.	1 and 2	Requires rule change to 15A NCAC 03K .0102 and 15A NCAC 03K .0304
HARVEST CONCERNS		
1.Recommend collaborate with DEH and NOAA to monitor potential future red tide outbreaks.	5 and 6	Existing authority
2. Recommend pilot research into various approaches to control cownose ray predation on bay scallops.	1, 3, 4, and 5	Existing authority
3. Repeal the rule prohibiting soaking or swelling of bay scallops	1	Requires repealing the rule 15A NCAC 03K .0506

Table 3.1. The Marine Fisheries Commission selected management strategy, objectives followed, and required actions.

MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
STOCK ENHANCEMENT		
1. Recommend enhancement through spawner transplants of wild harvest stocks and by cultured release.	4 and 5	Requires rule change to 15A NCAC 03K .0103
2. Recommend to the Oyster Hatchery Planning Advisory Team consider multiple uses of the demonstration oyster hatchery facilities for different shellfish species.	4 and 6	The MFC approved this recommendation and submitted a letter in April 2006 to the Oyster Hatchery Planning Advisory Team asking that the planning stages for the hatchery consider all shellfish species. The letter is included in Appendix 12.4.

4.0 INTRODUCTION

The bay scallop (*Argopecten irradians*) fishery of North Carolina is an important fishery because: (1) it is a high value product that gives a high return per unit of effort; (2) it is active when other fisheries in the area are slow; (3) it is confined to small areas in the state (Core and Bogue Sounds and occasionally Back Sound, the lower portion of New River, and along Hatteras Island in Pamlico Sound) so that limitations in the population are felt strongly by these localized regions; and (4) it is a source of personal enjoyment to recreationally harvest them.

In recent years, harvest has decreased to essentially no landings because of recruitment failure resulting from a red tide event in 1987, several hurricanes in the 1990's and cownose ray predation. The goals of this plan is to implement a management strategy that restore the stock, maintain sustainable harvest, maximize the social and economic value, and consider the needs of all user groups

4.1 MANAGEMENT AUTHORITY

All authority for management of North Carolina's bay scallop fishery is vested in the State of North Carolina. Management of the bay scallop fishery includes all activities associated with maintenance, improvement, and utilization of the bay scallop population and their habitats in the coastal area, including research, development, regulation, enhancement, and enforcement. Bay scallop harvest occurs from coastal waters and is under rules of the North Carolina Marine Fisheries Commission (MFC). However, the North Carolina Department of Environment and Natural Resources (DENR) is the agency directed by North Carolina General Statute 113-182.1 (G.S. 113-182.1) to prepare

Fishery Management Plans (FMPs) for all commercially or recreationally significant species or fisheries that comprise State marine or estuarine resources. These plans must be approved and adopted by the MFC.

Many different state laws (General Statutes - G.S.) provide the necessary authority for fishery management in North Carolina. General authority for stewardship of the marine and estuarine resources by the DENR is provided in G.S. 113-131. The Division of Marine Fisheries (DMF) is the branch of the DENR that carries out this responsibility. G.S. 113-136 provides enforcement authority for DMF Marine Patrol officers. General Statute 113-163 authorizes research and statistical programs. The MFC was created to "manage, restore, develop, cultivate, conserve, protect, and regulate the marine and estuarine resources of the State of North Carolina including aquaculture facilities which cultivate or rear marine and estuarine resources"(G.S. 113-132 and 143B-289.51). The MFC can regulate harvest times, areas, gear, seasons, size limits, and quantities of shellfish harvested and possessed (G.S. 113-182 and 143B-289.52). General Statute 143B-289.52 allows the MFC to delegate authority to implement its regulations for fisheries "which may be affected by variable conditions" to the Director of DMF by issuing public notices called "proclamations". Thus, North Carolina has a very powerful and flexible legal basis for coastal fisheries management. The General Assembly has retained for itself the authority to establish commercial fishing licenses and mandates that there will be no fees charged for permits. It has delegated authority to the MFC to establish permits for various commercial fishing activities.

The Fisheries Reform Act of 1997 (FRA) establishes a process for preparation of coastal fisheries management plans in North Carolina (G.S. 113-182). The FRA was amended in 1998 and again in 2004. In 1998 the FRA was amended for several changes, that: 1) determine limited entry authority in Federal quota-based fisheries; 2) authorized that FMPs and management measures from FMPs be reviewed by the regional advisory committees; 3) authorized that MFC meetings must have a super quorum; 4) clarified definitions; and 5) clarified licensing provisions for standard commercial fishing licenses (SCFL) and recreational commercial gear licenses (RCGL). The amendment of the FRA in 2004 required FMPs to achieve sustainable harvest rather than optimal yield and to specify a time period not to exceed 10 years for ending overfishing and rebuilding a fishery. The FRA states that "the goal of the plans shall be to ensure the long-term viability of the State's commercially and recreationally significant species or fisheries. Each plan shall be designed to reflect harvest 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 relevant fish stocks, stock assessments for multi-year species, fishery habitat, and water quality considerations consistent with Coastal Habitat Protection Plans adopted pursuant to G.S. 143B-279.8, social and economic impact of the fishery to the State, and user conflicts.

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

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

d. Specify a time period, not to exceed 10 years from the date of adoption of the plan, for ending overfishing and achieving a sustainable harvest. This subdivision shall 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 10 years impracticable (G.S. 113-129(12d)).

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" (G.S. 113-129(14a)). Overfished is defined as "the condition of a fishery that occurs when the spawning stock biomass of the fishery is below the level that is adequate for the recruitment class of a fishery to replace the spawning class of the fishery" (G.S. 113-129(12c)). Overfishing is defined as "fishing that causes a level of mortality that prevents a fishery from producing a sustainable harvest" (G.S.113-129(12d)).

4.2 GENERAL PROBLEM STATEMENT

Maintenance and improvement of suitable estuarine habitat and water quality are probably the most important factors in providing a sustainable bay scallop stock. Habitat protection, conservation, and restoration are essential to accomplish the goals and objectives of this plan.

A commercial market has developed for North Carolina bay scallops and supply has never been able to keep up with the increasing demand. Low landings in recent years resulting from red tide, hurricanes and predation from cownose rays are a major concern. When bay scallops are available, commercial fishermen can get a good price for them, regardless of the number of pounds they are able to land. Since the fishery occurs in the winter months when other fisheries are slow and is confined to only a small area (Core and Bogue sounds) of the state, limitations in the population are felt strongly in this region. Recreational harvest is allowed at the same time as the commercial season and is also managed with minimum trip limits. No data are available on recreational harvest at this time.

Management options such as area and season closures, size and trip limits, gear restrictions, and prohibited take are considered. Research on spawning sanctuaries, stock enhancement, genetics, and abundance indicators are addressed. Issues on predation by cownose rays and impacts from weather events are explored. Other management issues include fishing gear and their impacts to habitat used by bay scallops and commercial and recreational socioeconomic and fishery data limitations.

4.2.1 INSUFFICIENT DATA

The statutory obligation to manage bay scallops according to sustainable harvest cannot be met until the appropriate data are collected. Data on bay scallops are limited to landings from the commercial fishery and an independent survey that has not been sampled consistently until recently. Individual trip information has been available since the initiation of the trip ticket program in 1994. A long-term fishery-independent monitoring program is necessary to provide an indicator of abundance. A socioeconomic survey on the commercial participants and processors is necessary to determine specific business characteristics and the economics of working in the fishery.

Recreational harvest data does not exist and funding is unavailable to collect information on the recreational harvest of bay scallops at this time. Collection of recreational harvest information would provide a better estimate of fishing mortality and relative abundance of bay scallops. A socioeconomic survey on the recreational participants would provide information on the economic impacts and social importance of the recreational bay scallop fishery. It would improve our knowledge of the variation in abundance caused by a combination of both fishing effort and environmental change. A more accurate account of landings would allow managers to examine the proportional harvest of recreational and commercial fisheries and make better decisions on management strategies for both harvest sectors.

Specific issues, options, and potential actions are outlined in Sections 7.0, 9.0 and 10.0.

4.2.2 ENVIRONMENTAL CONCERNS

The bay scallop, unlike many estuarine species, is very habitat specific in its distribution, occurring almost exclusively in high salinity beds of Submerged Aquatic Vegetation (SAV). The use of any gears in SAV has been controversial since these seagrasses provide protection and food for a multitude of species, including bay scallops. Several bottom disturbing fishing gears have the potential to destroy or damage SAV. Damage from fishing gear varies in severity. Hand gear such as bull rakes and hand tongs can uproot SAV and cause damage, but generally to smaller areas than mechanical gear. Gears that disturb the sediment and below-ground plant structures, like toothed dredges, and heavy trawls, may cause total loss of SAV in the affected area, requiring extensive time to recover. The greatest potential for trawling over SAV beds is in Core and Bogue sounds where the majority of the bay scallop population occurs. Current knowledge of bay scallop dredging indicates that they have impacts on SAVs that negatively effect juvenile bay scallops. Effects from boat prop scarring are additional negative impact to SAVs. Suitable and adequate habitat is a critical element in the ecology and productivity of bay scallops. The extent to which extreme weather and water quality events impact bay scallop survival is still poorly understood.

Specific issues, options, and potential actions are outlined in Sections 8.0, 9.0, and 10.0.

4.2.3 HARVEST CONCERNS

Low landings in recent years are the result of several environmental disturbances that have occurred since the 1980s. A red tide event occurred in October of 1987 resulting in a significant reduction in landings, especially in Bogue Sound where consistently high bloom concentrations were found. A further reduction in harvest was also seen following the 1999 hurricane season where tropical storm Dennis saturated the ground and Hurricane Floyd caused massive flooding in eastern North Carolina. After these events, landings were reduced to extremely low levels.

In addition, there has been a growing concern in North Carolina about predation on bay scallops by cownose rays. Cownose rays feed in areas where bay scallops occur in high densities. The period of high mortality of bay scallops occurs during the summer before spawning and therefore do not contribute to the population the following year. The site-specific selection of seagrass beds in these areas by large schools of cownose rays may be related to a highly efficient feeding behavior as they migrate south resulting in a large number of scallops being lost to the fishery.

These low landings are also a socioeconomic concern. Other issues of concern are the harvest of whole and roe-on scallops from polluted areas and the prohibition of soaking scallop meats.

Specific issues, options, and potential actions are outlined in Sections 9.0, and 10.0.

4.2.4 STOCK ENHANCEMENT

Currently, there is no enhancement program for bay scallops in North Carolina. However, with low population levels coastwide, other states have considered stock enhancement and sanctuaries as management strategies to revive depleted fisheries. Restocking of bay scallops and enhancement through spawner transplants by cultured release would be difficult and expensive without the ability to produce and raise them in a state hatchery. Currently, there are no state operated hatcheries for shellfish restoration in North Carolina. In 2005 state legislators approved funding of $600,000 annually for two years to investigate options for incorporating oyster hatcheries at the North Carolina aquariums. The use of hatcheries for species other than oysters has been discussed. These hatcheries could allow for small scale seeding projects and public education for future programs. Productive bay scallop areas also need to be identified

Spawning sanctuaries have already been established for oysters that provide a protected haven from fishing effort, promote growth and survivability, and have the potential to establish populations beyond the sanctuary boundaries. It is still unknown how many acres of bottom need to be protected to create a sanctuary that will function properly. Valuable input from commercial fishermen is needed in the development of these areas. Designated sanctuaries would provide a platform to introduce bay scallops to areas where habitat and harvest would be protected.

Specific issues, options, and potential actions are outlined in Sections 8.0, 9.0, and 10.0.

4.3 DEFINITION OF THE MANAGEMENT UNIT

The management unit includes the bay scallop (*Argopecten irradians)* and its fisheries in all waters of coastal North Carolina.

4.4 EXISTING PLANS, STATUTES, AND RULES OF NORTH CAROLINA

4.4.1 PLANS

There are no federal or interstate FMPs regulating bay scallops in North Carolina.

4.4.2 STATUTES

G.S. 113-168.2 Standard Commercial Fishing License

A $200 license to commercially harvest and sell finfish, crabs, and shrimp to licensed seafood dealers. An endorsement to this license to commercially harvest and sell shellfish is free to North Carolina residents only.

G.S. 113-168.5 License endorsements for Standard Commercial Fishing License.

A no charge shellfish endorsement for North Carolina residents holding a SCFL. The endorsement allows the holder to take and sell shellfish.

G.S. 113-168.6 Commercial fishing vessel registration.

This registration is a requirement for commercial fishermen who use boats to harvest seafood. Fees are based on boat length. Fees range from $1.00 to $6.00 per foot.

G.S. 113-169.2 Shellfish license for NC residents without a SCFL

There is an annual $25.00 license for individuals to commercially harvest shellfish. This license is available only to residents of North Carolina. This statute also sets the limits for taking shellfish for personal use without a license.

G.S. 113-169.3	License for fish dealers. This General Statute establishes a license requirement and establishes a $50.00 fee for dealing in scallops. Dealer's licenses are restricted to North Carolina residents.
G.S. 113-182.1	Fishery Management Plans (FMP) Requires the Department to prepare and the MFC to adopt FMPs for all commercially or recreationally significant species.
G.S. 113-202	New and renewal leases for shellfish cultivation; termination of leases issued prior to January 1, 1966. Allows shellfish leases meeting certain standards to be granted in coastal fishing waters except in Brunswick County and Core Sound.
G.S. 113-202.1	Water column leases for aquaculture. Allows shellfish lease holders to use the water column above their bottom lease for shellfish cultivation if certain standards are met.
G.S. 113-202.2	Water column leases for aquaculture for perpetual franchises. Allows shellfish franchise holders to use the water column above their franchise area for shellfish cultivation if certain standards are met.
G.S. 113-208	Protection of private shellfish rights. This statute establishes a maximum $5,000 fine for theft from a shellfish lease.
G.S. 113-269	Robbing or injuring hatcheries and other aquaculture operations. Fines and punishment for robbing or injuring aquaculture operations are set forth in this statute.
G.S. 143B-279.8	Coastal Habitat Protection Plans Establishes plans that shall provide for the long-term enhancement of coastal fisheries associated with coastal habitats including shellfish beds. Also requires the EMC, CRC, and MFC to adopt and follow the plans.

4.4.3 RULES

SECTION .0100 – SHELLFISH GENERAL

15A NCAC 03K .0101 PROHIBITED SHELLFISH AREAS/ACTIVITIES

(a) It is unlawful to possess, sell, or take oysters, clams or mussels from areas which have been designated as prohibited (polluted) by proclamation by the Fisheries Director except as provided in 15A NCAC 03K .0103, .0104, .0107, and .0401. The Fisheries Director shall issue such proclamations upon notice by the Division of Environmental Health that duly adopted criteria for approved shellfish harvest areas have not been met. The Fisheries Director may reopen any such closed area upon notification from the Division of Environmental Health that duly adopted criteria for approved shellfish harvest areas have been met. Copies of these proclamations and maps of these areas are available upon request at the Division of Marine Fisheries, 3441 Arendell St., Morehead City, NC 28557; (252) 726-7021.

(b) The Fisheries Director may, by proclamation, close areas to the taking of oysters, clams, scallops and mussels in order to protect the shellfish populations for management purposes or for public health purposes not specified in Paragraph (a) of this Rule.

(c) It is unlawful to possess or sell oysters, clams, or mussels taken from polluted waters outside North Carolina.

(d) It is unlawful to possess or sell oysters, clams, or mussels taken from the waters of North Carolina except as provided in G. S. 113-169.2 (i) without a harvest tag affixed to each container of oysters, clams or mussels. Harvest tags shall be affixed by the harvester and shall meet the following criteria:

1) Tags shall be identified as harvest tags. They shall be durable for at least 90 days, water resistant, and a minimum of two and five-eighths inches by five and one-fourth inches in size.

(2) Tags shall be securely fastened to the outside of each container in which shellstock is transported. Bulk shipments in one container and from the same source may have one tag with all required information attached. Harvesters who are also certified shellfish dealers may use only their dealers tag if it contains the required information. The required information shall be included on all lots of shellfish subdivided or combined into market grades or market quantities by a harvester or a certified shellfish dealer.

(3) Tags shall contain legible information arranged in the specific order as follows:

(A) The harvester's name, address and shellfish license or standard or retired standard commercial fishing license with shellfish endorsement number.

(B) The date of harvest.

(C) The most precise description of the harvest location as is practicable (e.g., Long Bay, Rose Bay) that can be easily located by maps and charts.

(D) Type and quantity of shellfish.

(E) The following statement in bold, capitalized type: "THIS TAG IS REQUIRED TO BE ATTACHED UNTIL CONTAINER IS EMPTY AND THEREAFTER KEPT ON FILE FOR 90 DAYS".

History Note: *Authority G.S. 113-134; 113-168.5; 113-169.2; 113-182; 113-221; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. July 1, 1993;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2003.

15A NCAC 03K .0102 PROHIBITED RAKES

It is unlawful to use a rake more than 12 inches wide or weighing more than six pounds to take oysters or scallops.

History Note: *Authority G.S. 113-134; 113-182; 143B-289.52;*
Eff. January 1, 1991.

15A NCAC 03K .0103 SHELLFISH OR SEED MANAGEMENT AREAS

(a) The Fisheries Director may, by proclamation, designate Shellfish Management Areas which meet any of the following criteria. The area has:

(1) Conditions of bottom type, salinity, currents, cover or cultch necessary for shellfish growth;

(2) Shellfish populations or shellfish enhancement projects which may produce commercial quantities of shellfish at ten bushels or more per acre;

(3) Shellfish populations or shellfish enhancement projects which may produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas.

(b) It is unlawful to use a trawl net, long haul seine, or swipe net in any designated Shellfish or Seed Management area. These areas shall be marked with signs or buoys. Unmarked and undesignated tributaries shall be the same designation as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the designation of any such body of water or portion thereof, nor shall any such unauthorized removal or relocation or the absence of any marker affect the applicability of any rule pertaining to any such body of water or portion thereof.

(c) It is unlawful to take oysters or clams from any Shellfish Management Area which has been closed and posted, except that the Fisheries Director may, by proclamation, open specific areas to allow the taking of oysters or clams and may designate time, place, character, or dimensions of any method or equipment that may be employed.

(d) It is unlawful to take oysters from Seed Management Areas for planting on shellfish leases or franchises without first obtaining a Permit to Transplant Oysters from Seed Management Areas from the Fisheries Director. The procedures and requirements for obtaining permits are found in 15A NCAC 03O .0500.

History Note: *Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. March 1, 1994;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2003.

15A NCAC 03K .0105 HARVEST OF CRABS AND SHELLFISH

(a) It is unlawful for individuals who harvest blue crabs for a recreational purpose to possess more than 50 blue crabs per person per day not to exceed 100 blue crabs per vessel per day.

(b) It is unlawful to exceed the daily vessel limits specified in G.S. 113-169.2 without each person having ready at hand a valid standard or retired standard commercial fishing license with shellfish endorsement or a shellfish license.

(c) It is unlawful to take oysters or clams on Sundays and scallops on Saturdays and Sundays except:

(1) during open seasons, and

(2) in accordance with limits outlined in G.S. 113-169.2.

History Note: *Filed as a Temporary Amendment Eff. October 9, 1995 for a period of 180 days or until the permanent rule becomes effective, whichever is sooner;*
Authority G.S. 113-134; 113-169.2; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. May 1, 1997; March 1, 1996; March 1, 1994; February 1, 1992; September 1, 1991;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000.

15A NCAC 03K .0304 PROHIBITED TAKING

(a) It is unlawful to take clams by any method, other than by hand tongs, hand rakes, or by hand, except as provided in 15A NCAC 3K .0302 and .0303. Regardless of the areas which may be opened, it is unlawful to take clams by any method:

(1) other than hand tongs, hand rakes as described in 15A NCAC 3K .0102, or by hand in any live oyster bed, or

(2) by hand rakes as described in 15A NCAC 3K .0102, or by hand in any established bed of submerged aquatic vegetation as defined in 15A NCAC 3I .0101 or salt water cordgrass (Spartina alterniflora) that may exist together or separately.

(b) It is unlawful to possess clam trawls or cages aboard a vessel at any time, or have kick/deflector plates normally used in the mechanical harvest of clams affixed to a vessel at any time, except during the time period specified for a mechanical clam harvest season in internal waters in accordance with 15A NCAC 3K .0302(a). A period of 14 days before and after the season as specified will be allowed for the installation and removal of kick/deflector plates and clam trawls or cages. Vessels with permits for activities provided for in 15A NCAC 3K .0104, .0107, .0303(a), and .0401 shall be exempt from this Rule during the times such activities are permitted.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. May 1, 1997; July 1, 1993.

SECTION .0500 – SCALLOPS

15A NCAC 03K .0501 BAY SCALLOPS - SEASONS AND HARVEST LIMITS

(a) The Fisheries Director may, by proclamation, specify open seasons for the taking of bay scallops during the following periods:

(1) During the month of December for a total of not more than four days;

(2) Between the second Monday in January and the last Friday in May; and

(3) Between August 1 and September 15 by hand harvest methods only as described by proclamation.

(b) The Fisheries Director may impose any or all of the following restrictions during any open season specified:

(1) Specify number of days;

(2) Specify areas;

(3) Specify means and methods which may be employed in the taking;

(4) Specify time period; and

(5) Limit the quantity.

(c) For any season provided from December through May, it is unlawful to take more than 20 standard U.S. bushels per person per day or to exceed a total of 40 standard U.S. bushels per day in any combined fishing operation.

(d) For any season provided from August 1 through September 15, it is unlawful to take more than ten standard U.S. bushels per person per day or exceed a total of 20 standard U.S. bushels per day in any combined fishing operation.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991.

15A NCAC 03K .0502 TAKING BAY SCALLOPS AT NIGHT AND ON WEEKENDS

It is unlawful to take bay scallops between sunset and sunrise, or on Saturdays or Sundays, except as provided in 15A NCAC 3K .0105.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;Eff. January 1, 1991;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000.

15A NCAC 03K .0503 PROHIBITED BAY SCALLOP DREDGE

It is unlawful to take bay scallops with dredges weighing more than 50 pounds or equipped with teeth. Any other instrument or device designed to drag the bottom to aid in the taking of bay scallops is also prohibited.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991.

15A NCAC 03K .0506 SOAKED OR SWELLED BAY SCALLOPS PROHIBITED
It is unlawful to possess, sell, or take part in the production of soaked or swelled bay scallops that have been shucked. It is unlawful to permit bay scallops to be placed in still or standing water.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. July 1, 1993

5.0 STATUS OF THE STOCK

5.1 LIFE HISTORY

5.1.1 DISTRIBUTION

In the United States the bay scallop (*Argopecten irradians*) (Lamarck, 1819) ranges from the north shore of Cape Cod, Massachusetts south to Laguna Madre, Texas. Three subspecies are recognized within the range: *A. irradians irradians* (Lamarck, 1819) extending from Cape Cod to New Jersey, *A. irradians concentricus* (Say, 1822) from New Jersey to the Chandeluer islands in the Gulf of Mexico, and *A. irradians amplicostatus* (Dall, 1898) from Galveston, Texas to Laguna Madre, Texas (Fay et al. 1983). Recent studies indicate that there may be distinct morphological differences within the subspecies and the North Carolina *concentricus* subspecies may be distinct from the *concentricus* subspecies found in Florida (A. Wilbur, UNCW, personal communication 2005) (Wilbur and Gaffney 1997). In North Carolina bay scallops are associated with seagrass beds in localized areas of Bogue, Back, and Core Sounds with periodical expansions into Pamlico Sound along Ocracoke and Hatteras islands and the lower portion of New River (Figure 5.1).

5.1.2 HABITAT TOLERANCES AND PREFERENCE

More detailed habitat and water quality information is available in Section 8.0: Environmental Factors. Bay scallops are found almost exclusively in estuarine waters of North Carolina. They are found in the sounds in shallow water flats which are exposed or nearly exposed at low water to depths usually no more than 6 feet (Gutsell 1930). Since bay scallops are found in estuarine environments, they are able to tolerate exposure to low salinity for varying lengths of time depending on temperature (Mercaldo and Rhodes 1982). They prefer higher salinities but have been found in areas where salinities are as low as 10 parts per thousand (ppt) (Gutsell 1930). Bay scallops can endure freshwater longer in cold water (1 ^{o}C) than in warmer water (Sastry 1961; Duggan 1975; Mercaldo and Rhodes 1982). Long-term exposure to low salinities will increase mortality and may explain why bay scallops are not found in estuaries where heavy freshwater runoff exists.

Bay scallops can tolerate temperatures as low as -4 ^{o}C (Sastry 1961). Often temperature-induced mortalities are a result of exposure during a combination of abnormally low tides and periods of extreme cold (Gutsell 1930; Spitsbergen 1979).

Appropriate substrates for settlement, attachment, and feeding are crucial for bay scallop survival. Bay scallops are associated with SAV because the grass provides an above-sediment surface for the attachment of spat to grow for a short period before dropping to the bottom (Gutsell 1930; Thayer and Stuart 1974; Fay et al. 1983). Soft mud and silt can be harmful to settling juveniles if they do not attach directly to seagrass (Castagna 1975; Fay et al. 1983). Adult bay scallops are found in mud, hard sand bottoms, and SAV (Gutsell 1930; Castagna 1975).

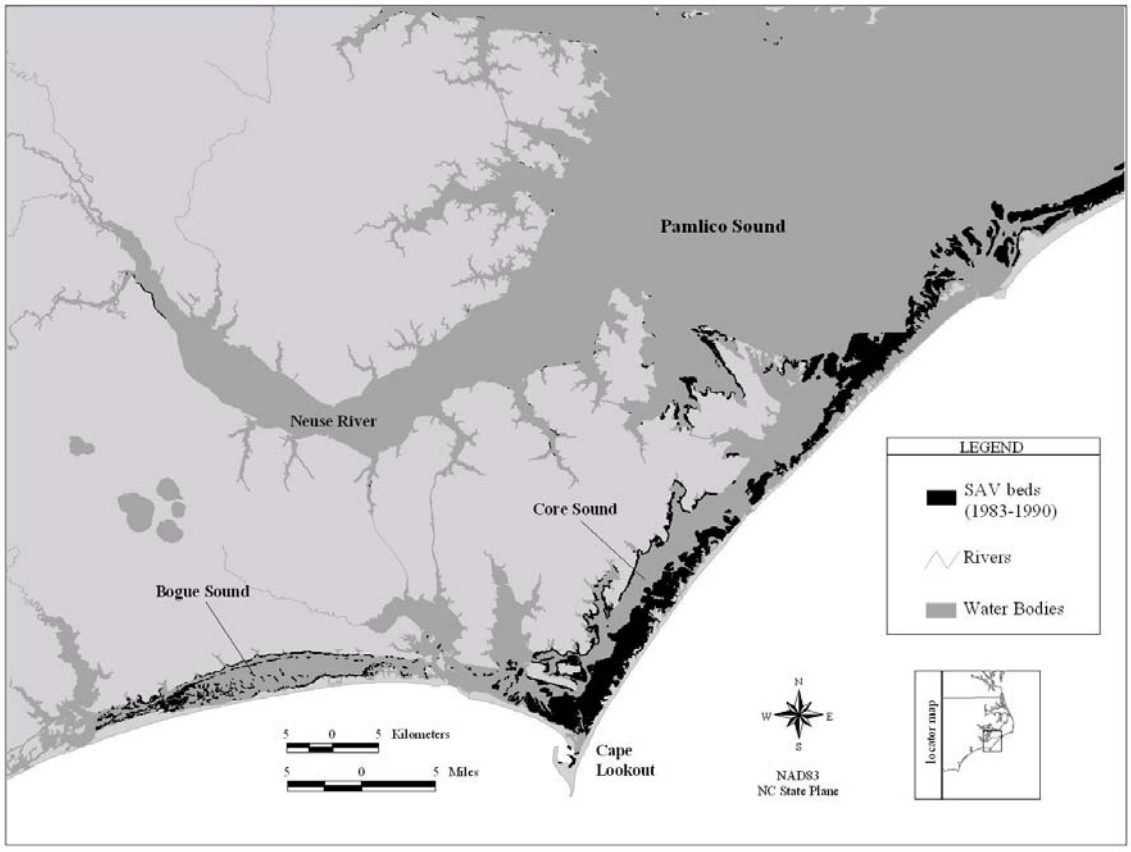


Figure 5.1. Location of known SAV habitat in Bogue, Core, and southern Pamlico sounds (Ferguson and Wood 1994; Carraway and Priddy 1983). Note: Absence of SAV beds in a given area does not suggest actual presence/absence of SAV because surveys have not been conducted in all areas. DMF GIS database.

5.1.3 FOOD AND FEEDING

The primary food of bay scallops is benthic diatoms (Davis and Marshall 1961). In aquaculture, successful larval growth occurs using a combination of marine flagellates,

diatoms, and green algae (Castagna 1975; Fay et al. 1983). Bay scallops are filter feeders that pump water through the mantle cavity and strain food matter on the gill cilia (Figure 5.2). Rate and duration of feeding is dependent on food particle densities (Kirby-Smith 1970). The filtration rate depends on body size, and the normal feeding position of adults is resting on the bottom on the right valve with an open shell (Fay et al. 1983). Water movement is from front (anterior) to back (posterior). When a scallop lands on the left valve it will flip itself over using its foot and expelling water (Fay et al. 1983). In coarse sand substrate, bay scallops have been found burrowed with the left valve exposed in the water to feed.

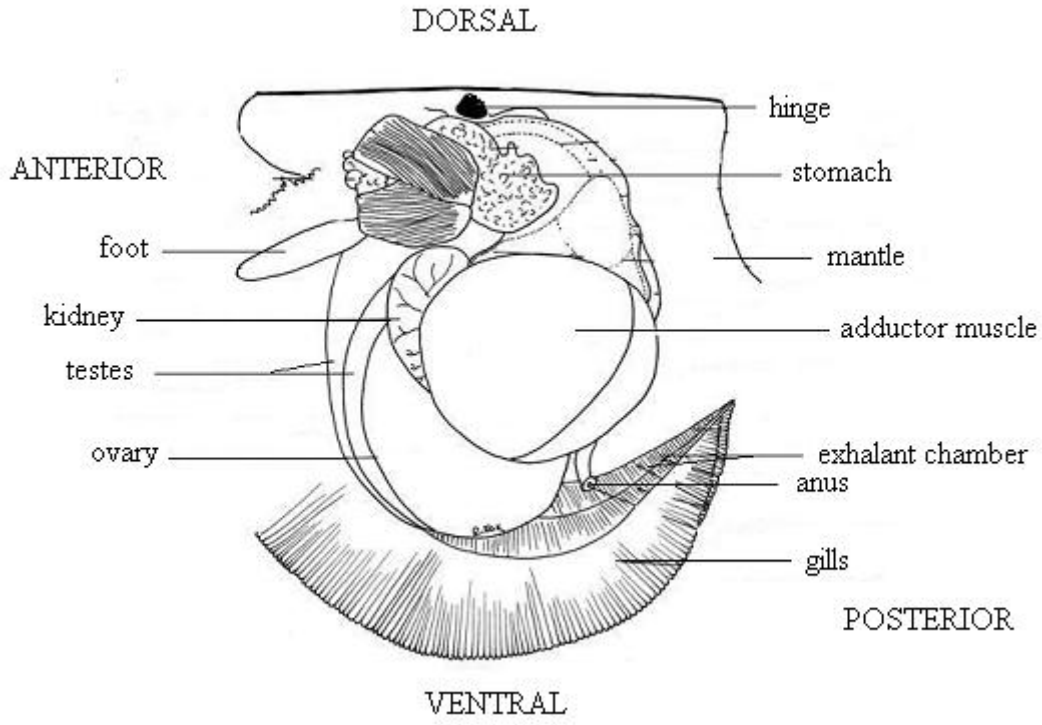


Figure 5.2. The left side of *Argopecten irradians*. The left valve, mantle skirt, and gill have been removed to reveal the organs underneath (Fox 2004).

5.1.4 REPRODUCTIVE BIOLOGY

The bay scallop is a hermaphroditic (containing both testes and ovaries when mature) bivalve. Only one type of sex product is given off at any one time, probably to prevent self-fertilization (Brousseau 2005). The short lifespan of the bay scallop (1-2 years) usually limits spawning to only once in their lifetime. There are considerable differences in the timing of the spawning season for bay scallops along its range (Gutsell 1930; Sastry 1966; Spitsbergen 1979). Variation in the timing may be an adaptive response to differences in water temperature and the timing of the maximum food availability (Sastry 1963; Sastry 1970). Spawning tends to occur later in the year in the more southerly populations (Sastry 1966; Barber and Blake 1985; Peterson et al. 1989; Brousseau 2005). Spawning in North Carolina occurs primarily in the fall during

decreasing water temperature. However, observations have determined that gonadal development also occurs in the spring (Gutsell 1930; Sastry 1966; Kirby-Smith 1970; Spitsbergen 1979) (Figure 5.3).

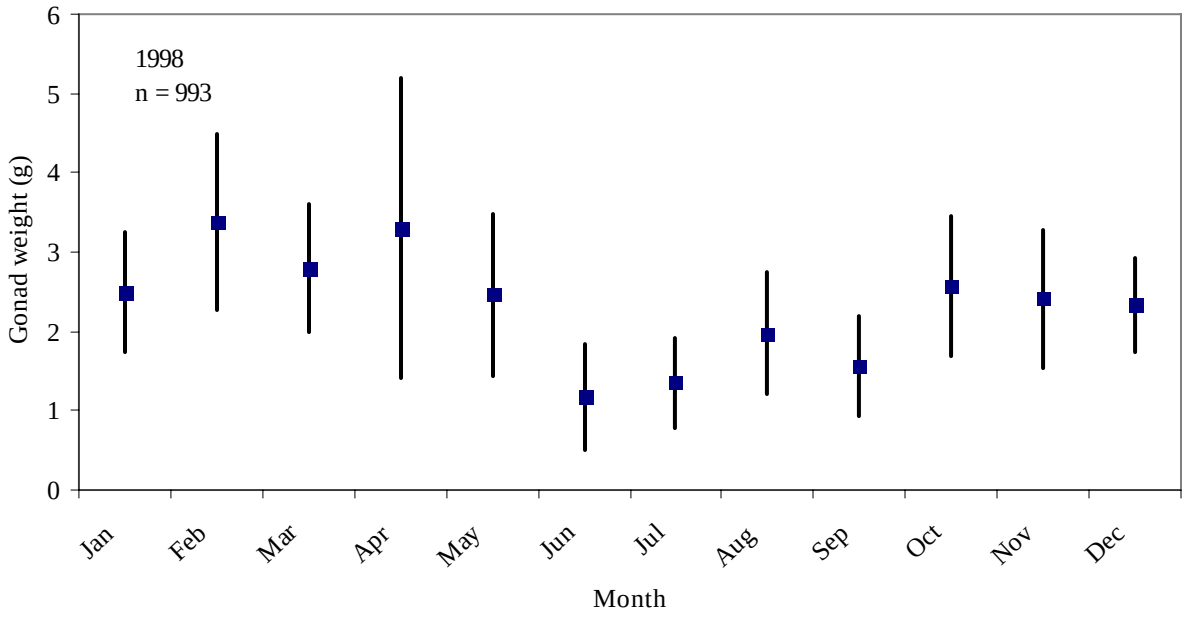


Figure 5.3. Average monthly bay scallop gonad weight (g)(wet) in 1998 with one standard deviation from the mean. DMF biological sampling.

Fertilization occurs in the water column and fertilized eggs settle to the bottom (Gutsell 1930; Sastry 1965) (Figure 5.4). Bay scallops have a multitude of free-swimming larval stages before developing into a juvenile. This section will only discuss two generalized larval stages that undergo many changes during growth and development. It takes approximately one to two days for the fertilized eggs to develop into free-swimming trochophore larvae. The trochophore larvae stage develops into the veliger larvae stage quickly where the first appearance of a shell occurs. The veliger stage is usually reached within 2-3 days after initial fertilization (Gutsell 1930; Sastry 1965). The veliger stage lasts approximately ten days during which development of most of the internal organs occurs, the foot becomes fully developed, and gills are present. Once the foot has developed, the behavior of the larvae begins to change (Figure 5.4). The veliger larvae alternately swim and rest on the bottom. The foot has a gland that secretes the byssus, or thread, needed for the attachment period in their development. Total time between egg fertilization and settlement is about 14-20 days (Gutsell 1930; Sastry 1965; Fay 1983).

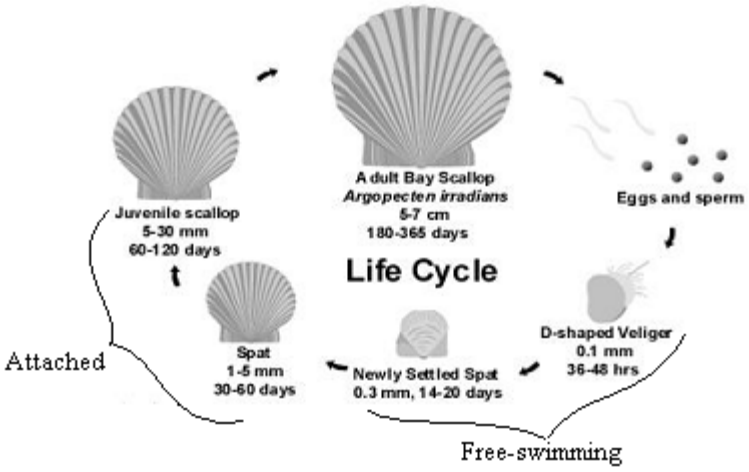


Figure 5.4. Life cycle of the bay scallop (*Argopecten irradians*). (From: Florida Fish and Wildlife Commission. Fish and Wildlife Research Institute. http://research.myfwc.com/features)

Juvenile bay scallops prefer to be suspended off the bottom during the attached stage in their development (Fay 1983) (Figure 5.4). Young scallops cannot tolerate highly silted substrates, and attachment to epibenthic surfaces it may improve survival (Castagna 1975). It has been noted in North Carolina that only larvae settling on relatively stable eelgrass beds appear to form a reproductively significant population. However, juveniles use a variety of substrates for attachment and are not solely dependent on submerged vegetation (Gutsell 1930; Kirby-Smith 1970; Thayer and Stuart 1974). Young scallops grow faster in slow currents. Since seagrass beds tend to slow normal water currents, their preference for these beds may be due to the slower currents (Kirby-Smith 1972; Castagna 1975). Periodic losses of seagrass beds from disease have impacted bay scallop populations (Brousseau 2005). Juveniles remain attached until they grow to 20-30 mm and then drop to the bottom (Figure 5.4). Juveniles on the bottom crawl using the foot, byssal thread, and tentacles until they develop the ability to swim. Juvenile bay scallops (< 50 mm shell height; based on Spitsbergen 1977 and 1979) were present year-round in DMF sampling (Figure 5.5). Juveniles were most abundant from May to July with peak abundance in June.

The adult stage is characterized by the radial furrows and ridges on the shell. Another distinguishing characteristic of adults is a concentric ridge on the shell caused from slow growth in the winter months. This is analogous to an annulus on a fish scale (Fay 1983). Adults retain the ability to use byssal threads for attachment but are seldom seen attached as an adult (Castagna 1975; Peters 1978). Adults are effective swimmers at all sizes, and they "swim" by pulsed expulsion of water through the mantle cavity to move from unfavorable environmental conditions and predators (Figure 5.2) (Castagna 1975; Fay 1983). Adults reach 50% maturity by July when the gonad weight begins to increase for the spawning period (Figures 5.3 and 5.5).

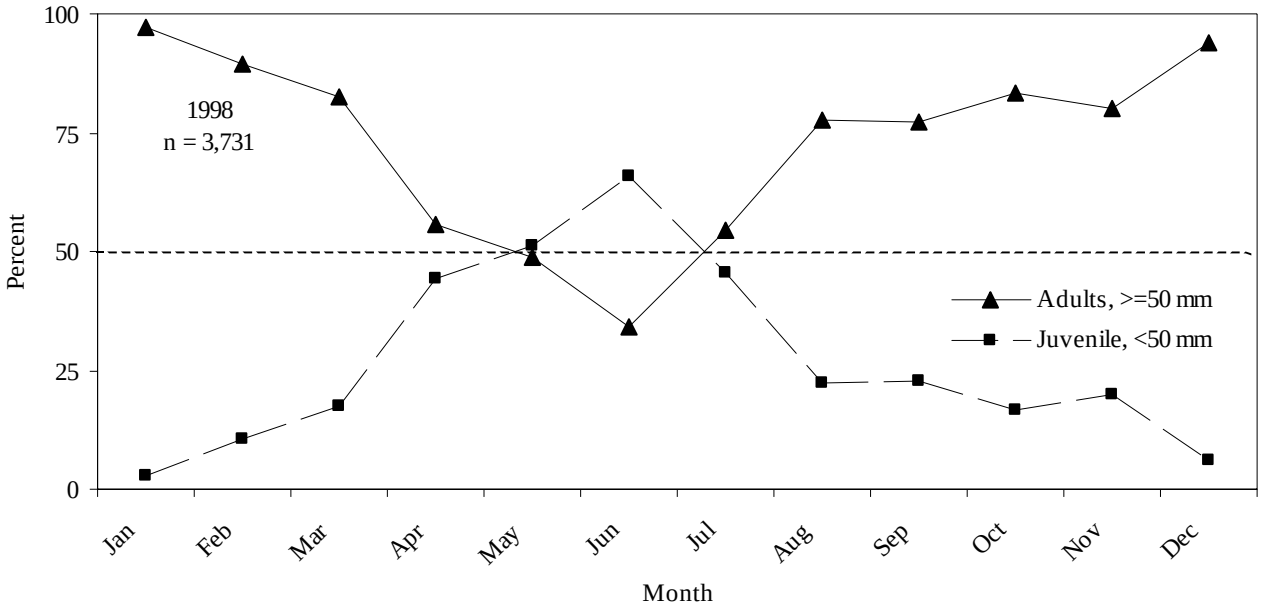


Figure 5.5. Percentage of juvenile (<50 mm shell height) and adult (≥ 50 mm) bay scallops by month in 1998. Dashed line indicates 50% maturity for adults. DMF biological sampling.

5.1.5 AGE AND GROWTH

The average lifespan of bay scallops range from 12 to 24 months in waters south of Maryland. North of Maryland the average lifespan is longer ranging from 20 to 26 months (Sastry 1961; Castagna 1975; Fay 1983). The maximum lifespan in North Carolina was determined to be 14 to 18 months (Gutsell 1930). Adult bay scallops experience a period of mass mortality during their second winter, and it has been estimated that only about 20% reach two years of age (Fay 1983).

Growth rates of bay scallops depend on water temperature, current velocity, food abundance, and sometimes scallop density (Fay 1983). Growth accelerates in April with the onset of warmer water temperatures. By August, 75% of the year class is greater than 50 mm in height by August (Figure 5.5) (Spitsbergen 1977; Spitsbergen 1979). Shell growth slows from September through the spring with very limited growth from September through November (Figure 5.6) (Kirby-Smith 1970; Spitsbergen 1979).

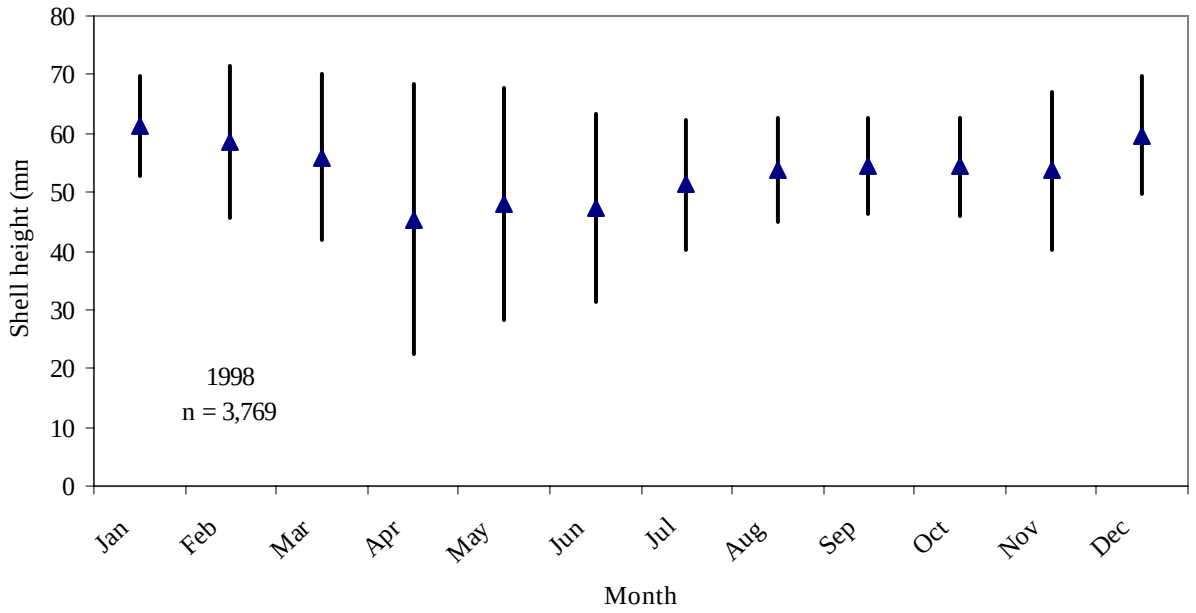


Figure 5.6. Average monthly bay scallop shell height (mm) in 1998 with one standard deviation from the mean. DMF biological sampling.

5.1.6 PREDATORS AND DISEASE

See the issue paper (Section 9.3) on predators affecting bay scallops for more specific information. Bay scallops are vulnerable to a wide range of predators due to their thin shells, epifaunal habit, and inability to maintain prolonged valve closure (Fay et al. 1983). Herring and ring-billed gulls (*Larus argentatus* and *L. delawarensis*), blue crabs (*Callinectes sapidus*), knobbed whelks (*Busycon carica*), starfish (*Asterias* sp. and *Merthasterias* sp.), and cownose rays (*Rhinoptera bonasus*) are common predators of the bay scallop (Gutsell 1930; Kent 1981; Smith and Merriner 1985; Peterson et al. 1989; Prescott 1990; and Peterson et al. 2001).

The occurrence of unusual algal blooms known as “brown tides” have been linked to recruitment failure of bay scallops in northern states (Wanziak et al. 2004; Brousseau 2005). An outbreak of the red tide dinoflagellate, *Karenia brevis*, from October 1987 to February 1988 in North Carolina severely impacted harvest levels for several years after the event (Summerson and Peterson 1990).

Parasitism by the pea crab, *Pinnotheres maculates*, has been documented in bay scallops (Kruczynski 1972; Pearse 1997; Bologna and Heck 2000). Infestation by pea crab can stunt growth and reduce the meat weight of a bay scallop (Kruczynski 1972; Pearse 1997). It can also cause erosion of the gills and mantle or deformity of the shell, which can reduce the ability to feed. Bologna and Heck (2000) found that the gonad indices of infested bay scallops in Florida were significantly lower than uninfested scallops, suggesting an impact on reproductive potential where prevalence is significant. In Florida, prevalence of pea crab infestation ranged from 0 to 20%. In a study in Bogue Sound, incidence of pea crab infestation ranged from 48% in fall to 10% in summer

(Kruczynski 1972). *Polydora* is a parasitic polychaete of bay scallops that causes shell deformities (Rhodes 1991).

Diseases in bay scallops have been documented in relation to aquaculture operations. Karlsson (1993) compiled a review of diseases and parasites reported in bay scallops in Rhode Island. Morrison and Shum (1982) reported a *Chlamydia*-like organism in the digestive diverticula of bay scallops in Canada. In China, over 50% of cultured bay scallops from Quingdao, Shangdong Providence died due to mantle erosion disease (Ren et al. 2004). A virus and *Chlamydia*-like organism that were observed were correlated with the disease. No information on diseases in bay scallops in North Carolina was available.

5.2 PRESENT STOCK STATUS

5.2.1 INTRODUCTION

The bay scallop population in North Carolina was decimated by a red tide event (*K. brevis*) in October of 1987. During that time the bay scallop fishery decreased to less than 15% of the historical average (1965-1986) with the largest losses occurring in Bogue Sound, followed by Back Sound and Core Sound. Slow recovery from this decline suggests that bay scallops in North Carolina are recruitment limited within the different water basins (Peterson and Summerson 1992). Recently, bay scallop populations in both Core Sound and Bogue Sound have become virtually non-existent because of heavy predation by cownose rays (*R. bonasus*) in the fall, (Powers and Gaskill in press). Commercial landings were below 150 pounds in 2004.

North Carolina's bay scallop stocks are listed as a species of concern because of the population declines. Species are designated by DMF as concern because of incomplete or unavailable stock assessments, or are of concern due to outside influences such as disease, habitat degradation, weather, or the nature of the fishery (roe fisheries). Annual commercial landings of bay scallops show large fluctuations through time and are presumed to be driven by changing climate conditions (i.e., winter freezes, high freshwater runoff), predation, and red tide. Therefore, bay scallops are vulnerable to overharvest because of these different factors affecting their survival.

5.2.2 STOCK STATUS INDICATORS

Bay scallops are considered an annual crop because of their short life span. Their populations are more affected by environmental conditions such as temperatures, salinities, predation, and habitat and water quality. Although fishing does reduce the population size over a fishing season, fishing would not normally reduce year class strength for the following year unless the spawning stock has been reduced below some minimum threshold. In the case of bay scallops, high natural mortality from red tide, hurricanes, and cownose ray predation has most likely occurred since the 1980s, resulting in a reduced spawning stock. It is during this time that spawning stock may be reduced

below amounts needed to sustain the stock. High natural mortality also seems to occur during the fall (October-December) and coincides with fall spawning of bay scallops.

Independent data have been collected by the DMF since 1984 and consistently collected since 1998 to evaluate recruitment into the population and recruitment into the fishery for the current fishing season. Commercial landings data are the only fishery-dependent data collected and have been recorded since the 1880s. Trip level information for commercial landings has been collected since 1994. There are no recreational harvest estimates available. Other data exists from research conducted by scientists at the University of North Carolina-Institute of Marine Science. Independent data taken during July captures population information from scallops spawned during the previous fall before the arrival of cownose rays in the following fall. Data taken in November captures population information after ray predation but before the fishing season opens. This information is used to estimate abundance before the fishing season begins.

Analyses of these data have demonstrated some trends between DMF independent data when comparing November data with landings from the following year. The long term landings data (1972-present) most likely reflect population abundance to some extent because the fishery is prosecuted until scallop densities reach levels below those that make the fishing economically viable (Peterson and Summerson 1992) (Figure 6.3). Correlation analysis of Bogue Sound (r^2=0.6707, p=0.046) shows a good relationship between fishery-independent CPUE data collected in November and commercial landings data (Figure 5.7). However the relationship in Core Sound (r^2=0.5175, p=0.107) is less clear and may be confounded by both the short timeframe of the data and the low harvest levels in recent years (Figure 5.7). Both data sets indicate that bay scallop populations are in a very vulnerable condition.

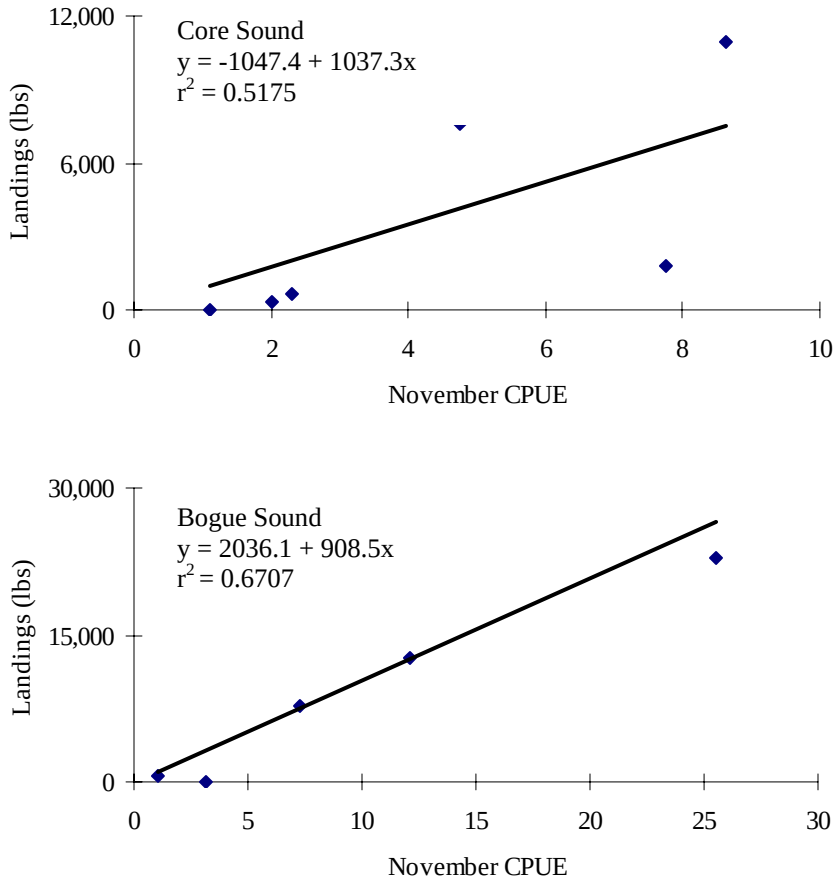


Figure 5.7 Correlation between commercial landings data and fishery-independent data in Core Sound and Bogue Sound (1998-2004). DMF biological sampling and DMF Trip Ticket Program.

Every effort should be made to evaluate the costs and benefits associated with available data collection methods, and a method should be chosen that allows adequate evaluation and management of the stock. Despite how we collect and analyze bay scallop data, an important issue that needs to be considered is stock identification. A stock, for assessment and management purposes, consists of a population of a single species for which population processes (recruitment, survival, etc.) are independent of processes from other populations. If multiple unit stocks are ignored, there is the risk of over- or under-harvesting in regions where conditions differ from the statewide trend.

There may be several discrete populations of bay scallops in North Carolina waters. Recent mitochondrial DNA data show small but significant genetic differences among bay scallops found in Topsail, Bogue, Back, and Pamlico sounds (P. Marko, Clemson University, personal communication 2005). Although gene flow is great enough to prevent big genetic differences, there is not enough larval dispersal to provide connectivity between these sounds. In other words, if scallops were lost in one sound, it would take some time to recolonize that sound because of low larval exchange. Because

of this low connectivity between sounds, bay scallop populations may need to be considered separate units from an ecological and management point of view (P. Marko, Clemson University, personal communication 2005).

5.2.3 RESEARCH RECOMMENDATIONS

Data collection needs to be improved in order to be more proactive in making management decisions or setting a management trigger for these sensitive species. Increased sampling in the early fall prior to population declines should be implemented along with better methods to quantify these declines. Other data that are valuable to collect in order to make better management decisions include larval recruitment information, spat settlement information, and cownose ray monitoring. Genetic information to determine conclusively how many separate stocks exist in North Carolina would also benefit the management of bay scallops.

6.0 STATUS OF THE FISHERIES

6.1 COMMERCIAL FISHERY

6.1.1 HISTORICAL FISHERY

The bay scallop has been an important food source in the central coastal area of North Carolina since the prehistoric natives consumed them and threw the empty shells on kitchen middens. When settlers came into coastal North Carolina, they too began to eat them (Gutsell 1928).

Other than local consumption and peddling, the commercial bay scallop industry did not really begin until the years immediately following the Civil War. Prior to that, bay scallops were gathered in the summer by rake and by hand from the shoals around Beaufort, NC, shucked, and peddled to hotels and restaurants catering to the growing tourist industry. In the 1870s, Connecticut native George Ives came to NC and began shiping of scallops from Beaufort and Morehead City to New Bern by rail. He bought scallops by the bushel and paid to have them opened. Shipments were made to New York, Philadelphia and other northern markets with very few shipped to other parts of the state. These shipments amounted to several thousand gallons in 1876-77 and then stopped abruptly due to the destruction of the scallops and scallop grounds by the "August storm" of 1879 (Chestnut 1951).

In the 1880s, J.H. Potter of Beaufort began sending shipments of scallops in iced-down barrels to New York only when it was profitable to do so. This continued into the early 1900s and increased considerably around 1913. Large quantities of scallops were taken from Bogue Sound, Harkers Island, the mouth of Newport River, and other nearby areas in the winter months and shipped daily from Morehead City and Beaufort. Despite a hard freeze in the winter of 1917-18, tax records indicate that over 54,000 gallons of scallop meats were shipped during that season. Prices ranged from $2.25 to $4.82 per

gallon and there were 612 licensed scallop fishermen. This period marked the beginning of the modern bay scallop industry in North Carolina (Gutsell 1928).

The principle scallop grounds were Bogue and Core sounds, but occasionally, scallops were found at Hatteras and Ocracoke to the north, and in New River to the south. Fishermen waded on shoals and harvested the scallops by hand using a six-tined hand rake called a "potato or a peanut digger" with a wire basket fitted to retain the shellfish. Scoop nets were reported as a harvesting gear as early as 1897. A scoop is a wire ring about six inches in diameter with a mesh bag sewn onto it and attached to a wooden handle. Scallops are sighted on the bottom and "scooped up" until the bag is filled and then dumped into the boat or tub.

Fishermen also towed dredges with boats ranging in length from 18 to 35 feet. These dredges or "drags" were small toothless dredges about three feet wide with a twine bag that had holes in the upper part of it to allow sea grass to pass through. Dredges were attached to poles fastened across the gunwales of the boat and most vessels pulled four dredges at a time. Core Sound dredgers fastened the pole forward in the boat and towed the dredges even with the stern while Bogue Sound dredgers placed the pole well aft and towed the dredges well astern of the boat. The boats used in the scallop fishery were also used in crabbing and in other fishing ventures (Gutsell 1928).

The fishermen often shucked the scallops themselves with the help of family members. This was done at their homes or in specially constructed shucking houses built over the water. Dealers also provided shucking for a price. The adductor muscle (meat) was separated from the shells and viscera and placed in gallon containers. The shells and viscera were discarded, unless the viscera was used for fertilizer. Scallops harvested from Bogue and Core sounds were originally taken by boat to Morehead City and Beaufort, where almost all of the dealers were. Improvement in "Downeast" roads made shipment by truck possible in the 1920s and dealers established themselves in places like Marshallberg and Atlantic to purchase bay scallops. Nearly all shipments of North Carolina scallops were sent to New York and other northern cities (Gutsell 1928).

Regulation of the bay scallop industry began in 1915. In that year, the Shellfish Commission (which had originated in 1891) and the Fish Commission (which dated from the 1870s) were combined to form the North Carolina Fisheries Commission (Thorsen 1982). A scallop dealer's license fee of $5.00, an individual scallop fisherman's fee of $1.00, and a dealer's tax of ten cents per gallon of meats were enacted in 1917. The laws passed by the Fisheries Commission concerning bay scallops in the 1915-1918 period included a minimum shell size of 2 inches from the hinge to the mouth, a closed scallop season from April 15 through December 15 to allow for spawning, the prohibition of steam powered vessels in the harvest of scallops and the prohibition of tongs in the "raking only" areas of the scallop grounds. The soaking or "swelling" of scallops in water to increase the weight of the individual meats was prohibited and the number of dredges allowed per boat was restricted. Area closures began in 1919 with dredges prohibited from Spooners Creek in Bogue Sound to the east end of Carrot Island in Beaufort. From 1922-24, an additional two weeks in December was added to the closed

season. Seasons generally opened in January and closed in April. Harvest of scallops for local consumption was allowed year-round (Gutsell 1928).

During the 1980s at the peak of the calico scallop fishery on the east coast of Florida, Mr. Bill Lambert patented a mechanical shucking machine to shuck calico scallops. Four shucking machines were set up in North Carolina; one in Salter Path, one in Broad Creek, one on Highway 58 north of Cape Carteret, and one in Sneads Ferry. These machines primarily shucked calico scallops shipped from Florida in trucks, but also engaged in bay scallop shucking when they were present in sufficient quantities to operate them profitably.

The presence of the mechanical shucking machines in North Carolina influenced the bay scallop prices and harvest limits during the seasons. When bay scallops were plentiful, the mechanical shucking facilities could profitably start up and would buy bay scallops by the bushel at a reduced price. This was in direct competition with the hand shucking operations, which desired a level of volume that would provide the highest price. Many fishermen would urge the Division to set harvest limits each season just below those which would enable the mechanical shucking machines to operate profitably.

Bay scallop abundance and harvest have widely fluctuated since the 1930s. Landings have ranged from a peak at approximately 1,400,000 pounds of meats in 1928 when North Carolina led the nation in scallop production, to a low of less than 150 pounds in 2004 (Figure 6.1). Landings are closely linked to weather and other environmental events.

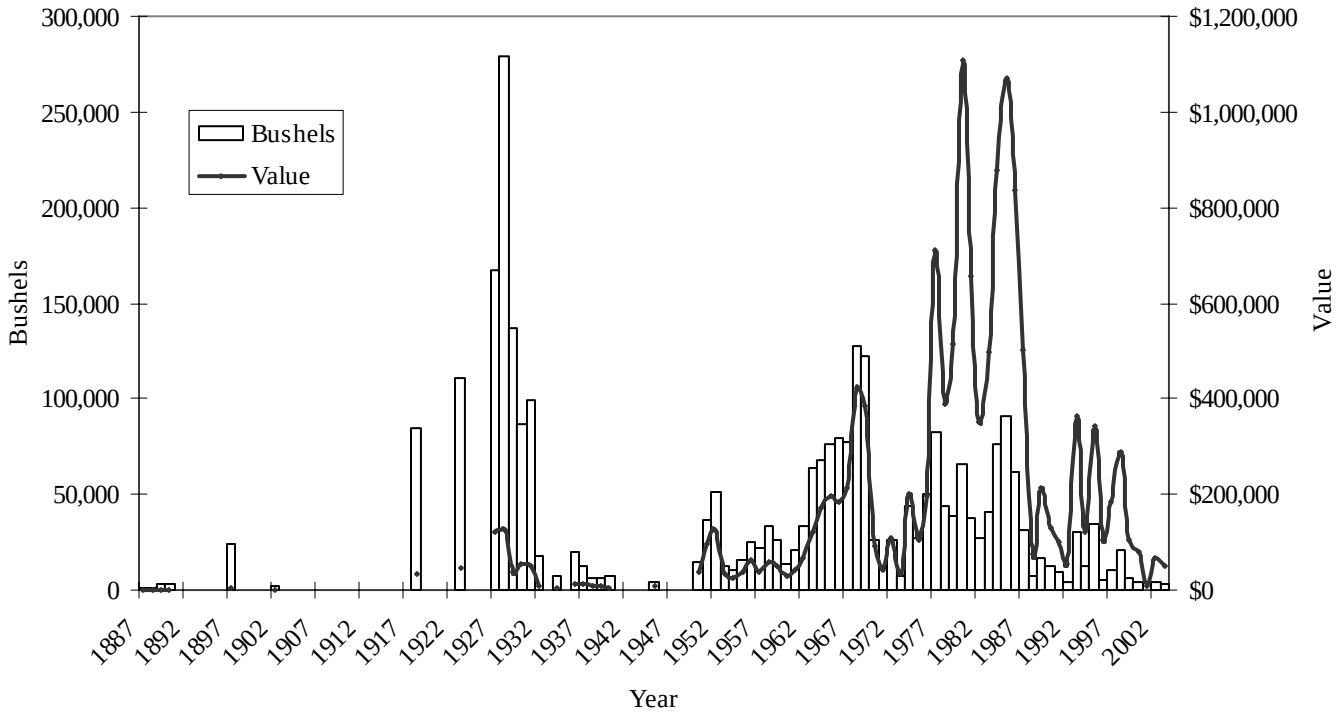


Figure 6.1. Bay scallop historical landings (bushels) and value, 1897-2003. DMF Trip Ticket Program.

Bay scallops are very susceptible to hurricanes because of freshwater runoff, direct physical damage and habitat loss. Hard freezes kill scallops in shallow, tidal waters. The loss of SAVs is detrimental to juveniles since they are dependent on their leaves to provide support. In the 1930s, the majority of the eel grass in North Carolina was killed by wasting disease (*Labyrinthula macrocystis*) and it took until the 1960s for the scallop populations to rebound to pre-1930s levels (Thayer and Stuart 1974; Thayer et al. 1984).

The red tide (toxic dinoflagellate) event of late autumn 1987 and early 1988 caused mortality to approximately 21% of the adult scallops in Bogue and Back sounds and reduced recruitment of juvenile scallops the following spring to only 2% of normal (the mean of the previous three red tide-free years) (Summerson and Peterson 1990). This event has had lasting impacts to the bay scallop fishery and repopulation of the Bogue, Back and Core sound region has not fully occurred. Landings in recent years have been extremely low because of the failure of scallop stocks to recover after the red tide, fishing pressure, and a possible increase in cownose ray predation.

Since the bay scallop fishery is confined mainly to Carteret County waters and occurs in the winter months when few other fisheries exist, fluctuations in abundance are felt keenly by the local fishermen. Throughout the 1970s and 1980s, fishermen in Carteret County depended on bay scallops to buy Christmas presents and pay bills during December and January when finfishing and shrimp trawling was over. That income can no longer be relied upon. While fluctuation in the abundance of bay scallops has been is

common over the past century with long periods of recovery following natural events, the last decade has seen some of the lowest landings on record.

6.1.2 PRESENT FISHERY

6.1.2.1 COLLECTION OF COMMERCIAL STATISTICS

Annual North Carolina landings data were collected by the Division of Commercial Fisheries (U.S. Fish and Wildlife Service, Department of the Interior) from 1880 to 1974 (Chestnut and Davis 1975). The National Marine Fisheries Service (NMFS) standardized the collection methods of landings statistics for U.S. south Atlantic fishery species in 1972. Landings were collected monthly from major seafood dealers, although reporting was not mandatory. The DMF and NMFS began a cooperative commercial fishery data collection program in 1978, maintaining the same methodology established in 1972. However, DMF assumed the primary role of data collection for the state and further improved data collection coverage with additional staff. Under-reported landings, however, were a growing concern due to the reliance on voluntary program cooperation from seafood dealers. The rising perception of deteriorating attitudes towards fisheries management by North Carolina fishermen in the late 1980s and early 1990s contributed to the reform of the DMF/NMFS cooperative statistics program (Lupton and Phalen 1996). With the support of the commercial fishing industry, DMF instituted a mandatory, dealer-based, trip-level, reporting system for all commercial species in 1994, that greatly improved reporting compliance. Improved collection methods that began in 1994 should be considered when comparing pre-1994 landings with post-1994 landings.

6.1.2.2 LANDINGS ALONG THE ATLANTIC EAST COAST

Bay scallops have been harvested commercially since colonial times and rank third in the magnitude of catch of the three commercially exploited scallops along the Atlantic east coast, after sea scallops (*Placopecten magellanicus*) and calico scallops (*Argopecten gibbus*) (Fay 1983; NOAA 2005). Fluctuations in commercial annual landings are common along the Atlantic east coast with an abrupt decline beginning in the late1980s (Figure 6.2).

Massachusetts has dominated the Atlantic coast bay scallop landings from 1950 to the mid-1990s with North Carolina ranked third after New York (Table 6.1). Recruitment failure of bay scallops in these states have since impacted landings, making North Carolina the dominant state in recent years (Table 6.1)(Wanziak et al. 2004; Brousseau 2005). In response to decreasing landings, strict regulations have been in effect in most states along the Atlantic coast for over a decade (Appendix 12.2). Virginia initiated a moratorium on bay scallops in February 1999, and Florida's east coast has not been open to bay scallop harvest since 1994.

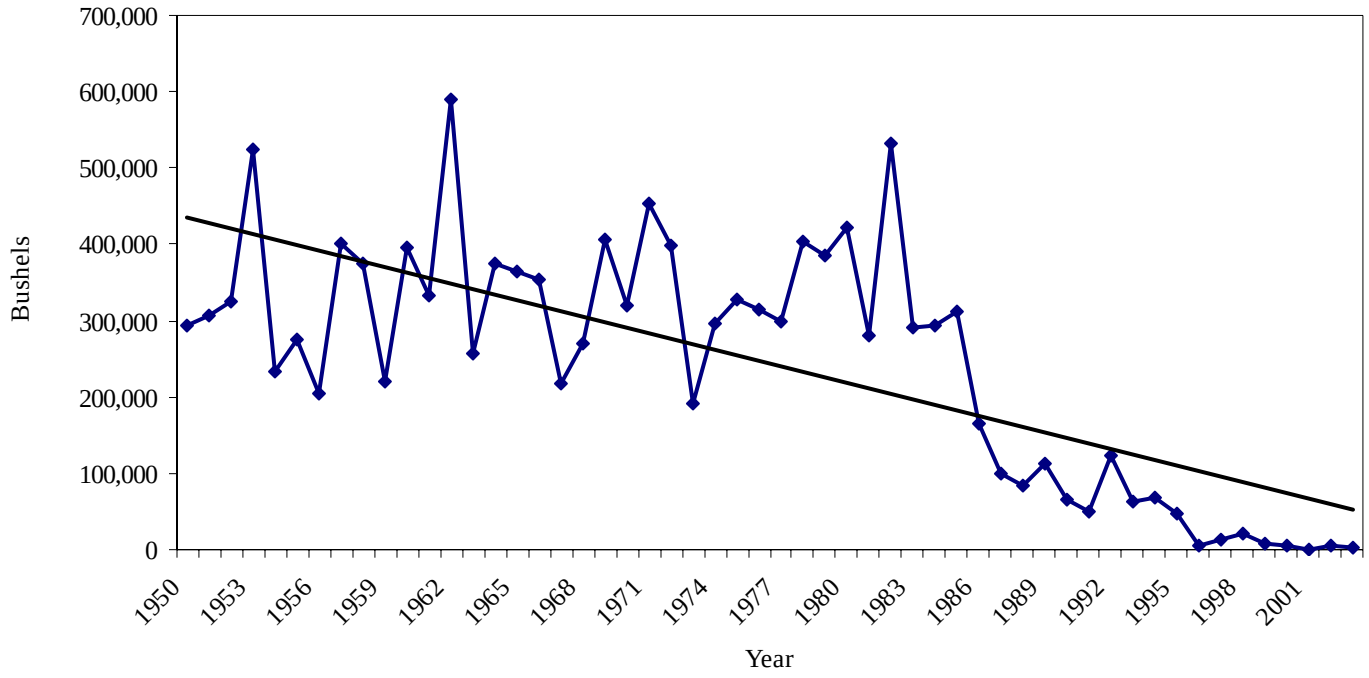


Figure 6.2. Commercial bay scallop landings (bushels) along the Atlantic east coast, 1950-2003. NMFS commercial fisheries landings database.

Table 6.1. Bay scallop commercial landings (bushels) by state, 1950-2003. NMFS commercial fisheries landings database.

Year	Massachusetts	New Jersey	New York	North Carolina	Other*	Total
1950	197,140		5,400	14,320	78,060	294,920
1951	222,840		20,220	36,680	27,740	307,480
1952	210,260		36,460	50,760	27,340	324,820
1953	357,720		32,400	13,060	121,740	524,920
1954	152,240		25,440	10,340	45,220	233,240
1955	174,620		45,220	15,660	39,380	274,880
1956	67,060	62,820	29,940	25,040	82,600	204,640
1957	204,480	14,320	117,900	21,680	55,880	399,940
1958	170,740	18,700	118,800	33,880	50,600	374,020
1959	84,200	880	76,280	25,660	35,000	221,140
1960	185,120		168,600	13,740	27,420	394,880
1961	114,560	14,160	158,220	21,140	40,200	334,120
1962	252,220	72,940	197,580	33,700	105,780	589,280
1963	66,640	54,780	60,480	64,220	66,420	257,760
1964	87,880	75,260	137,420	67,940	80,580	373,820
1965	89,060	19,100	177,200	75,800	21,900	363,960
1966	176,000	34,920	63,480	79,820	34,920	354,220
1967	91,020	17,100	32,400	77,460	17,100	217,980
1968	98,260	3,360	40,280	127,740	3,360	269,640
1969	234,440		49,740	122,500		406,680
1970	220,240		72,980	26,040		319,260
1971	410,000		28,800	12,000	2,540	453,340
1972	355,300		18,680	25,660		399,640
1973	138,820	12,120	33,740	7,480	12,120	192,160
1974	113,400	3,240	135,560	44,080	3,240	296,280
1975	210,800		88,820	26,960		326,580
1976	177,920		87,600	49,700		315,220
1977	201,780		39,800	51,400	7,060	300,040
1978	214,340		56,060	43,710	90,100	404,210
1979	248,780		69,160	38,687	27,620	384,247
1980	270,580		86,160	65,556	600	422,896
1981	192,660		48,840	37,888	200	279,588
1982	402,160		100,060	27,327	2,260	531,807
1983	207,720		33,440	40,496	8,830	290,486
1984	156,420		55,700	76,725	5,220	294,065
1985	187,140		34,760	91,130		313,030
1986	101,860		2,580	61,235		165,675
1987	68,160		60	30,914		99,134
1988	75,861		60	7,785		83,705
1989	95,520		320	16,895		112,735
1990	50,878		2,134	12,404		65,415
1991	38,169		3,094	8,909		50,173
1992	112,964		4,904	4,344	885	123,097
1993	27,205		3,025	30,501	1,857	62,588
1994			54,292	14,610	120	69,022
1995	5		5,186	40,211	1,666	47,068
1996	268		11	5,848	16	6,143
1997			1,448	12,760		14,208
1998			365	20,615		20,979
1999			1,155	5,931		7,087
2000			736	4,255		4,991
2001			759	504		1,262
2002			460	3,845	10	4,315
2003	258		361	2,839	60	3,518
Total	7,515,708	403,700	2,664,569	1,880,382	1,125,645	13,186,304

* Other includes: Maine, New Hampshire, Rhode Island, Connecticut, Maryland, and Florida east coast.

6.1.2.3 ANNUAL LANDINGS

Unlike the overall trends for the east coast, bay scallops in North Carolina are landed in much greater abundance than sea scallops or calico scallops. The North Carolina bay scallop commercial fishery has had fluctuations in landings throughout its history. In the 1950s, the average annual commercial harvest was 24,708 bushels per year. In the 1960s, the average annual landings increased to 68,406 bushels a year (Figure 6.3). The 1970s showed some decline in commercial landings from the previous decade with an average of 35,680 bushels harvested per year. Improved harvest in the 1980s increased the average annual landings to 45,595 bushels per year. A decline in the late 1980s continued into the 1990s with average annual commercial landings of 14,647 bushels per year. For the past five years landings have been minimal each year ranging from 4,206 bushels in 2000 to less than 30 bushels in 2004. The average annual commercial landings for the last five years (2000-2004) has only been 2,282 bushels per year.

Both the number of dealers and participants have declined. The number of participants involved in the bay scallop fishery each year since 1994 ranged from a high of 284 in 1995 to a low of 1 in 2004. Since 1980, the number of dealers per year ranged from a high of 35 in 1981 to a low of 1 in 2004.

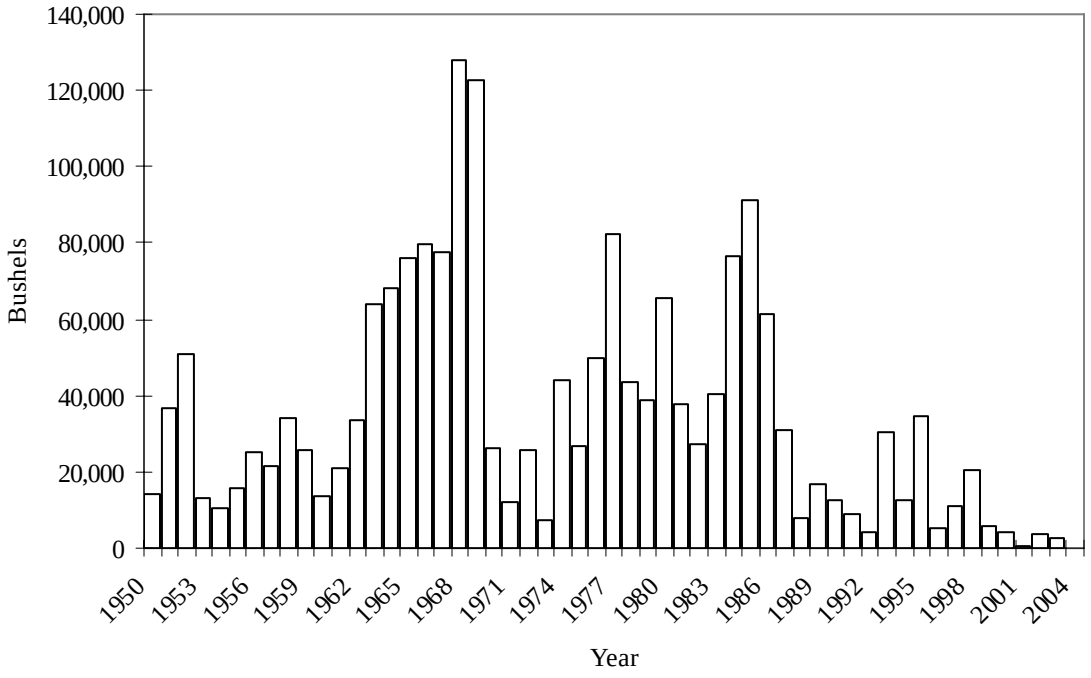


Figure 6.3. North Carolina commercial bay scallop landings (bushels), 1950-2004. DMF Trip Ticket Program.

6.1.2.4 HARVEST SEASON AND ADDUCTOR MUSCLE WEIGHT

The general harvest season for bay scallops in North Carolina has remained relatively unchanged since the 1920s with a few short openings due to social or predator interaction concerns (Gutsell 1928; D. Taylor, DMF, personal communication 2005). The main harvest season begins in January when peak landings (average 670 bushels) occur and landings slowly diminish as the season progresses to the last Friday in May (Figure 6.4). Shorter opening in recent years included: four days in December of 1994 to 1998 and a limited season in a small area of Back Sound, North River, and Straits from August 1 to September 15 in 2001 to 2003 to allow harvest before the cownose ray migration and resulting predation. An average of 590 trips per year were taken from 1994 to 2004 (Figure 6.4). The average harvest from 1994 to 1998 in December was 188 bushels however meat yields tend to be increasing (Figure 6.4 and 6.5). The average total harvest for the month of August during 2001 to 2003 was 30 bushels.

A relationship between meat weights and gonadal development guides fisheries managers in setting the bay scallop season. The season allows for the completion of spawning and an increase in meat size in order to obtain the highest yield. In general, adductor meat weights are at their lowest during the fall when gonad development is high (Figure 6.5). After bay scallops begin to spawn in October, meat weights begin to increase with maximum meat weights occurring from February to May (Figure 6.5) (Spitsbergen 1979; Kellogg and Spitsbergen 1983).

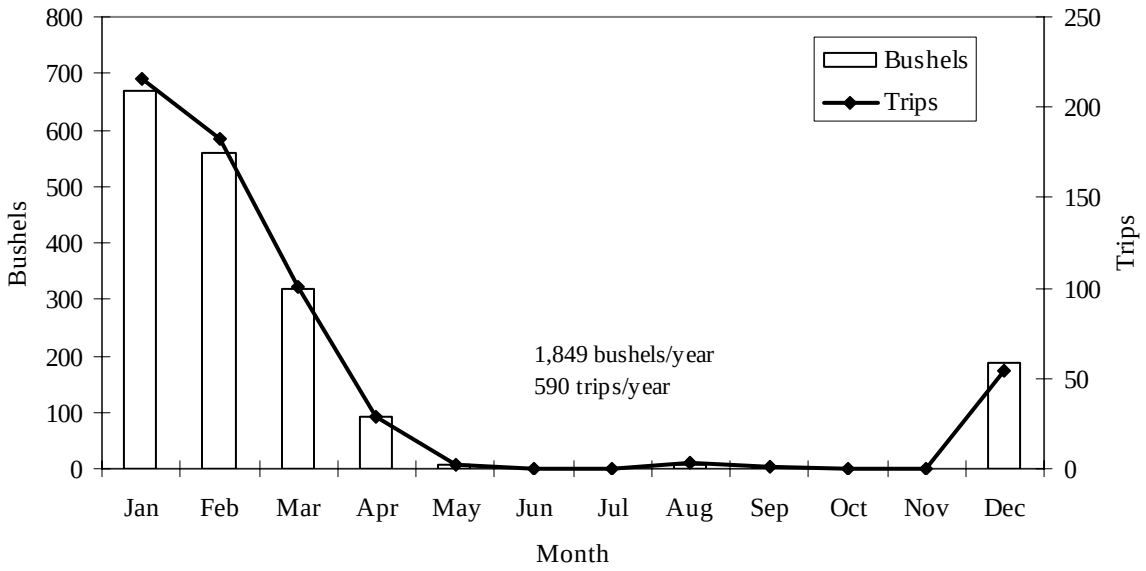


Figure 6.4. Average monthly commercial landings (bushels) and trips in the bay scallop fishery, 1994-2004. DMF Trip Ticket Program.

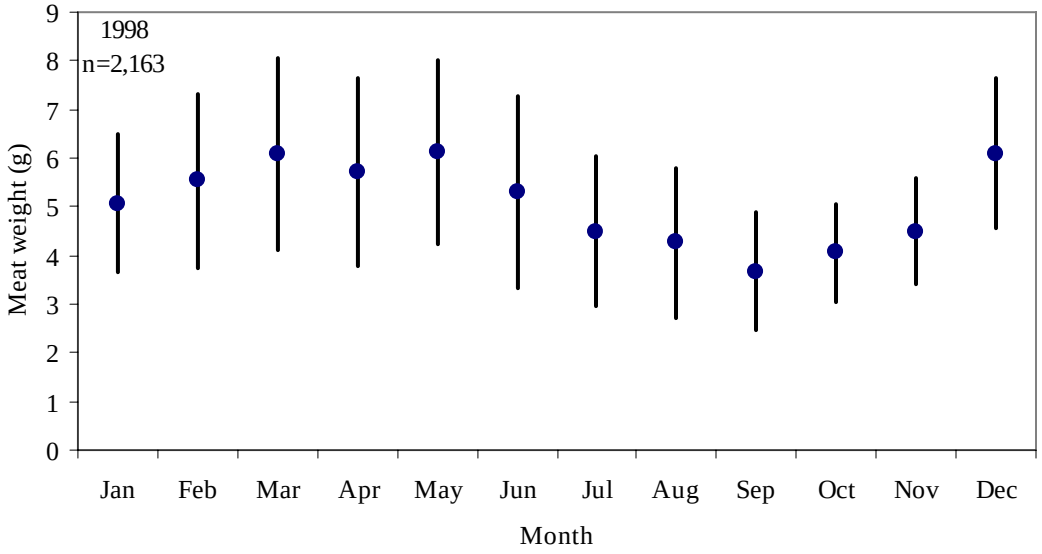


Figure 6.5. Average monthly bay scallop meat weight (g) in 1998 with one standard deviation from the mean. Using bay scallops with shell height $\geq$ 50 mm only to ensure complete maturity. DMF biological sampling.

6.1.2.5 PRIMARY WATERBODIES OF HARVEST

Core, Back, and Bogue sounds are the primary waterbodies where bay scallops are harvested in North Carolina and accounted for 97% of the landings from 1994 to 2004 (Figure 6.6). Landings have occurred periodically in the lower portion of New River, in eastern Pamlico Sound, White Oak River, Neuse River, Newport River, Stump Sound, Topsail Sound, and the Intercoastal Waterway (ICW) of Onslow county.

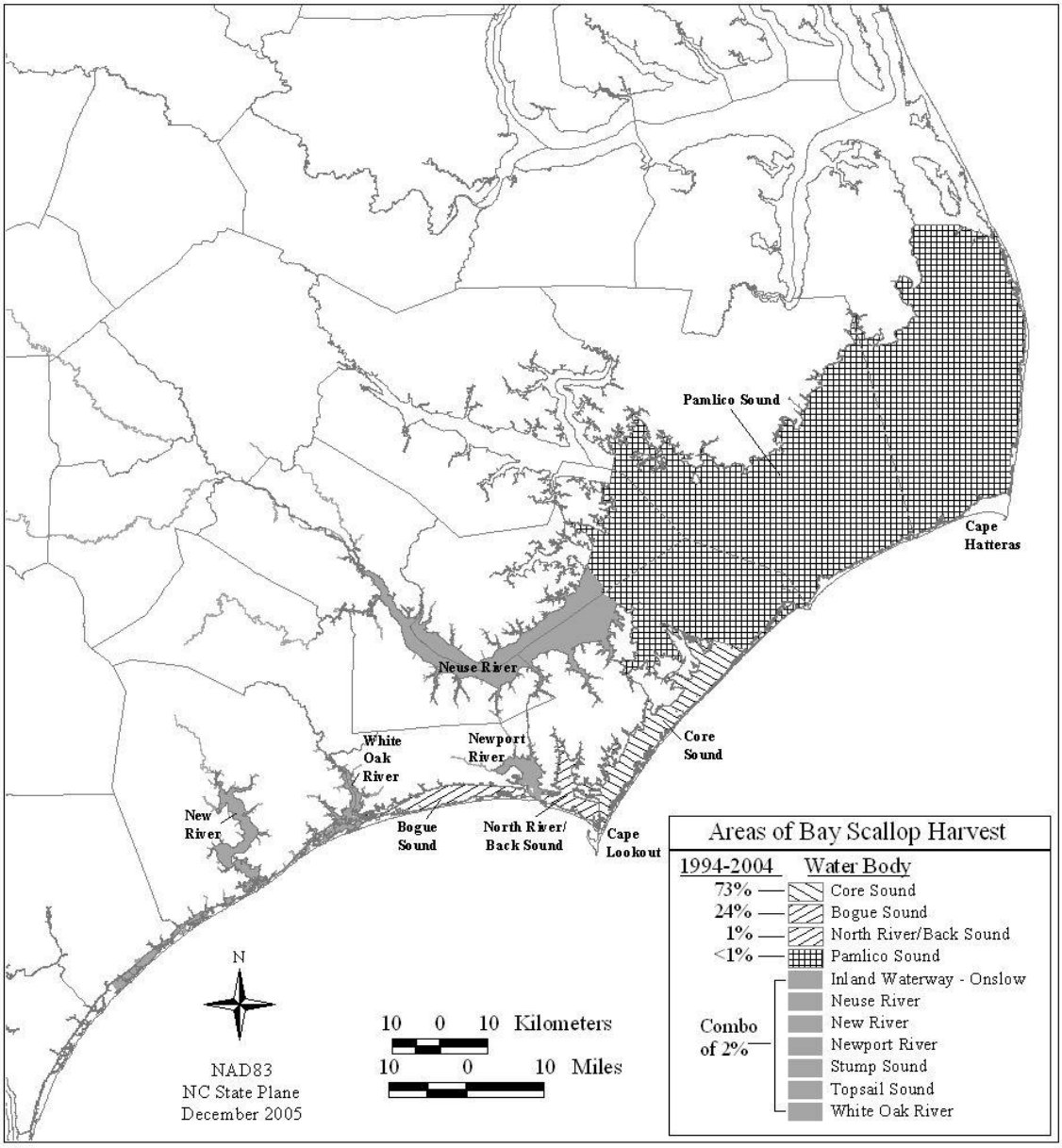


Figure 6.6. Bay scallop harvest areas of North Carolina, 1994-2004. DMF Trip Ticket Program and DMF GIS database.

Bogue Sound was the dominant waterbody for bay scallop landings from 1972 to 1981 and accounted for 53% of the total landings (Figure 6.7). From 1982 to 1993, Core Sound became the dominant waterbody for bay scallop landings, and accounted for 48% of the total landings. The highest annual bay scallop landings were 59,482 bushels from Core Sound in1985. Landings declined in both areas in 1987 before the red tide event occurred in October (Figure 6.8). Core Sound continued to be the dominant waterbody since the initiation of the DMF Trip Ticket program in 1994 and accounted for 74% of the overall landings from 1994 to 2004. The last year with a significant amount of landings was in 1995, when 32,798 bushels were harvested from Core Sound (Figure 6.8). Other waterbodies where landings appear periodically include the North River/Back Sound areas and Pamlico Sound. Pamlico Sound experienced an abundance of bay scallops in 1987 and the North River/Back Sound waterbody showed an increase in landings in the early 1980s.

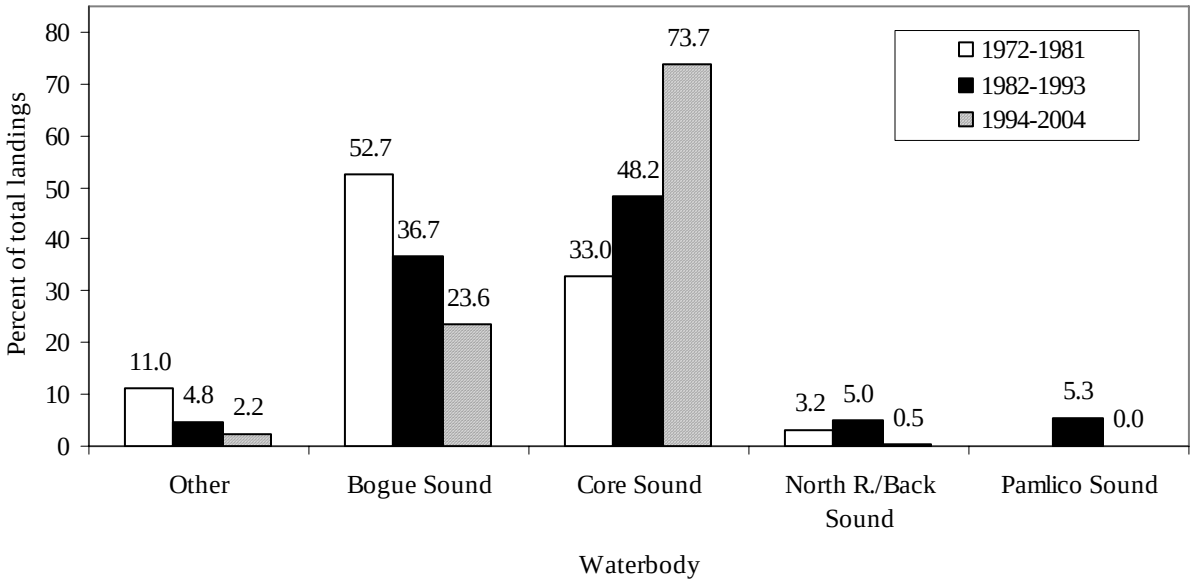


Figure 6.7. Average percentage of total bay scallop landings by waterbody for three distinct time periods: 1972-1981, 1982-1993, and 1994-2004. Other waterbodies include: Inland waterways, New River, White Oak River, Neuse River, Newport River, Stump Sound, and Topsail Sound. DMF Trip Ticket Program.

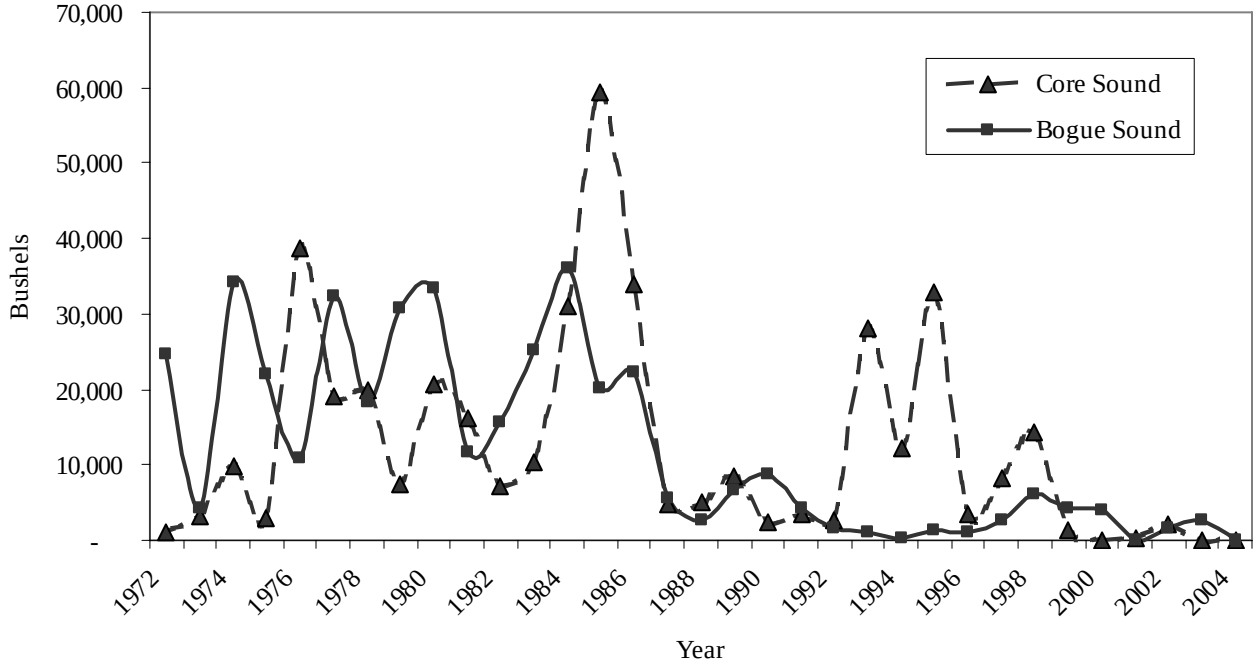


Figure 6.8. Bay scallop landings (bushels) from the top two areas in North Carolina, 1972-2004. DMF Trip Ticket Program.

6.1.2.6 CHARACTERIZATION OF BAY SCALLOP TRIPS AND CATCH PER UNIT EFFORT

There are pronounced year-to-year fluctuations in the number of trips harvesting bay scallops. The annual number of trips has declined since 1994 with the highest number of trips occurring in 1995 (Figure 6.9). Adverse weather conditions (i.e., hurricanes, cold winters) can impact the annual landings. Hurricane Floyd, Tropical storm Dennis (1999) and Hurricane Isabel (2003) likely decreased bay scallop harvest in the following year. Most trips (98%) harvested less than 25 bushels of bay scallops (Figure 6.10). Forty-six percent of the trips harvested were between 15 to 20 bushels of bay scallops from 1994 to 2004.

Occasionally, bay scallop fishermen have been known to sell their catch from more than one trip to a licensed dealer at one time. This likely accounts for trip tickets that reported more than the allowable limit, but it could also inflate the catch per unit effort (bushels per trip). However, it is not known to what extent this occurs (C. Burgess, DMF, personal communication 2005).

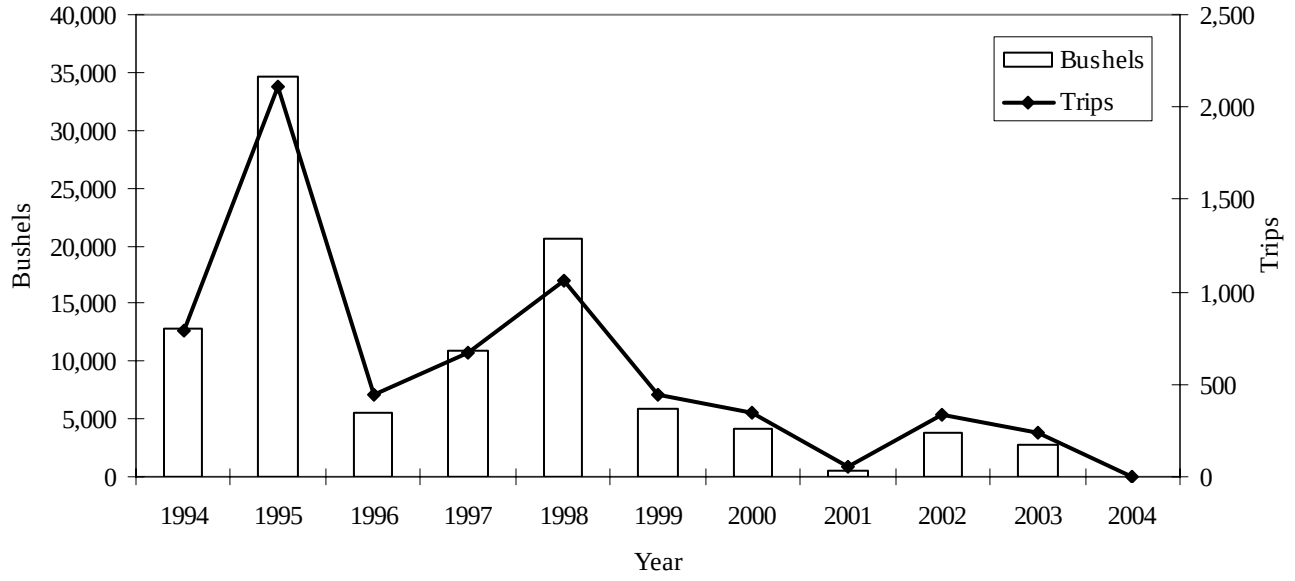


Figure 6.9. Number of trips with bay scallop commercial harvest in North Carolina, 1994-2004. DMF Trip Ticket Program.

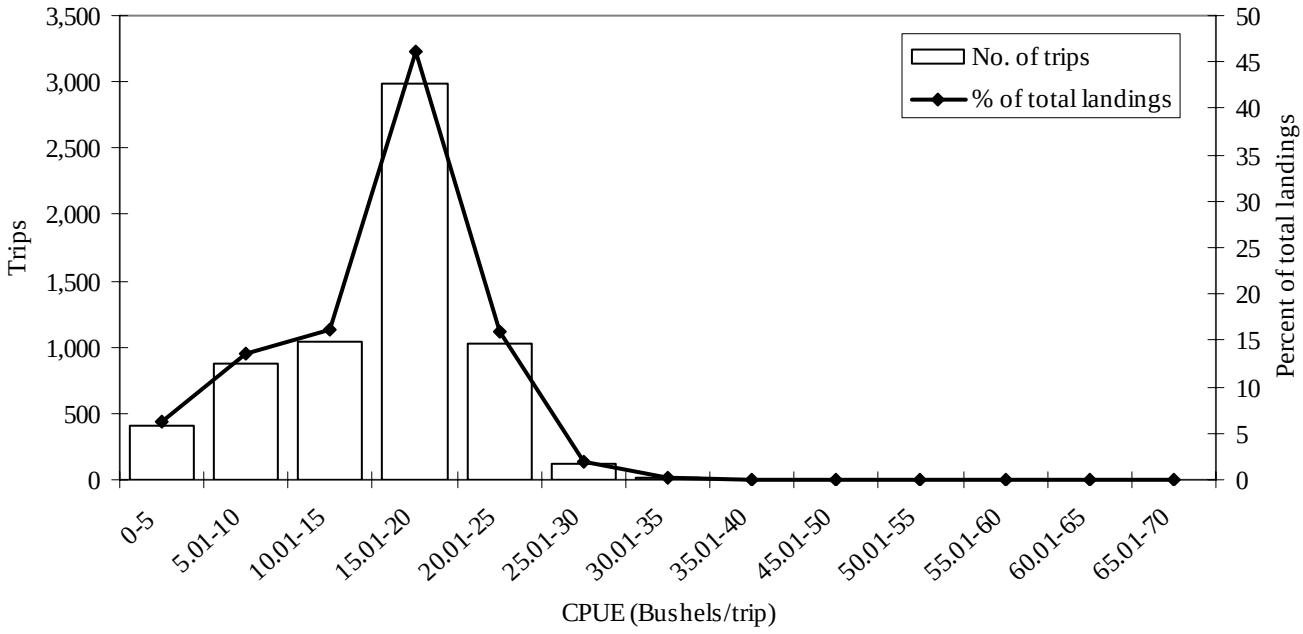
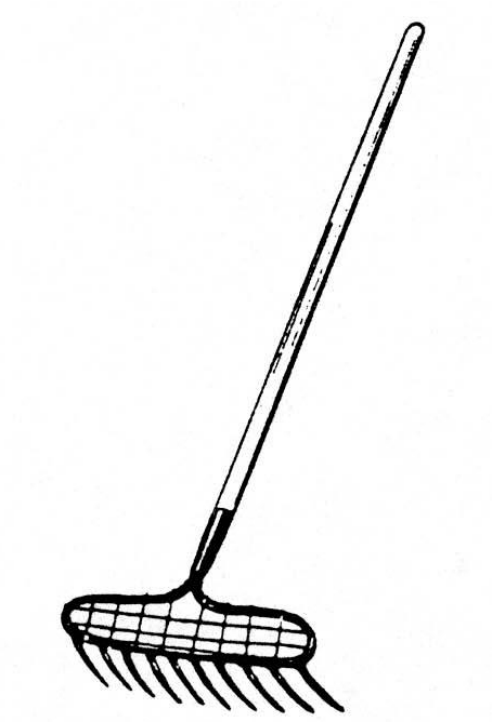


Figure 6.10. Total number of trips in each 5-bushel weight class of commercial harvest of bay scallops in North Carolina, 1994-2004. DMF Trip Ticket Program.

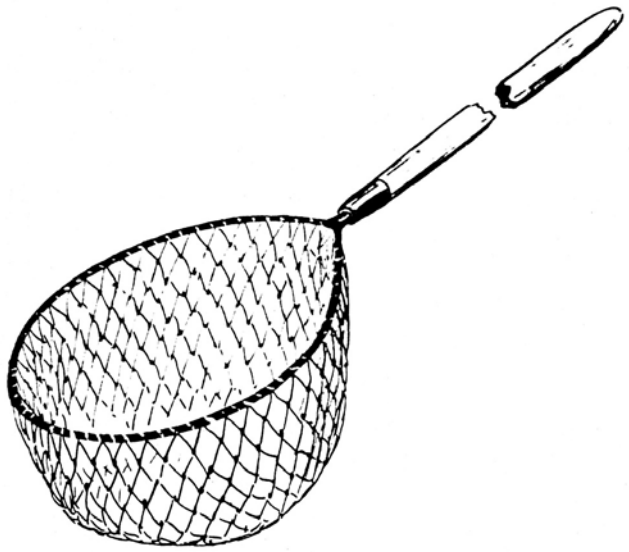
6.1.2.7 MAJOR GEAR TYPES AND CATCH PER UNIT EFFORT

The scallop scoop, hand rake, and bay scallop dredge are the three primary gears used in the fishery and accounted for 92% of the bay scallop landings from 1994 to 2004 (Figures 6.11 and 6.12). Harvesting bay scallops by hand accounted for 7% of the landings for the same time period (Figure 6.12). Regular hand rakes have evolved from garden type ones to lightweight aluminum models (Figure 6.11a). The scallop scoop is a common gear used by hand in which a nylon mesh bag is attached to long handle and used by fishermen standing in the bow of a boat or wading in the water. The scoop can hold 20-30 scallops at a time (Cunningham et al. 1992) (Figure 6.11b). The bay scallop dredge is a metal framework with a baglike pocket of nylon webbing or wire netting attached. The dredge is 3-4 feet long and about 24-30 inches wide and is towed over the bottom by boat (Figure 6.11c). One to six dredges are pulled at one time during the open harvest season. Other gears that captured incidental amounts of bays scallops included: clam trawl kicking, clam trawl dredges, shrimp trawls, and hand tongs.

A. Hand rake



B. Scallop scoop



C. Bay scallop dredge

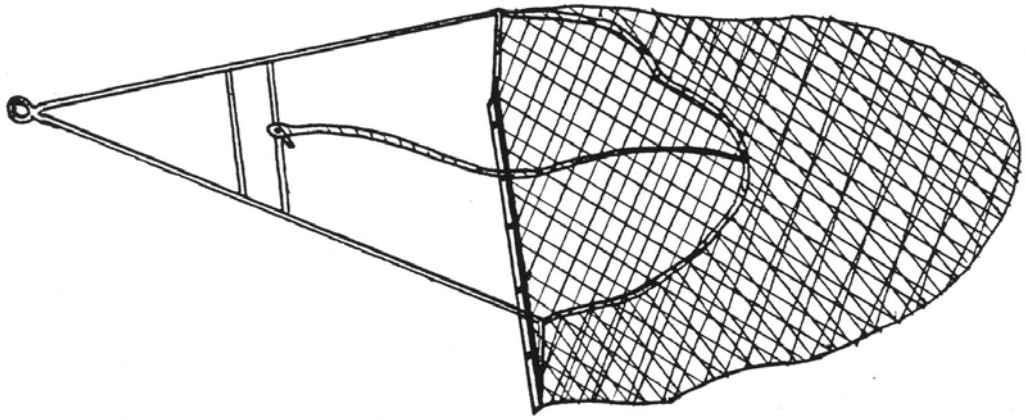


Figure 6.11. Primary types of gear used in the bay scallop fishery of North Carolina. A. Hand rake; B. Scallop scoop; and C. Bay scallop dredge (Cunningham et al. 1992).

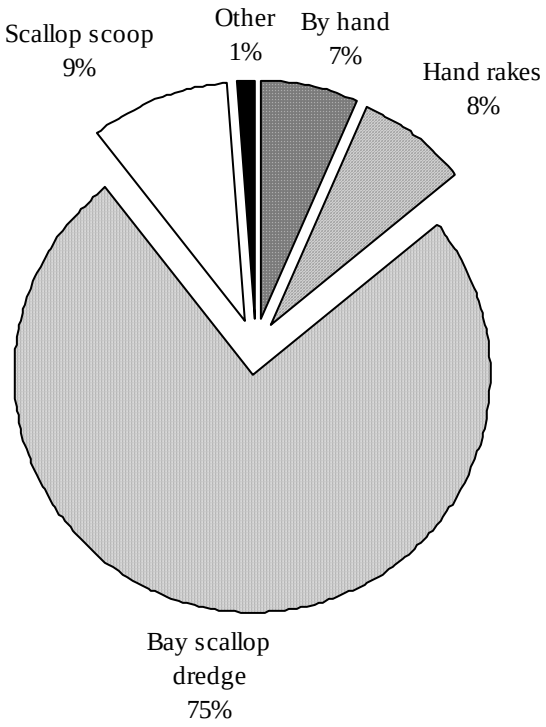


Figure 6.12. Proportion of landings by gear types in the bay scallop fishery of North Carolina, 1994-2004. DMF Trip Ticket program.

For catch per unit effort (CPUE) information, it was best to separate bay scallop landings into the hand harvest and bay scallop dredge (mechanical) harvest gears that target bay scallops exclusively. Hand harvest gears included: scallop scoops, dip nets, rakes, hand tongs, and by hand. The bay scallop dredge was the only mechanical harvest gear included in the CPUE estimate since it was the only mechanical harvest gear that targeted bay scallops. Other mechanical harvest gears (i.e., sea scallop dredge, clam trawl kicking, clam trawl dredge, and shrimp trawls) take bay scallops only as incidental catch in the trip. An annual CPUE with a range of 7.6 to 14.5 bushels of bay scallops per trip were harvested by hand from 1994 to 2003 (Figure 6.13). Mechanical harvest usually had a higher annual CPUE, with a range of 10.5 to 22.0 bushels of bay scallops per trip from 1994 to 2003.

Concern for habitat loss makes scallop dredging an intensely managed portion of the fishery and typically is only allowed two days a week. No dredging was allowed in Bogue Sound from 1993 to 1997. Beginning in 2000, dredging has been delayed until later in the season after scallops have been harvested out of the shallow areas. No mechanical harvest occurred in 2001 (Figure 6.14). Overall annual dredge effort was higher in Bogue Sound than in Core Sound (Table 6.2). Core Sound did not land any dredged bay scallops in 2000 or 2003. Annual hand harvest effort ranged from 5.9 to 12.9 bushels/trip in Bogue Sound and ranged from 4.8 to 17.2 bushels/trip in Core Sound from 1994 to 2004. The combined annual CPUE was higher in Core Sound than Bogue Sound for most years.

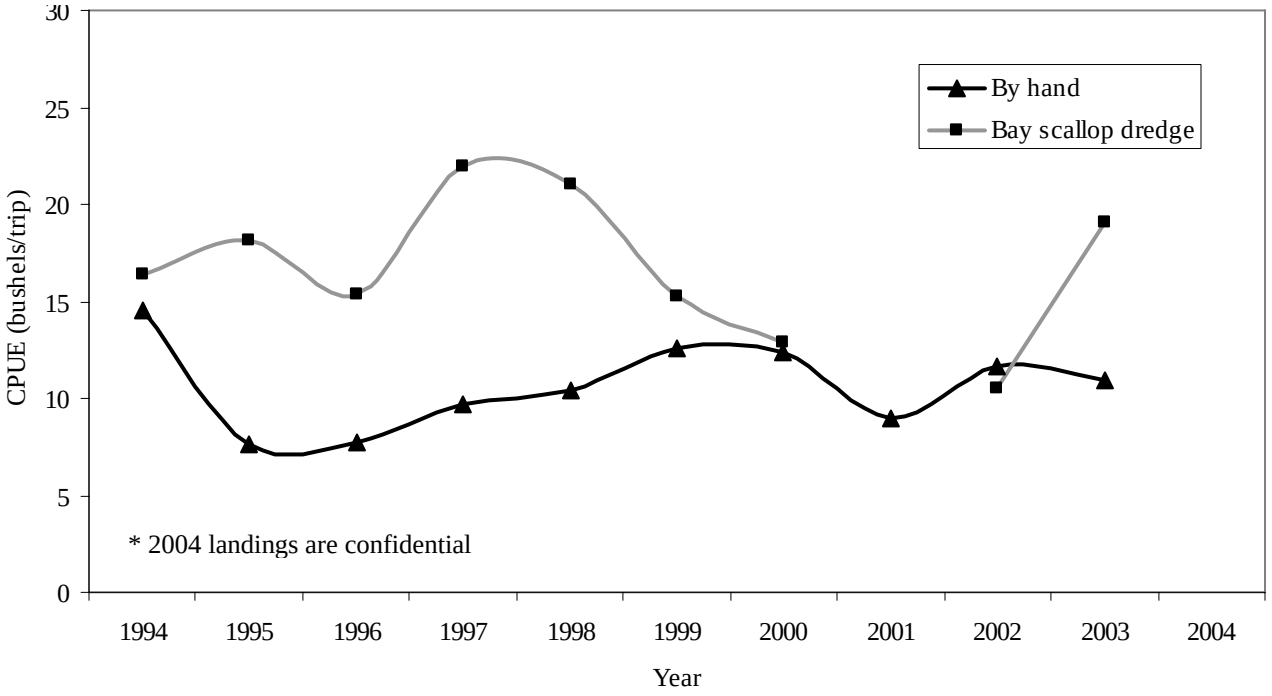


Figure 6.13. Annual catch per unit effort (CPUE, bushels/trip) for bay scallop dredges only (mechanical) and hand harvest of bay scallops in North Carolina, 1994-2004. DMF Trip Ticket Program.

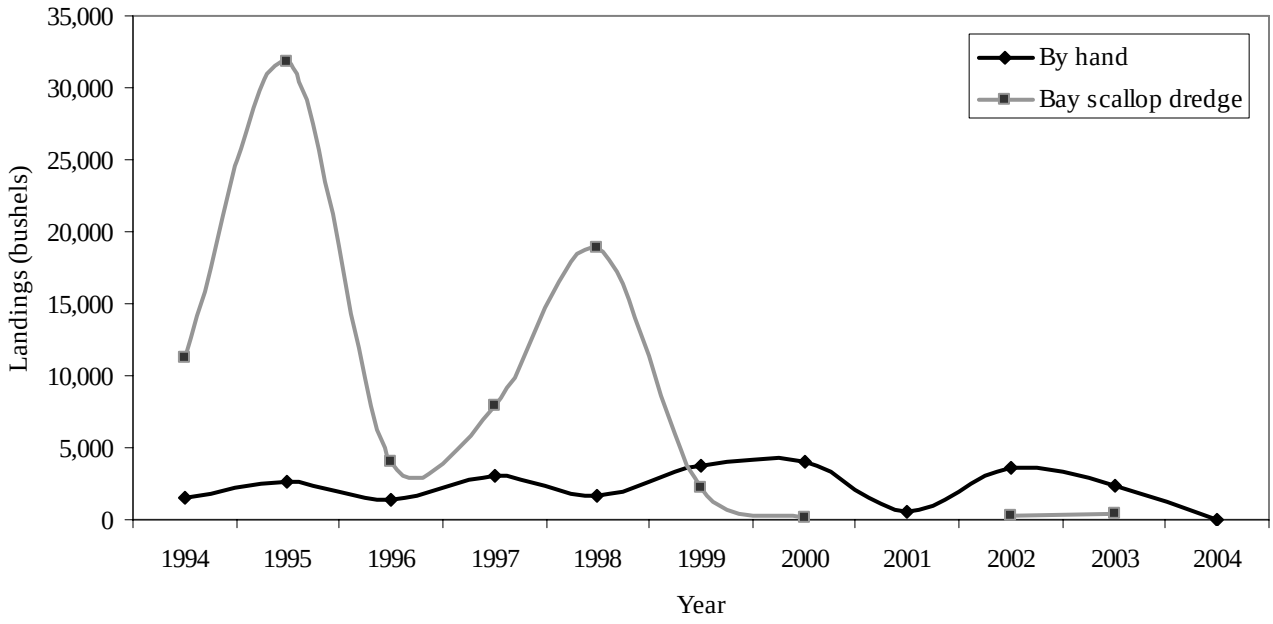


Figure 6.14. Annual bay scallop landings (bushels) separated into hand and bay scallop dredges only (mechanical) harvest methods in North Carolina, 1994-2004. DMF Trip Ticket Program.

Table 6.2. Annual catch per unit effort (CPUE) of bay scallops (bushels/trip) in Core Sound, Bogue Sound, and all other areas combined separated by hand and bay scallop dredge harvest methods, 1994-2004. DMF Trip Ticket Program.

	Bogue Sound			Core Sound			Other areas		
Year	By hand	Bay scallop dredge	Total	By hand	Bay scallop dredge	Total	By hand	Bay scallop dredge	Total
1994	9.54	-	9.54	17.23	16.48	16.54	12.26	11.83	12.19
1995	5.93	-	5.93	9.95	18.18	17.82	10.80	*	10.76
1996	6.87	*	6.96	9.29	15.50	14.98	16.61	14.68	14.98
1997	9.97	-	9.97	7.33	21.99	20.51	*	0.00	*
1998	10.58	22.79	18.74	10.35	20.49	19.77	*	*	6.85
1999	12.94	16.07	13.49	8.60	14.46	13.90	8.77	*	11.04
2000	12.74	12.84	12.74	4.76	-	4.76	9.10	-	*
2001	7.03	-	7.03	10.85	-	10.85	3.80	-	*
2002	10.73	*	10.77	13.50	10.27	13.00	4.91	0.00	4.91
2003	11.46	19.04	12.31	9.32	0.00	9.32	7.78	0.00	7.78
2004	*	0.00	*	0.00	0.00	0.00	0.00	0.00	0.00
1994-2004	10.42	20.92	12.06	11.59	18.37	17.63	9.70	14.63	11.05

* Data is confidential; - no harvest allowed with dredges.

6.2 RECREATIONAL FISHERY

In North Carolina one-half bushel of bay scallops per person not to exceed one bushel per vessel may be taken per day during the bay scallop season with no license (North Carolina fisheries Rules for Coastal Waters 15A NCAC 3K .0105). Recreational harvest seasons are open at the same time they are opened by proclamation for the commercial fishery with the exception that recreational harvest may also occur on the weekends.

In 1985, the U. S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) and the U. S. Department of the Interior, Fish and Wildlife Service (USFWS) completed a survey in 1985 to quantify recreational shellfishing activities in the United States (NOAA 1991). Trends cannot be assessed for recreational shellfishing because of limitations with the data. The definition of shellfish included all mollusks (i.e., scallops, mussels, oysters, and clams) and crustaceans (i.e., lobsters, crabs, and shrimp). The survey indicated that 129,972 shellfishermen expended 1,009,000 days shellfishing in North Carolina in 1985. During 1991, the telephone survey portion of the North Carolina Marine Recreational Fishery Statistics Survey (MRFSS) included a question on the number of recreational shellfishing trips taken. Results from the survey indicated there were more than one million trips to harvest shellfish in North Carolina during that time. No data on shellfish harvest was given. There are no other known data on recreational shellfishing in North Carolina and no data on bay scallop harvest in the recreational fishery.

7.0 SOCIOECONOMIC ASPECTS OF THE BAY SCALLOP FISHERY

7.1 COMMERCIAL FISHERY

7.1.1 EX-VESSEL VALUE AND PRICE

Bay scallops have been an economically important shellfish fishery since the earliest records were kept. However, the economic value of bay scallops has always lagged behind that of oysters (*Crassostrea virginica*) and hard clams (*Mercenaria mercenaria*) (Chestnut and Davis 1975). Figure 7.1 shows the “inflated” ex-vessel value (the actual amount paid dockside to the fisherman) and the ex-vessel value of landings “deflated” (normalized) for all years to the value of a dollar in 1972. The year 1972 was chosen for the deflation year because that was when we began to have data that covered all species managed by the DMF. Deflated values are calculated to provide a dollar value that is comparable across all years and species. There are no comparable deflated figures prior to 1918 because the US government did not begin calculating the Consumer Price Index (CPI) as a measure of inflation until that year.

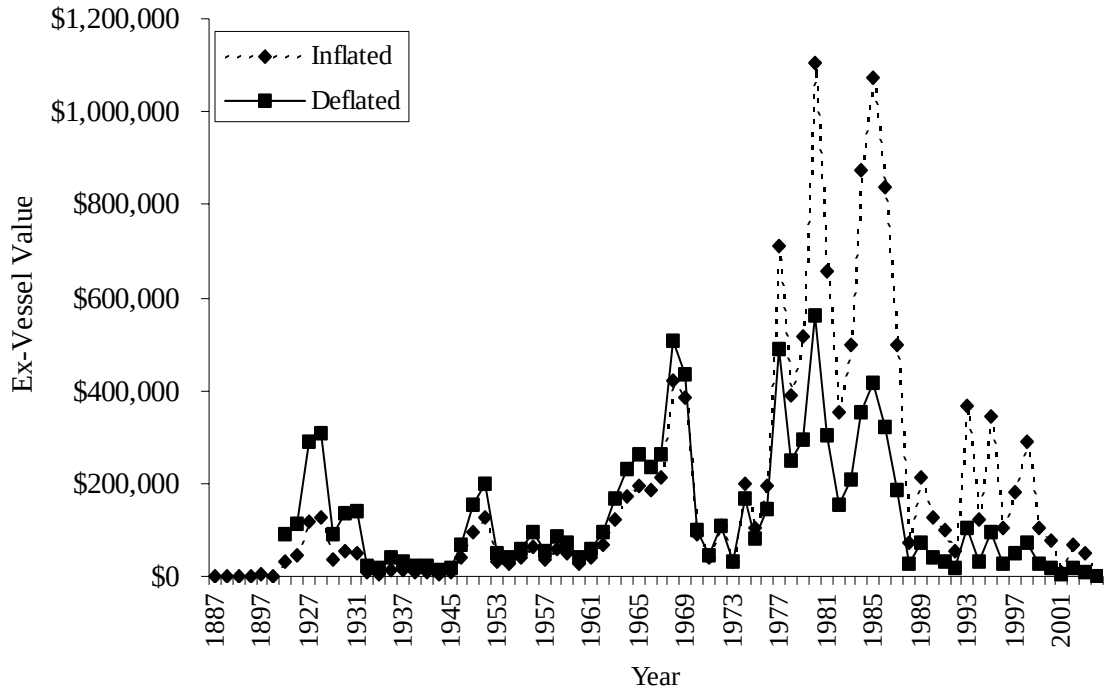


Figure 7.1. Commercial ex-vessel value of bay scallop landings, North Carolina, 1887-2004 (Chestnut and Davis 1975). DMF Trip Ticket Program.

The landings values viewed from a historical perspective indicate there have been irregular fluctuations in bay scallop landings. The periods of 1932-1945, 1953-1962, 1970-1975, and from 1988-2004 were years when the deflated landings values appear to be quite a bit lower than the years preceding or after. A particularly disturbing issue is that the most recent decrease in landings value is the lowest it has been since records were kept (Table 7.1).

Table 7.1. Inflated and deflated ex-vessel and price per pound of bay scallop landings, North Carolina, 1887-2004 (Chestnut and Davis 1975). DMF Trip Ticket Program.

Year	Inflated Value	Deflated Value	Inflated Price/Lb.	Deflated Price/Lb.
1887	$100		$0.03	
1888	$200		$0.05	
1889	$700		$0.04	
1890	$800		$0.04	
1897	$6,000		$0.05	
1902	$1,000		$0.08	
1918	$32,000	$88,683	$0.08	$0.21
1923	$46,000	$112,444	$0.08	$0.20
1927	$120,000	$288,276	$0.14	$0.35
1928	$125,845	$307,621	$0.09	$0.22
1929	$37,960	$92,791	$0.06	$0.14
1930	$53,923	$134,969	$0.12	$0.31
1931	$50,250	$138,188	$0.10	$0.28
1932	$7,000	$21,358	$0.08	$0.23
1934	$6,000	$18,716	$0.17	$0.52
1936	$14,175	$42,627	$0.14	$0.43
1937	$11,680	$33,904	$0.19	$0.55
1938	$7,971	$23,630	$0.27	$0.80
1939	$7,000	$21,050	$0.21	$0.64
1940	$4,000	$11,943	$0.12	$0.35
1945	$7,770	$18,044	$0.35	$0.81
1950	$38,906	$67,480	$0.54	$0.94
1951	$95,696	$153,850	$0.52	$0.84
1952	$126,900	$200,167	$0.50	$0.79
1953	$32,650	$51,115	$0.50	$0.78
1954	$25,850	$40,168	$0.50	$0.78
1955	$39,150	$61,062	$0.50	$0.78
1956	$62,600	$96,201	$0.50	$0.77
1957	$37,073	$55,148	$0.34	$0.51
1958	$57,935	$83,795	$0.34	$0.49
1959	$51,314	$73,709	$0.40	$0.57
1960	$27,480	$38,806	$0.40	$0.56
1961	$42,280	$59,107	$0.40	$0.56
1962	$67,400	$93,289	$0.40	$0.55
1963	$121,914	$166,102	$0.38	$0.52
1964	$172,622	$232,761	$0.51	$0.69
1965	$196,342	$260,543	$0.52	$0.69
1966	$184,198	$237,638	$0.46	$0.60
1967	$211,291	$264,430	$0.55	$0.68
1968	$422,136	$507,048	$0.66	$0.79
1969	$382,718	$435,902	$0.62	$0.71
1970	$91,087	$98,130	$0.70	$0.75
1971	$42,412	$43,773	$0.71	$0.73
1972	$110,339	$110,339	$0.86	$0.86
1973	$33,059	$31,123	$0.88	$0.83
1974	$199,391	$169,058	$0.90	$0.77
1975	$104,622	$81,286	$0.78	$0.60
1976	$194,457	$142,852	$0.78	$0.57
1977	$711,311	$490,640	$1.72	$1.19
1978	$389,161	$249,493	$1.78	$1.14
1979	$514,419	$296,181	$2.66	$1.53
1980	$1,107,072	$561,597	$3.38	$1.71
1981	$655,725	$301,533	$3.46	$1.59
1982	$352,169	$152,546	$2.58	$1.12
1983	$498,539	$209,226	$2.46	$1.03
1984	$876,122	$352,473	$2.28	$0.92
1985	$1,072,296	$416,561	$2.35	$0.91
1986	$837,722	$319,496	$2.74	$1.04
1987	$500,068	$184,004	$3.24	$1.19
1988	$73,179	$25,857	$1.88	$0.66
1989	$214,136	$72,185	$2.53	$0.85
1990	$127,545	$40,791	$2.06	$0.66
1991	$99,661	$30,586	$2.24	$0.69
1992	$54,124	$16,125	$2.49	$0.74
1993	$365,274	$105,664	$2.40	$0.69
1994	$120,054	$33,861	$1.88	$0.53
1995	$343,921	$94,330	$1.98	$0.54
1996	$105,716	$28,164	$3.86	$1.03
1997	$183,172	$47,705	$3.35	$0.87
1998	$288,911	$74,089	$2.81	$0.72
1999	$102,998	$25,842	$3.47	$0.87
2000	$78,554	$19,068	$3.74	$0.91
2001	$10,423	$2,460	$4.14	$0.98
2002	$68,365	$15,885	$3.56	$0.83
2003	$48,628	$11,047	$3.43	$0.78
2004	< $500	< $100	$5.00	$1.11

In peak years, the annual ex-vessel value of bay scallops is routinely higher than $100,000. In a few years (1968, 1969, 1977, 1980, and 1985), the deflated ex-vessel value of landings has been greater than $400,000.

The inflated ex-vessel values show the same fluctuation trend. Between 1963 and 1999 there were only six years (1970, 1971, 1973, 1988, 1991, and 1992) where the

inflated ex-vessel value was less than $100,000 per year. In recent years, the ex-vessel value ranged from $78,554 in 2000 to a value of less than $500 in 2004.

A survey is conducted periodically by DMF to obtain price estimates from dealers for seafood purchased from fishermen. The data from the survey are used to determine an average annual price per unit for each market grade of each species commercially landed. Bay scallop landings and total market value are currently at historic lows. The last major peak in the fishery in terms of economic value is from 1976 through 1987 (Figure 7.2).

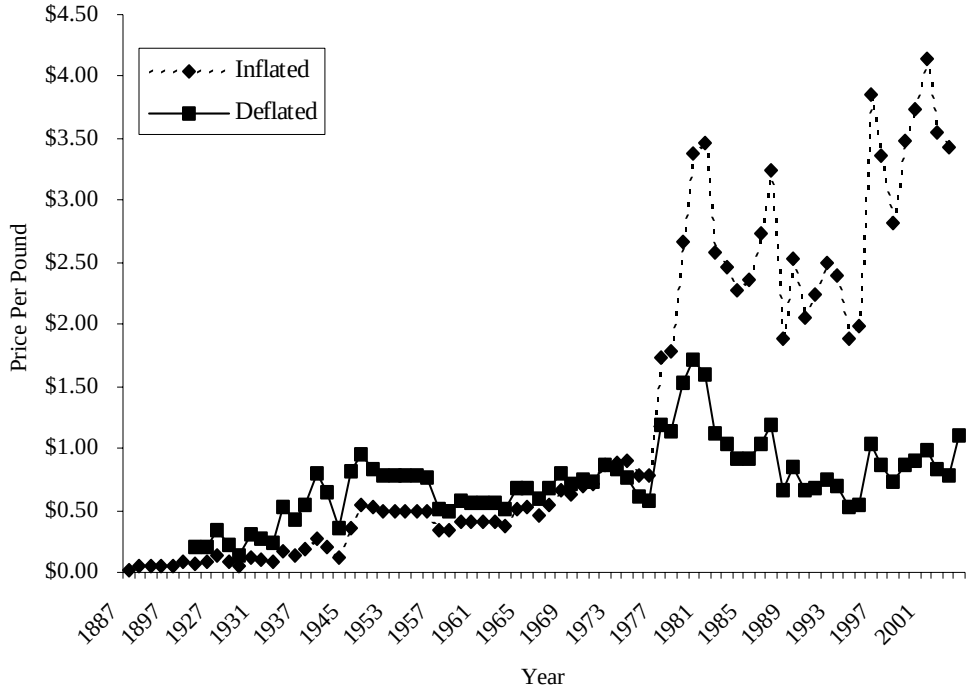


Figure 7.2. Commercial ex-vessel price per pound for bay scallops, North Carolina, 1887-2004 (Chestnut and Davis 1975).DMF Trip Ticket Program.

Price per pound of bay scallops has steadily increased over the years regardless of the number of pounds landed. The lowest inflated price per pound for bay scallops was $.03 in 1887 with the highest being $4.14 per pound in 2001. When inflation is taken into account, 1929 had the lowest price per pound at $.14. The highest deflated price per pound for bay scallops was $1.71 and occurred in 1980. The relationship of the bay scallop price per pound increasing over time is statistically significant ($r_{(69)} = 0.574$, $p < 0.001$). This finding indicates that over time, a market has developed for North Carolina bay scallops and that supply has never been able to keep up with the increasing demand. When bay scallops are available, fishermen can get a good price for them, regardless of the number of pounds they are able to land.

7.1.2 GEAR

The advent of the North Carolina trip ticket program in 1994 allowed the NC DMF to track landings by individual trips taken by fishermen for the first time. Bay scallops are primarily harvested by hand, rakes, or using mechanical methods. Hand harvest methods also include harvesting by scallop scoop. Mechanical harvest methods primarily consists of scallop dredges.

Table 7.2 shows the number of trips taken, ex-vessel value (unadjusted for inflation), and average price per pound paid to fishermen who landed bay scallops by gear type. The number of trips taken in a given year reflects the availability of bay scallops and the length of the season. Prior to 1999 the majority of trips that landed bay scallops used mechanical methods. In 1999, the majority of trips were harvested with rakes. Since 2000, the majority of bay scallop trips used hand-harvesting methods. There were no mechanically harvested bay scallops in 2001 because a DMF proclamation prohibited their use. In 2004, there were only two trips reported that landed bay scallops.

The average ex-vessel value per trip (unadjusted for inflation) ranged from a low of $47 in 1997 for bay scallops harvested with rakes to a high of $334 in 1997 for bay scallops harvested using mechanical methods. In most years, hand harvesting of bay scallops resulted in a higher average ex-vessel value per trip. The average ex-vessel value per trip was highest in all years that mechanical harvesting of bay scallops occurred except 2000.

7.1.3 WATERBODIES

In the early years of the trip ticket program, Core Sound saw the greatest portion of the bay scallop catch each year. Figure 7.3 shows the annual ex-vessel value of bay scallops from Core Sound, Bogue Sound, and all other state water bodies combined. Between 1994 and 1999 there were wide fluctuations in the annual value of bay scallops harvested from Core Sound. The ex-vessel value in 1995 for Core Sound was over $300,000 and approximately $200,000 in 1998. This value declined considerably beginning in 1999 with the highest ex-vessel value of $39,520 occurring in 2002. Beginning in 1999, more bay scallops were harvested from Bogue Sound than Core Sound in most years. From 1998 to 2000 the ex-vessel value of landings from Bogue Sound ranged from about $76,000 to $92,000 per year, the highest years since the Trip Ticket Program began. The year 2000 was the last in which more than $50,000 in ex-vessel value of bay scallops was harvested from any single water body.

Table 7.2. Trips, ex-vessel value, and average price per pound for harvesting by hand, rakes, and mechanical methods for bay scallops, North Carolina, 1994-2004. DMF Trip Ticket Program.

	Hand Harvest				Rakes				Mechanical Harvest			
Year	Trips	Value	Avg. Value per Trip	Price Per Pound	Trips	Value	Avg. Value per Trip	Price Per Pound	Trips	Value	Avg. Value per Trip	Price Per Pound
1994	75	$10,458	$139	$1.92	29	$4,256	$147	$2.10	688	$105,341	$153	$1.87
1995	249	$28,167	$113	$2.78	96	$8,528	$89	$3.03	1,841	$307,226	$167	$1.92
1996	99	$14,450	$146	$3.86	100	$11,640	$116	$3.86	285	$79,625	$279	$3.86
1997	258	$43,414	$168	$3.35	172	$8,081	$47	$3.35	394	$131,678	$334	$3.35
1998	96	$15,778	$164	$2.78	108	$8,675	$80	$3.13	1,106	$264,458	$239	$2.81
1999	178	$35,829	$201	$3.63	223	$28,174	$126	$3.27	178	$38,995	$219	$3.49
2000	237	$49,296	$208	$3.93	200	$26,759	$134	$3.41	15	$2,499	$167	$3.89
2001	58	$9,577	$165	$4.15	8	$846	$106	$3.99	0	$0	$0	$0
2002	295	$41,366	$140	$3.49	99	$20,990	$212	$3.53	29	$6,009	$207	$4
2003	191	$28,117	$147	$3.21	96	$12,113	$126	$3.72	38	$8,398	$221	$4
2004	2	*	*	*	0	$0	$0	$0	0	$0	$0	$0

* Data are confidential

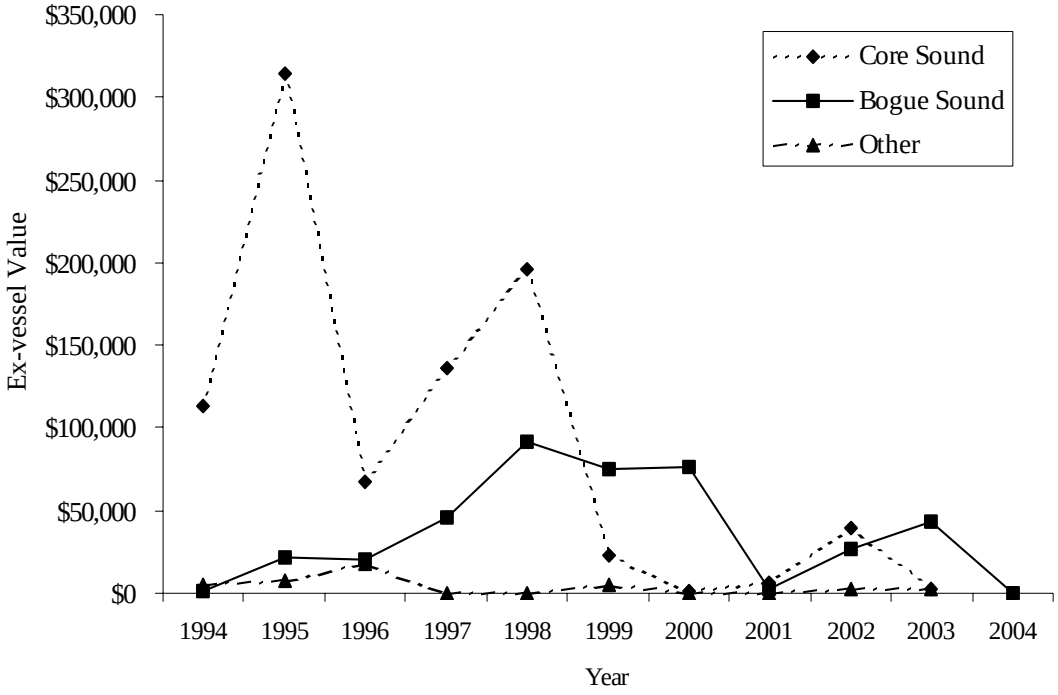


Figure 7.3. Annual ex-vessel value (inflated) for bay scallops from selected water bodies, North Carolina, 1994-2004. DMF Trip Ticket Program.

7.1.4 PARTICIPANTS

The North Carolina trip ticket program enables managers to monitor fishing activity at the trip level, and gives an indication of how many people participate in a fishery. The number of participants in the bay scallop fishery depends greatly on the availability of bay scallops for harvest. North Carolina fishermen are noted for being opportunistic, switching between fisheries based on their understanding of which fishery will provide them the greatest return for their efforts. Since the trip ticket program began in 1994, participants ranged from a high of 284 in 1995 when bay scallops were more plentiful to only one participant in 2004 when landings were extremely low.

Table 7.3. Number of participants and annual ex-vessel landings value for bay scallops, North Carolina, 1994-2004. DMF Trip Ticket Program.

Annual Ex-Vessel Value	Year										
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
< $100	23	35	13	10	18	9	11	9	12	15	0
$100.01 - $500	108	97	28	28	38	24	21	9	26	29	1
$500.01 - $1,000	29	52	14	20	20	17	16	4	17	12	0
$1,000.01 - $5,000	29	87	33	24	38	27	22	4	18	11	0
> $5,000	2	13	1	14	20	4	2	0	1	1	0
Total Participants	191	284	89	96	134	81	72	26	74	68	1

Data from trip tickets indicate that fishermen who land bay scallops are not very likely to land other species on those same trips. This is an indication that when fishermen go out to harvest bay scallops, they are not likely to land other marketable species, nor is there much marketable bycatch associated with harvesting bay scallops. Conversely, bay scallops are not likely to appear as bycatch in other directed fisheries although they are occasionally landed in clam kicking and shrimp trawling trips. Traditionally, bay scallops are harvested in winter when there are fewer species available. Table 7.4 shows the percent of total ex-vessel value comprised by bay scallops by participants for trips where bay scallops were landed.

Table 7.4. Percent of total market value of bay scallops compared to the total value for trips in which bay scallops were landed by participants, North Carolina, 1994-2004. DMF Trip Ticket Program.

% Bay Scallops	Year										
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
<= 99%	12	34	8	13	9	12	7	4	9	12	0
100%	179	250	81	83	125	69	65	22	65	56	1
Total Participants	191	284	89	96	134	81	72	26	74	68	1

Table 7.5 shows the number of dealers statewide who reported landings of bay scallops on trip tickets between 1994 and 2004. The number of dealers closely mirrors landings. In years where there were fewer bay scallops harvested, there are corresponding smaller number of dealers purchasing from fishermen. Between 1994 and 2004 the range of the number of dealers purchasing bay scallops went from a high of 30 in 1995 to a low of 1 in 2004. Most years saw between 16 and 23 dealers purchasing bay scallops. It is interesting to note that while the number of dealers purchasing bay scallops typically fluctuated within a fairly small range, there is a statistically significant relationship in the value of the landings over the years. Individual dealers tended to buy fewer bay scallops from licensed North Carolina fishermen over time ($r_{(10)} = -.693$, $p < .05$). Many dealers want to buy scallops in spite of the lack of availability because of the market's willingness to pay a good price for any bay scallops that are harvested and therefore some fishermen might be buying dealer licenses and selling scallops directly to the public.

Table 7.5. Number of dealers and annual ex-vessel landings value for bay scallops, North Carolina, 1994- 2004. DMF Trip Ticket Program.

Annual Ex-vessel Value	Year										
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
<= $500	4	7	2	2	6	4	9	7	8	11	1
$500.01 - $1,000	3	2	2	3	0	5	1	0	2	1	0
$1,000.01 - $2,500	3	3	7	0	2	4	3	2	4	3	0
$2,500.01 - $5,000	3	5	2	4	3	3	2	2	7	3	0
$5,000.01 - $10,000	5	7	2	4	5	0	2	0	1	1	0
>=$10,000	4	6	2	3	6	5	3	0	1	1	0
Total Dealers	22	30	17	16	22	21	20	11	23	20	1

The majority of dealers purchasing bay scallops from North Carolina fishermen are located in Carteret County because the bulk of all North Carolina bay scallops traditionally are harvested from Core and Bogue sounds. Table 7.6 indicates the number of dealers who purchased bay scallops from licensed commercial fishermen and their county location. Other counties that recorded landings in at least one year include Dare, Craven, Onslow, Pender, and New Hanover.

Table 7.6. Number of dealers reporting bay scallop purchases by county, North Carolina, 1994-2004. DMF Trip Ticket Program.

County	Year										
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Carteret	18	26	13	13	18	18	17	9	17	16	1
Other Counties	4	4	4	3	4	3	3	2	6	4	0
Total Dealers	22	30	17	16	22	21	20	11	23	20	1

7.1.5 PROCESSING

The North Carolina Department of Environmental Health's (DEH) Shellfish Sanitation Section previously certified scallop processing operations. These certifications covered all types of scallops: bay, calico, and sea. The majority of sea scallops are processed at sea. In most years, few calico scallops are harvested in NC. Bay scallops represent the majority of scallops processed in these operations.

In the past, DEH offered two types of certification. The first was for shucker/packer operations that were permitted to shuck, pack, and/or repack scallops into labeled containers. The second type of certification allowed a small retail operation to shuck scallops into small non-labeled containers for onsite sales or into containers for other dealers. Certification records go back to 1968 and ended in 1994.

Certifications ended in 1994 because North Carolina and the National Shellfish Sanitation Program no longer required operations to be certified when only the adductor muscle was the end product. The reason for this was that the adductor muscle itself does not concentrate pathogenic bacteria. While oysters, clams and mussels also have adductor muscles, the entire animal is typically eaten, including the stomach, intestines and gills which can concentrate pathogens. Bay scallop adductor muscles are occasionally eaten raw, as are some other shellfish, but they are not harmful as such. Oysters, clams, or mussels harvested from closed shellfishing areas may not be safe to eat even if cooked, because the animals can concentrate biotoxins, chemicals, or even bacterial toxins that are heat stable and not cooked out of the product. Additionally, the FDA approved a chemical process in 1992 involving soaking bay scallops in a solution of water and sodium tripolyphosphate to preserve the moisture content and improve the quality of the product (FDA 1992). Table 7.7 shows the number of bay scallop certifications by type from 1968 to 1994.

By 1976, shucker certification was no longer issued. Some of the operations upgraded themselves in order to receive the more stringently controlled shucker/packer

certification. A rank order correlational analysis shows a statistically significant relationship indicating a decline in the number of bay scallop processors in the 25 year time series ($r_{(24)} = -0.636$, $p = 0.001$). The certification year of 1968-69 had the highest number of operations certified with 77. The 1991-92 certification year saw only 15 operations certified, the least of any year in the time series. Some factors that might have influenced the number of processors being certified could include the availability of bay scallops for harvest or the requirements for obtaining certification. Considering that 1974-75 was the last year in which shucker certification was issued, it is interesting to note that the difference between that certification year and the next is a reduction of only two processors.

Table 7.7 Bay scallop shucker/packer (S/P) and shucker (S) operations certified in North Carolina, 1968-1994. DEH, Shellfish Sanitation Section.

Year	S/P	S	Total
1968-69	42	35	77
1969-70	20	15	35
1970-71	32	21	53
1971-72	22	12	34
1972-73	21	2	23
1973-74	39	8	47
1974-75	27	8	35
1975-76	33	0	33
1976-77	32	0	32
1977-78	36	0	36
1978-79	32	0	32
1979-80	31	0	31
1980-81	44	0	44
1981-82	32	0	32
1982-83	26	0	26
1983-84	33	0	33
1984-85	30	0	30
1985-86	37	0	37
1986-87	40	0	40
1987-88	32	0	32
1988-89	22	0	22
1989-90	27	0	27
1990-91	21	0	21
1991-92	15	0	15
1992-93	20	0	20
1993-94	0	0	0

North Carolina bay scallops are typically processed close to where they are harvested. Table 7.8 shows the number of different certified plants by county based on two year groupings provided by DEH. The majority of bay scallops are harvested in Core and Bogue sounds, consequently the vast majority of bay scallops were processed in Carteret County. This is consistent with historical records (Gutsell 1928).

Table 7.8. Locations of certified bay scallop processor operations, North Carolina, 1968-1994. DEH, Shellfish Sanitation Section.

Year Groups	County							
	Bertie	Carteret	Dare	Hyde	Onslow	Pamlico	Pasquotank	Washington
1968-1982	0	124	2	2	7	5	0	0
1983-1994	1	59	2	4	6	4	1	1

7.1.6 ECONOMIC IMPACTS OF COMMERCIAL FISHING

Burgess and Bianchi (2004) estimated the total economic impact of the bay scallop harvesting sector to be roughly $108,296 in 2002. As was shown in Table 7.4, harvest sector employment in 2002 was 74. The overall average earnings per worker in the fishery for that year were $692 based on a total landings value of approximately $68,365. The additional $40,000 that went into the economy as a result of the bay scallop fishery went to wages, and non-wage expenditures such as loan payments, fuel and oil, gear, repairs, and maintenance, etc. The bay scallop economic impact in 2002 also funded the equivalent of one additional full time job in the overall economy of North Carolina.

7.2 RECREATIONAL FISHERY ECONOMICS

While it is known that there are recreational landings of bay scallops for many years, there are no data available to indicate the number of participants, nor the economic impact of recreational harvest in North Carolina.

7.3 SOCIAL IMPORTANCE OF THE FISHERY

7.3.1 COMMERCIAL FISHERY

There are insufficient data available to indicate the current social importance of the commercial fishery.

7.3.2 RECREATIONAL FISHERY

There are insufficient data available to indicate the current social importance of the recreational fishery.

7.3.3 DEMOGRAPHIC CHARACTERISTICS

There are insufficient data available to indicate the demographic characteristics of the participants in the North Carolina bay scallop fishery.

7.3.4 RESEARCH RECOMMENDATIONS

Socioeconomic surveys of commercial participants in the bay scallop fishery need to be performed to determine specific business characteristics and the economics of working in the fishery, which issues are important to these businesses, attitudes towards management of the fishery, as well as general demographic information. DMF has conducted many surveys of this type in the past, however, none of the surveys has targeted participants in a specific state-managed fishery.

Neither DMF nor DEH currently license or certify bay scallop processors. A method needs to be determined to collect these data. The initial contact might be through dealers who purchase bay scallops. It is possible that these dealers or the fishermen who sell bay scallops to these dealers could be doing the processing. It is not known how many people were shucking scallops in any year since 1994. DMF trip tickets could be used to help identify potential processors. Once the potential processors have been identified, a socioeconomic survey could be devised to gather the data needed.

Currently, there are no data collection efforts in NC to determine the amount of shellfish (including bay scallops) harvested by recreational fishermen. The planned Coastal Recreational Fishing License (CRFL) has no provision for covering shellfish, nor does the current RCGL. Without any way of knowing who is participating in the fishery, it would be impossible to obtain estimates of the economic and social impact of recreational effort in the bay scallop fishery. Should there be a way to identify recreational shellfish participants, a survey similar to the one currently being conducted for RCGL holders could be completed for recreational bay scallop fishermen. Without knowing how many participate in the fishery, it is difficult to accurately estimate the costs of such a study.

8.0 ENVIRONMENTAL FACTORS

8.1 HABITAT

The bay scallop, unlike most estuarine species, is very habitat specific in its distribution, occurring almost exclusively in high salinity beds of SAV, also referred to as seagrass beds (Thayer et al. 1984). Bay scallops are dependent on an appropriate substrate for spat settlement. Although juveniles attach to other structures, such as oyster shell, self-sustaining populations of bay scallops are primarily found in seagrass beds (Kirby-Smith 1970; Thayer and Stuart 1974; Fay et al. 1983). Other habitats that directly or indirectly support bay scallop populations include wetlands, shell bottom, soft bottom, and water column. Much of the information in this section was derived from portions of the North Carolina Coastal Habitat Protection Plan (CHPP) (Street et al. 2005).

Submerged Aquatic Vegetation

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

It is well established in the scientific literature that SAV is a valuable habitat for many fishery species in North Carolina, including bay scallop. Between 1984 and 1989, DMF sampling documented over 150 species of fish and invertebrates and at least 49 adult fish species in seagrass beds in eastern Pamlico and Core sounds, of which 34 fish and six invertebrate species were important commercial species (DMF 1990). In addition to finfish, over 70 benthic invertebrate species have been reported from eelgrass beds along the east coast (Thayer et al. 1984). SAV is federally designated as Essential Fish Habitat by the South Atlantic Fishery Management Council (SAFMC) for red drum, Penaeid shrimp, and species in the snapper-grouper complex. Bay scallops occur almost exclusively in SAV beds (Thayer et al. 1984). Although SAV has not been designated as Essential Fish Habitat (EFH) for bay scallops because it is a state-managed species, it provides numerous beneficial ecological functions.

SAV enhances the entire ecosystem by stabilizing and trapping sediment, reducing wave energy, and cycling nutrients within the system (Thayer et al. 1984). The three-dimensional structure provides a surface of attachment for small plants and animals to attach to and provides a safe refuge and foraging area for a large number of juvenile fish and invertebrates (SAFMC 1998). Beds of SAV also produce large quantities of

organic matter, which support a complex food base for numerous fish and other organisms (Thayer et al. 1984). The structure of SAV grass blades provides an excellent nursery area and enhances a safe corridor between habitats, reducing predation (Micheli and Peterson 1999). Because of the strong dependence of bay scallop on SAV, and the additional ecosystem services that this habitat provides, Strategic Habitat Areas (SHA) that include SAV habitat should be designated.

Based on location and abundance of adult scallops in seagrass beds (Figure 8.1a-b), eelgrass and shoal grass are considered the preferred settling substrate for recruiting bay scallops (Gutsell 1930; Thayer and Stuart 1974; Fay et al. 1983). Vertical attachment on grass beds above the bottom reduces threat to predation of newly settled scallops. The grass bed reduces siltation and currents, which can improve survival and growth rates of scallop spat, respectively (Castagna 1975; Kirby-Smith 1972). Bay scallops forage on microalgae such as diatoms, as well as detritus, bacteria, and other organic matter, which is abundant within SAV beds (Castagna 1975). Spawned eggs are planktonic for approximately 10 – 19 days prior to attaching to a substrate with a byssal thread (Fay et al.1983). In areas having more SAV patches interspersed over a larger area, the probability of scallop larvae finding an appropriate settlement site is greater.

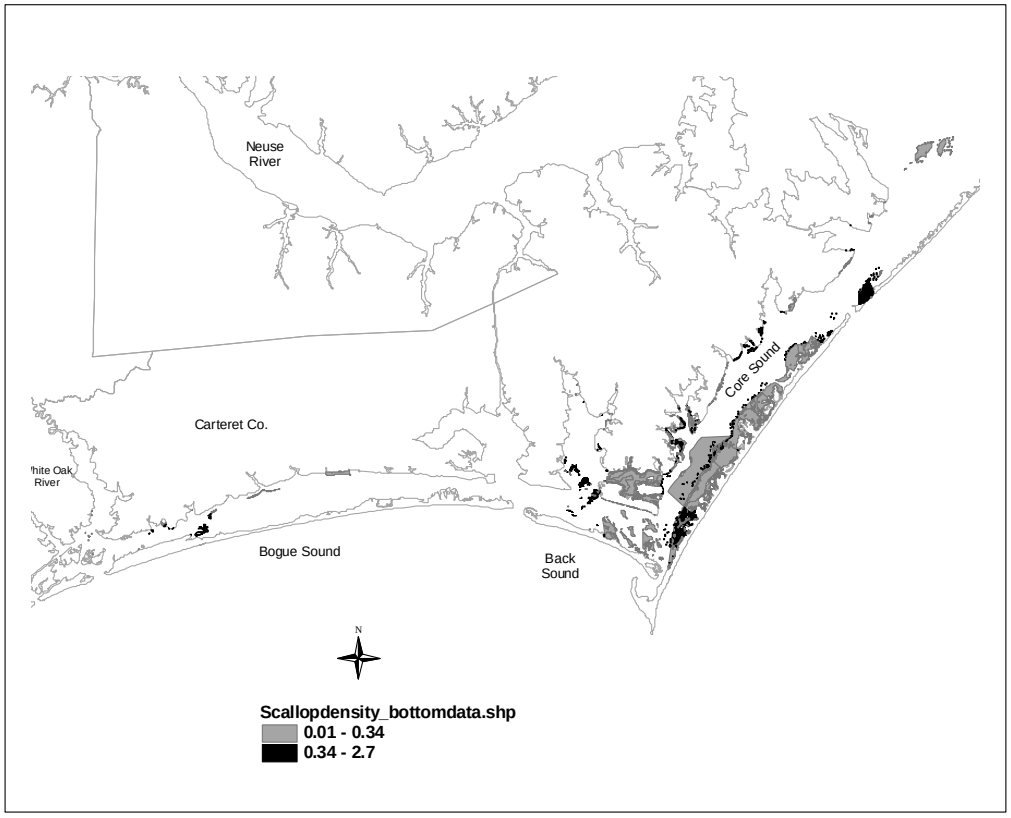


Figure 8.1a. Estimated mean density of bay scallops in Core and Bogue sounds. DMF bottom mapping data, 1996-2002. Units are number of bay scallops.

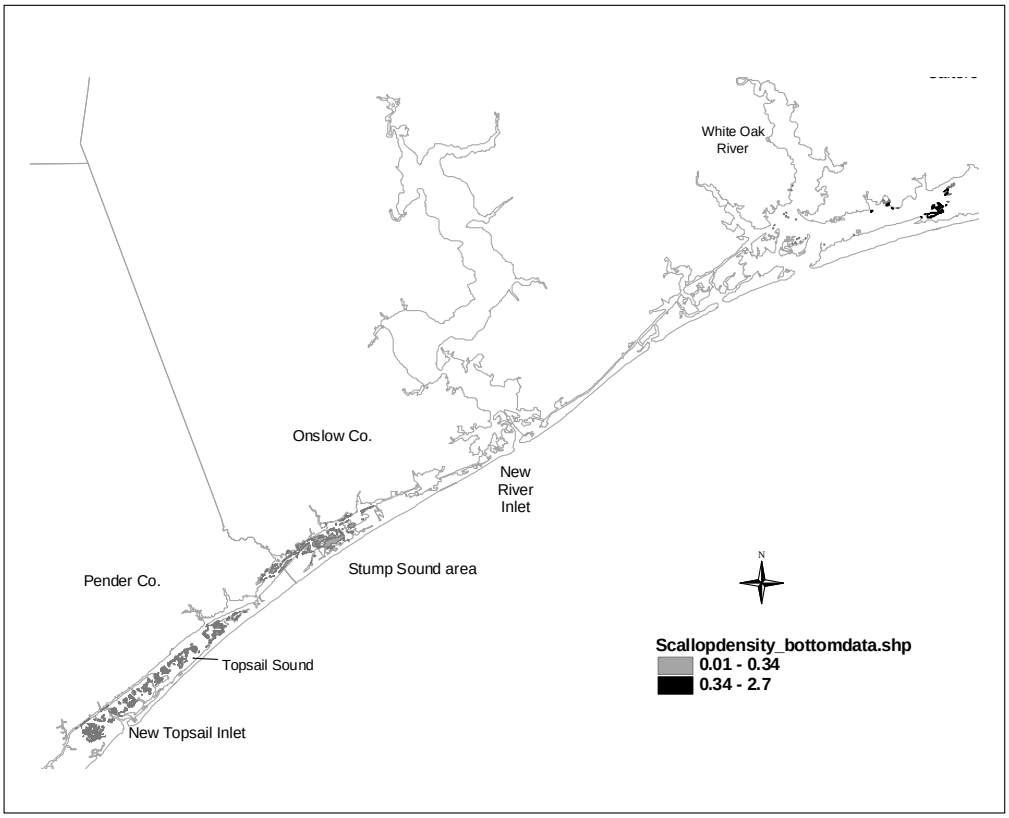


Figure 8.1b. Estimated mean density of bay scallops in Bogue Sound, New River, Stump and Topsail sounds. DMF bottom mapping data, 1996-2002. Units are number of bay scallops.

In North Carolina, SAV beds are often patchy, rather than large contiguous areas because of the currents and physical conditions of a given site (Irlandi et al.1999). The configuration and characteristics of grassbeds can affect the growth and survival of bay scallops (Irlandi et al. 1995; Irlandi et al. 1999). Scallop growth is greater in SAV beds with lower shoot density and along the edge of patches, possibly because there are higher current velocities under those conditions, which results in more food being transported to the scallops (Eckman 1987; Irlandi et al. 1995). However, the asset of increased growth rate is offset by increased predation in patchier, less dense grass beds (Irlandi et al. 1995). Predators include sea gulls, wading birds, whelks, cownose rays, starfish, pinfish, toadfish, and several crab species (Pattilo et al. 1997). Predation is discussed in a section 9.7.

Peterson et al. (1996) concluded after conducting spawner transplant experiments from Core Sound into Bogue Sound, that bay scallop populations are recruitment limited when hydrographically separated from an adult spawning stock (in other words, recruitment in one sound is limited by availability of larvae within that sound). In Bogue Sound, recruitment decreased with distance from Bogue Inlet, where currents were stronger and adult scallops more abundant. The proximity of adult scallops to

hydrologically accessible SAV could enhance the bay scallop population. SAV in areas with low current velocities will potentially be more isolated resulting in lower bay scallop recruitment.

The amount of SAV in North Carolina was estimated to be between 134,000 and 200,000 acres around 1990 (Ferguson and Wood 1994). However, the current spatial distribution and acreage of SAV may be somewhat different since some areas that historically supported SAV were not mapped, and changes may have occurred in mapped areas since the original mapping. Along the Atlantic coast, North Carolina supports more SAV than any other state, except Florida. The majority of SAV occurs in eastern Pamlico Sound and Core Sound in high salinity waters (Figure 8.2 a-b). These areas were mapped in 1990 (Ferguson and Wood 1994). Bogue Sound was mapped in 1981 (Carraway and Priddy 1983), and seagrass beds south of Bogue Sound have not been mapped at all. Because light is the primary limiting factor affecting its distribution, SAV is restricted to relatively shallow waters, usually less than 1 m in depth at low tide.

Although there are reports of large-scale losses of SAV in North Carolina's low salinity tributaries on the mainland side of Pamlico Sound (North Carolina Sea Grant 1997; J. Hawkins, DMF, personal comment, 2003), the high salinity grass beds behind the barrier islands that are inhabited by bay scallops appear relatively stable (Ferguson and Wood 1994). Changes in the amount or condition of high salinity seagrass beds will have a direct impact on bay scallop populations. Protection, enhancement, and restoration of this habitat should be high priorities for management of bay scallop populations.

The greatest threat to SAV is large-scale nutrient enrichment and sediment loading, which increases algal growth and turbidity, reducing light penetration, which negatively impacts SAV growth, survival, and productivity (Goldsborough and Kemp 1988; Kenworthy and Haunert 1991; Funderburk et al. 1991; Stevenson et al. 1993). Catastrophic losses of seagrass beds have been correlated with these water quality problems in other states in the past (Twilley et al. 1985; Orth et al. 1986; Durako 1994).

Sediment, epiphytes, or drift algae can also cover the surface of seagrass blades (Dennison et al. 1993; SAFMC 1998; Fonseca et al. 1998). Elevated nitrogen concentrations have also been shown to be toxic to eelgrass (Burkholder et al. 1992). In North Carolina, most of the low salinity areas that have experienced large reductions in SAV coverage (Tar-Pamlico River and Neuse River) are also designated Nutrient Sensitive Waters. Once SAV is lost, increased turbidity and sediment destabilization can result in accelerated shoreline erosion and make SAV recolonization more difficult (Durako 1994; Fonseca 1996). Therefore, prevention of any additional high salinity SAV loss through water quality maintenance and improvement is a high priority for bay scallop management.

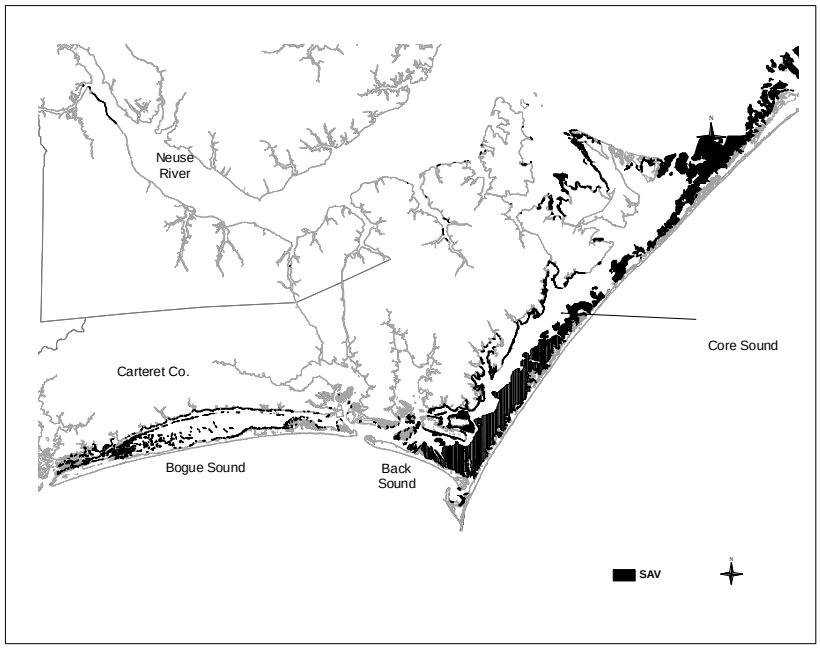


Figure 8.2a. Location of known SAV habitat in the central coast area of North Carolina (Ferguson and Wood 1994; Carraway and Priddy 1983).

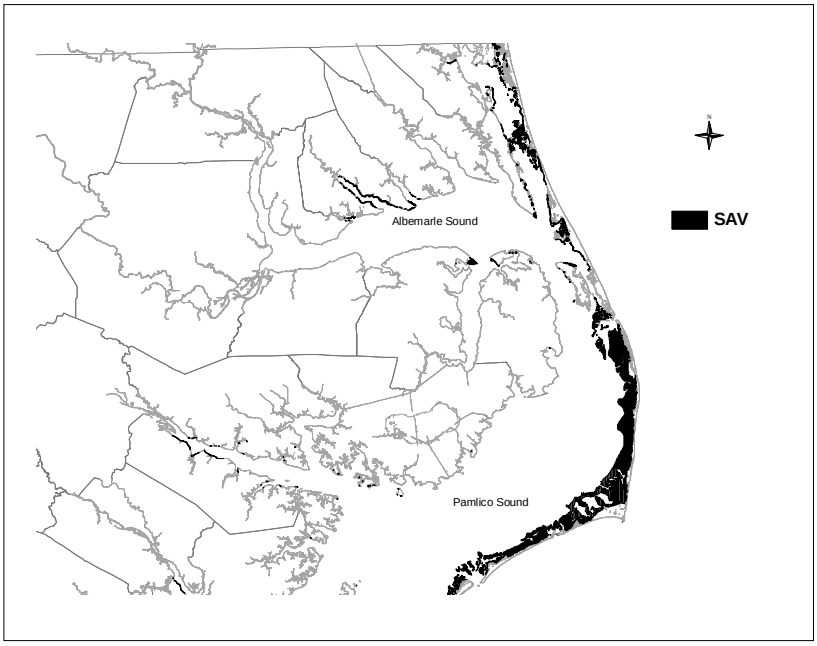


Figure 8.2b. Location of known SAV habitat in northeastern areas of North Carolina (Ferguson and Wood 1994).

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

In North Carolina, there is no official standard for light attenuation or light availability. There are Environmental Management Commission (EMC) standards for other light associated parameters including turbidity, total suspended solids (TSS), and chlorophyll *a*. Research is currently being conducted at NMFS in Beaufort to determine specific light requirements for SAV in North Carolina's estuaries and the relationship between light attenuation and other water quality parameters (P. Biber, NMFS, personal communication 2004). Preliminary results indicate that, given certain combinations of turbidity and nutrients, North Carolina's current standards may not be adequate to sustain SAV (P. Biber, NMFS, personal communication 2004). Modifications may be needed to regulationsand monitoring programs to improve their effectiveness for SAV protection. A review of current chlorophyll, TSS, and turbidity standards should be conducted to determine if they are appropriate for the protection of SAV in North Carolina waters. The DENR should work with NMFS to determine what levels of TSS, chlorophyll a and other parameters are needed to achieve desired water clarity. The feasibility of a water quality standard for light attenuation should be investigated to provide a pro-active target or standard for protection and restoration of SAV.

In addition to effects from water quality degradation, SAV can be removed or damaged by water-based activities. Dredging for navigational channels, marinas, or infrastructure such as bridges, submarine pipelines, or cables can result in large, direct losses of SAV. Beach nourishment projects that involve mining of sand from inlets or relocating of inlet channels can result in significant loss of SAV due to both immediate dredging through grass, or scouring of newly positioned channels through once shallow grassbeds. Scouring of large areas of SAV beds in western Bogue Sound occurred following the relocation of Bogue Inlet channel in 2004, for beach nourishment of Emerald Isle (W. Cuthrell, pers. com, 2006). Results from aerial photography of Bogue Sound, taken in 2006 by NOAA will aid in determining the extent of impact of that project on SAV. Docks constructed over SAV can cause immediate loss during construction or gradual loss due to shading effects. Several studies in Florida have shown that SAV was significantly reduced or eliminated under and around docks that were less than 5.5 ft above mean high water or where light received was less than 14% of the available surface light (Loflin 1995; Shafer 1999). In addition to direct damage from

docks and marinas, indirect damage to SAV can result from boating activity associated with these structures. Shoals and other shallow bottoms supporting SAV may become scarred as boating activity to and from the docking areas increases. Boat wakes can destabilize and erode SAV beds, or resuspend sediment, reducing light penetration. As additional docks and marinas are constructed along the coast, the potential for boating-related damage increases.

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

Bottom disturbing fishing gears have the potential to destroy or damage SAV (DMF 1999). Also, the Fisheries Moratorium Steering Committee's Habitat Subcommittee identified specific habitat impacts from various commercial and recreational fishing gears used in North Carolina waters, and made recommendations to minimize such impacts (MSC 1996). The Fisheries Moratorium Steering Committee presented the summary of findings to the Joint Legislative Commission on Seafood and Aquaculture of the General Assembly.

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

Mobile gear, such as long haul seines or bottom trawls, can shear or cut the blades of SAV, or uproot plants without major disruption of the sediment (ASMFC 2000). Shearing of above-ground plant biomass does not necessarily result in mortality of SAV, but shoot density is reduced, decreasing productivity since energy is diverted to replace the damaged plant tissue. In addition, the nursery and refuge functions are reduced in the absence or reduction of structure rather than new growth. Trawl doors can dig into the sediment up to one foot deep depending on gear configuration, vessel speed and other factors. Other fishing practices can cause severe disruption of the sediment and damage the roots of SAV. Gears that disturb the sediment and below-ground plant structures, like toothed dredges, heavy trawls, and boat propellers, may cause total loss of SAV in the affected area, requiring an extended time period to recover (ASMFC 2000). SAV can

also be buried by excessive sedimentation associated with trawling, dredging, and propeller wash. High turbidity from use of bottom-disturbing fishing gear can reduce water clarity, affecting SAV growth, productivity, and in some cases, survival (ASMFC 2000).

All toothed dredges can cause severe damage when pulled through SAV. Because oyster dredges, crab dredges, and hydraulic clam dredges severely impact bottom structure, there are strict limits on their use in North Carolina. The vast majority of high salinity SAV occurs in areas where such mechanical methods are prohibited.

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

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

Several studies have examined the effect of scallop dredging on seagrass beds as well as on bay scallop populations and found potential impacts (Fonseca et al. 1984; Bishop et. al. 2005). Fonseca et al. (1984) found that eelgrass shoot density and dry leaf biomass decreased significantly as dredging effort increased. Because the time of scallop harvest coincided with the period that 1) early juveniles are most abundant attached to grass blades, 2) SAV is at its lowest seasonal density, and 3) sexual reproduction through seed production of eelgrass occurs, the authors hypothesized that scallop dredging could significantly reduce the reproductive potential of the scallop population. More recently, Bishop et al. (2005) conducted experimental harvesting of bay scallops to compare the effect of scallop dredges and hand harvest on habitat, scallop populations, and harvest.

The study found that dredging removed 127 times more grass biomass than hand harvesting, but seagrass appeared to be completely recovered one month later. However on a larger scale that would be more typical of actual scallop harvesting, the decline in biomass may be significant, as Fonseca et al. (1984) concluded. Within the dredged plots, the mean number of juvenile scallops was significantly reduced one month later, which was attributed to emigration of scallops to adjacent undisturbed areas. Although scallops were able to relocate to undisturbed grass beds in this study, the authors noted that during the actual commercial season, dredging occurs over a larger spatial scale. Juvenile scallops may not be able to migrate far enough to avoid dredging or could settle on unvegetated bottom, and be more susceptible to predation and siltation (Bishop et al. 2005). The effect of scallop dredges on fish habitat is discussed in more detail in a separate issue paper.

Fishery restrictions already exist for most of the gears used in North Carolina that are potentially damaging to SAV. Additional law enforcement may be needed to enforce buffers around SAVs. The greatest potential for trawling over SAV beds is in Core and Bogue sounds (Street et al. 2005). The boundaries of No Trawl Areas in Core Sound were modified in the Shrimp FMP (DMF 2006) to avoid most grass beds. Grass beds in the west end of Bogue Sound are currently open to trawling, although shallow water depth discourages use, with the exception of a small area that is closed by proclamation. The areas where trawling is allowed in Bogue Sound and the effect on bay scallop habitat is discussed and evaluated in more detail in section 9.3.

Shell bottom

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

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

Shell bottom provides many important functions that enhance the health of the entire ecosystem for fishery and non-fishery species. Oysters filter sediment and pollutants from the water column, enhancing water quality and improving conditions for SAV growth (Coen and Luckenbach 1998). The hard multi-faceted shell structure aids in

reducing wave energy, stabilizing sediment, and reducing shoreline erosion (Lowery and Paynter 2002). Oysters, like SAV and benthic microalgae, facilitate storage and cycling of nutrients. This process reduces the likelihood of coastal eutrophication and its detrimental effects on fish and fisheries. Oyster beds also increase shoreline complexity, modify circulation patterns, and enhance fish use of marsh edge habitat (Grabowski et al. 2000).

DMF's bottom mapping program documented bay scallop occurrence in shell bottom habitat in low densities, suggesting that the shell structure is suitable, but possibly not optimal for settlement (Figure 8.3a-b, DMF unpub. data). The three dimensional hard structure functions similar to SAV in providing a hard surface area for attachment off the bottom, and some reduction in turbidity. The structure also provides protective cover for juvenile and adult bay scallops (Meyer et al. 1996; Lenihan and Peterson 1998).

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

The current distribution of shell bottom is much less than what historically occurred (Newell 1988). Mechanical harvesting of oysters (oyster dredging) was the primary and initial cause of habitat loss (DMF 2001). Most shell bottom losses have been to subtidal beds in Pamlico Sound, where DMF has also found declines in oyster recruitment. Although mechanical harvesting of oysters has been greatly restricted, reefs have not recovered, possibly due to stress from water quality degradation and increased occurrence of disease (Dermo, MSX) (DMF 2001).

Other causes of shell bottom losses include dredging for navigation channels or marina basins, or hydrological modifications. These activities can physically remove or damage existing shell bottom or result in turbidity that clogs oyster gills or completely covers shell bottom. Hydrologic modifications related to drainage for urban/suburban development is steadily increasing and will continue to degrade shell bottom habitat unless current stormwater management strategies are modified and strengthened.

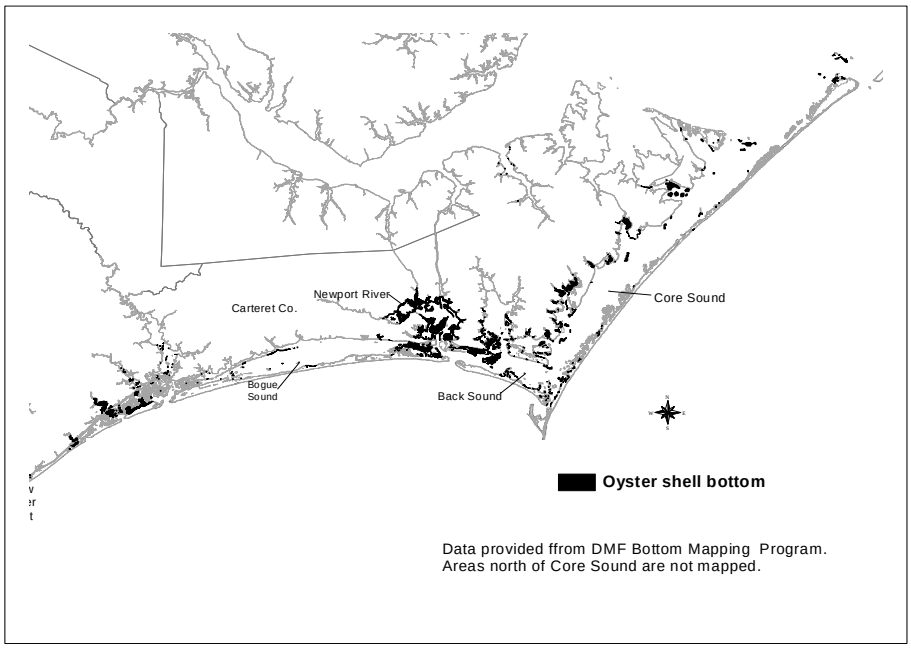


Figure 8.3a. Location of known shell bottom in the Core-Bogue Sound vicinity. DMF Bottom Mapping Program.

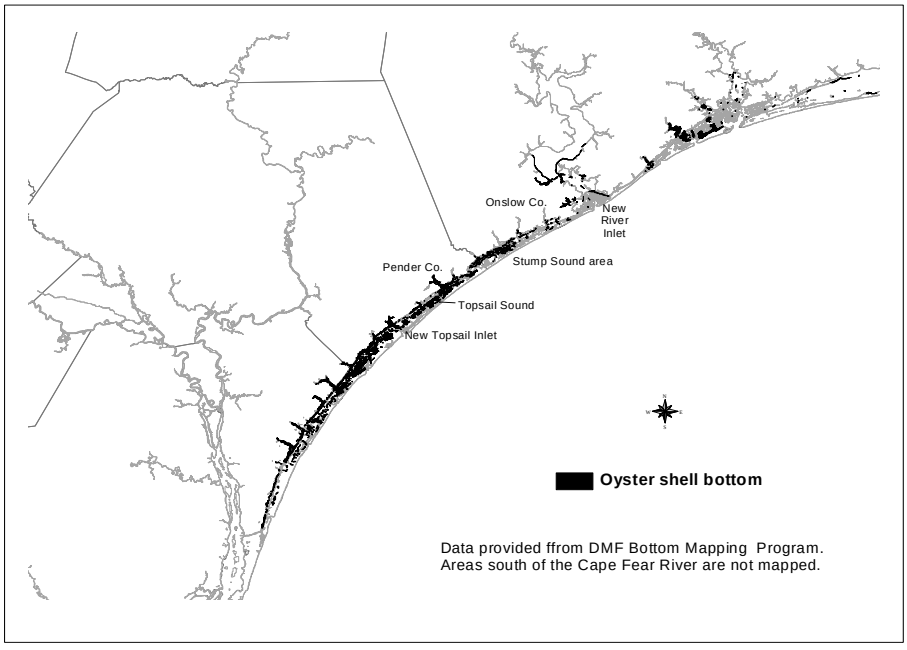


Figure 8.3b. Location of known shell bottom from White Oak River through New Hanover County waters. DMF Bottom Mapping Program.

Water column

The life history section of the plan (Section 5.1) reviewed the water quality tolerances and preferences of the different life stages of bay scallops. Bay scallops spawn in high salinity estuarine waters, and spawning is triggered by decreased water temperatures primarily in the fall. Bay scallops have a narrow range of environmental tolerances (Table 8.1). Temperature extremes, reduced salinities, and elevated turbidity stress bay scallops and can result in elevated mortality, with larvae and juveniles being most sensitive (Peterson et al. 1996).

Table 8.1. Water quality requirements of bay scallop egg and larvae (Pattilo et al 1997).

Parameter	Optimum	Max/min threshold
Temperature (C)	20-30	<32
Salinity (ppt)	18-30	>14
Dissolved Oxygen		>70ml/kg/hr
		> 7 ppm*
Turbidity (ppm)		< 500

*Peterson et al. 1996

Early larval stages are planktonic and depend on tidal currents to be transported to a suitable settlement site. Peterson et al. (1996) noted that scallops spawning in areas located near the hydrographic center of a tidal waterbody are less likely to result in reseeding of other areas due to lack of adequate current. Conversely, scallops located where tidal influence is greater, are more likely to enhance recruitment of the system.

All life stages require food to be transported to them through the water column. The most important factor controlling growth is food supply (Irlandi et al. 1999). Food is delivered from horizontal current flow as well as resuspended microalgae from the bottom. Recruitment studies have shown greater growth with increased current velocity since higher current velocities increase the flux of food (Eckman 1987; Ambrose et al. 1992; Irlandi et al. 1999). However, if currents are too great, growth can be inhibited (Eckman et al. 1989). Thus, currents and consequent food availability affect the location of successful larval settlement on other structure. Currents also aid in oxygenating the water to adequate levels (Peterson et al. 1996).

The condition of the water column and activities that threaten it are discussed further in Section 8.2, Water Quality.

Soft bottom

Soft bottom habitat is unconsolidated, unvegetated sediment that occurs in freshwater, estuarine, and marine systems. Sediment composition varies with geomorphology and location within the system and may be a factor in scallop

distribution. Bay scallops prefer shallow sandy substrate. Although soft bottom habitat is defined as "unvegetated" and lacks visible structural habitat, the surface sediments support an abundance of microscopic plants (benthic microalgae) and numerous burrowing animals hidden below the surface. Soft bottom provides a food source for juvenile and adult bay scallops. Scallops consume resuspended benthic microalgae, zooplankton, bacteria, detritus, and other organic matter (Pattilo et al. 1997). Shallow soft bottom habitat can potentially be colonized by SAV or oysters, and become more favorable for bay scallop use.

In addition to providing a food source for scallops, soft bottom plays a very important role in the ecology of estuarine ecosystems. Bottom sediments store, process, and release nutrients, chemicals, and microbes, regulating their supply in the water column (Matoura and Woodward 1983). Soft bottom also provides a rich food base for many invertebrates and fish due to the food base living on and in the sediment (Peterson and Peterson 1979; Currin et al. 1995). Although there is little structure to hide behind, bay scallops and other small organisms can find refuge from fish predators by remaining on very shallow flats that fish predators cannot access (Peterson and Peterson 1979; Ross and Epperly 1985). Scallops on flats are vulnerable to avian predators.

Activities that lead to the deepening, loss, or chemical contamination of shallow and intertidal habitat are the greatest threat to this habitat. Estuarine shoreline stabilization can degrade soft bottom habitat by reducing or eliminating the intertidal zone, deepening shallow soft bottom habitat, or contaminating sediment from leaching of toxic preservatives from wood structures (Weis et al. 1998). Refer to the water quality section (Section 9.2) for more information on chemical contamination of bottom sediments.

Soft bottom habitat may be affected by marina and dock facilities through alteration of the shoreline configuration, modified circulation patterns, and subsequently, changes in bottom sediment characteristics (Wendt et al. 1990). Because benthic microalgae, an important component of primary production in soft bottom habitat, are light-dependent, bottom sediments in dredged marinas will have reduced light availability due to the deeper water depth and shading from docking structures (Ianuzzi et al. 1996). Operation of a marina can also affect productivity of the soft bottom community due to introduction of heavy metals, hydrocarbons, and bacteria (Chmura and Ross 1978; Marcus and Stokes 1985; Voudrias and Smith 1986). Heavy metals and hydrocarbons are toxic to many soft bottom dwelling invertebrates and benthic feeding fish (Weis and Weis 1989). Dissolved oxygen (DO) may become depleted or below optimum thresholds in dredged marina basins and channels. A North Carolina marina study found significantly lower DO concentrations (less than 5.0 mg/L) inside some marinas compared to samples from water outside marinas (DEHNR 1990).

While MFC rules are designed to minimize commercial fishing gear impacts to fisheries habitat, these restrictions primarily focus on restricting the use of highly destructive bottom disturbing gear from most structural bottom habitats, such as oyster or SAV beds. Soft bottom habitat, because of its low structure and dynamic nature, has

historically been considered the most appropriate location to use bottom disturbing gear. Existing fishery rules that restrict bottom disturbing gears in soft bottom habitat include prohibition of trawls, dredges, and long haul seines in Primary Nursery Areas (PNA) [15A NCAC 3N .0104], and prohibition of trawls or mechanical shellfish gear in crab spawning sanctuaries [15A NCAC 3L .0205] in the five northern-most inlets of North Carolina during the blue crab spawning season (March-August).

Fishing gears documented to have the greatest potential to damage or degrade soft bottom are toothed dredges, followed by trawls (DeAlteris et al. 1999; Collie et al. 2000). Bottom trawling is used more extensively than dredging on soft bottom habitat in both estuarine and coastal ocean waters. Shrimp trawling accounts for the majority of bottom trawling effort in North Carolina. Trawling impacts fish habitat by directly removing or damaging epifauna, removing burrow or pit-forming invertebrates, reducing diversity and abundance of benthic community, smoothing sediment features, and increasing exposure to predators (Auster and Langton 1999; Collie et al. 1997). Sediment resuspension can increase turbidity, reducing light dependent benthic productivity, which in turn affects the benthic food web. While several studies have shown negative effects of trawling, other studies have found no negative impacts (Van Dolah et al. 1991; Currie and Parry 1996; Cahoon et al. 2002). Further research is needed to identify the location and duration of trawling in NC waters, and assess the cumulative long-term effect on the fish community.

Wetlands

Bay scallops have not been documented to settle on wetland stems in North Carolina. However, this habitat provides many ecosystem services that benefit bay scallops. Because bay scallops are sensitive to fluctuations in salinity and excessive turbidity, wetlands improve and moderate physical and chemical conditions in the water column by trapping and filtering sediment and pollutants, and storing and slowing the release of stormwater runoff into coastal waters (Mitsch and Gosselink 1993). Wetlands also contribute to estuarine primary production that is utilized by bay scallops. Wetland plants decay into detritus that is transported to soft bottom and grass beds. Nutrients from the broken down organic matter also support growth of benthic microalgae on the estuarine bottom (Peterson and Howarth 1987). Approximately 45% of salt marsh production is exported to the estuarine system in the form of detritus, dissolved organic matter, and transient fish (Teal 1962).

It is estimated that as much as 34-50% of North Carolina's original inland and coastal wetland coverage has been lost, primarily due to ditching, channelization, and filling for agriculture and development (Dahl 1990; DWQ 2000). The primary threats to wetland habitat today are dredging, filling, and hydrological alterations associated with development. Although the rate of wetland loss has slowed, losses continue to occur. Mitigation for permitted losses and voluntary restoration efforts in some areas have partially offset some recent losses. Ongoing initiatives such as wetland restoration, land acquisition and preservation, and agricultural cost-share Best Management Practices (BMP) need to be enhanced. Additional initiatives should also be implemented to protect and enhance wetland habitat.

8.2 WATER QUALITY

Adequate water quality is necessary to maintain the chemical properties of the water column needed by bay scallop populations, as well as sustain SAV, shell bottom, and soft bottom habitats that support bay scallops and the estuarine system. Human activities that degrade water quality or alter water flow can negatively impact bay scallop growth or survival. Hydrological modifications, sediment loading and eutrophication are probably the greatest water quality concerns for bay scallops, primarily because of their effects on SAV. Refer to the SAV section for specific information of nutrient and sediment loading and the effect on water clarity and SAV.

The majority of the bay scallop population occurs within the White Oak river basin. The White Oak River basin contains Core, Bogue, and Stump sounds. These areas have historically had excellent water quality; however, human development in the area is growing rapidly. According to the 2001 river basin plan, the estimated population based on 1998 census data was 149,032, with an overall density of 146 people/mi^2, which is denser than the statewide average (DWQ 2001). From 1982 to 2001 urban land cover increased by 81%, primarily by conversion of farmland and forest (Street et al. 2005). The population in the basin is expected to increase by 40,000 by the year 2015. A lack of good environmental planning was identified as a threat to water quality in this river basin at public meetings (DWQ 2001). Proper planning is essential to minimize impacts from urbanization and development.

The 2001 Use Support ratings for the White Oak River basin are summarized in six categories. Aquatic life and shellfish harvest are the most biologically pertinent categories. The aquatic life category is an indicator of whether aquatic invertebrates and fish can adequately live in the waters. Benthic invertebrate and fish community data, ambient water quality, and National Pollution Discharge Elimination System (NPDES) data are considered in the assessment. All monitored waterbodies in the White Oak River basin were rated as fully supporting in the 2001 summary (DWQ 2001). In the shellfish harvesting Use Support category, 28,058 acres (24%) of the monitored waters were rated as impaired, and 89, 601 acres (76%) were rated as fully supporting. This information is determined by shellfish closures due to elevated levels of fecal coliform.

The percent of impervious surfaces in a watershed is strongly correlated with fecal coliform abundance (Mallin et al. 2000). Nonpoint stormwater runoff is the primary cause of water quality contamination in more than 90% of shellfish closures (G. Gilbert, DEH, personal communication 2002). Impairment by fecal coliform is therefore an indication that nonpoint pollution from stormwater runoff is degrading the impaired waters. Sources of bacterial contamination contributing to shellfish closures include urbanization, construction of roadways and parking lots, pet waste, unauthorized discharges of sewage effluent, failing onsite septic systems, animal operations, marinas, farmland, forestry operations, wetland loss, and hydrological alterations (DEM 1994; Frankenberg 1995; Reilly and Kirby-Smith 1999; Schueler 1999).

Hydrologic modifications

Urbanization can have a large impact on the hydrology of a watershed as natural vegetation is replaced by impervious surfaces; streams and creeks are channelized (deepened and straightened) or ditched to improve drainage of adjacent lands; or dredged for navigation (North Carolina Sea Grant 1997), often resulting in increased runoff. Runoff from agriculture, urban/suburban development, and transportation infrastructure carries sediment, nutrient, and toxic chemical pollutants (DWQ 2000). Sediment, the number one pollutant of waterways in the United States, can clog shellfish gills or bury entire organisms (Coen et al. 1999). Excess nutrients can fuel algal blooms and low DO events, and in turn, cause mortality of benthic organisms on deep, subtidal shell bottom (Lenihan and Peterson 1998). Heavy metals, petroleum products, pesticides, and other toxic chemicals in the runoff can kill sensitive larvae (Wendt et al. 1990; Funderburk et al. 1991).

Channelized streams are often deeper, with more extreme flows. Channelization potentially affects bay scallops in several ways. By removing the meanders of the channel and increasing the slope of the shoreline, water velocities in the altered stream are higher, which can result in more rapid salinity fluctuations in the estuary, erosion of the shoreline, and increased sediment loading. In many channelized streams, storm flows are confined primarily to the main channel rather than passing through wetlands and achieving some filtration of pollutants, deposition of sediment, and water storage. In addition, the natural woody vegetation along the sides of the stream is often removed in the process of channelization. Consequently, loading and movement of sediment and other nonpoint source pollutants are often greater in channelized sections than natural streams, which can have negative impacts on water quality and therefore fish habitat (EPA 2001). Nutrient concentrations, particularly for nitrogen and phosphorus, may increase with channelization.

Low oxygen

Adequate supply of DO is critical to survival of benthic invertebrates and fish. However low dissolved oxygen is generally not an issue in shallow, tidally flushed, high salinity estuarine waters where scallops commonly occur.

Toxins

Because bay scallops are filter feeders, toxins can accumulate in scallop tissue and affect their growth and survival. While toxins can fluctuate between the sediment and water column, concentrations of toxic chemicals tend to accumulate in sediments at concentrations several orders of magnitude greater than in overlying waters (Kwon and Lee 2001). Toxic chemicals can become active in soft bottom sediment or overlying waters through several mechanisms, including resuspension from natural weather events or human activities, such as dredging and trawling.

Toxins in sediments or the water column can affect benthic invertebrates by inhibiting or altering reproduction or growth, or causing mortality in some situations (Weis and Weis 1989). Early life stages are most vulnerable to toxins (Funderburk et al. 1991). Some dinoflagellate algae can be toxic to bay scallops when present in sufficiently abundant concentrations (i.e., red tides) (Summerson and Peterson 1990). Nuisance algae blooms can also alter feeding rates of scallops and provide less nutritional value for growth. The effect of red tides and weather events like hurricanes, on bay scallop populations in North Carolina can be extreme and they are discussed in detail in Section 9.6.

While the survival of some aquatic organisms is affected by toxins, other organisms survive and bioaccumulate the chemicals to toxic levels, passing them along in the food chain. Multiple studies have shown clear connections between concentrations of toxins in sediments and those in benthic feeding fish and invertebrates (Kirby et al. 2001; Marburger et al. 2002). Heavy metal concentrations have caused mortality to bay scallops in laboratory experiments (Nelson et al. 1976).

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

The extent of sediment contamination in North Carolina coastal waters is not well known. Sediment sampling is not conducted by the DWQ since there are no sediment standards in the state. Studies examining sediment contamination at sites in North Carolina soft bottom areas have found various levels of contamination. The EPA Environmental Monitoring and Assessment Program surveyed 165 sites within North Carolina's sounds and rivers during 1994-1997 to evaluate condition of bottom sediments (Hackney et al. 1998). Highest contamination levels occurred in low salinity areas with low flushing and high river discharge. An additional source of data to determine water quality in North Carolina is the National Coastal Assessment Program conducted by the EPA. Approximately 33 stations have been sampled in the summer since 2002. Information is collected to determine sediment, benthic, and habitat indices, as well as fish tissue condition, in areas where bay scallops more typically occur and that lacked state monitoring (Pamlico, Core, and Bogue sounds). The assessment rated the Carolinian province as being in fair to good condition.

8.3 HABITAT AND WATER QUALITY PROTECTION

MFC Authority

Presently, the MFC has authority to manage, restore, develop, cultivate, conserve, protect, and regulate marine and estuarine resources. Marine and estuarine resources are defined as "All fish [including marine mammals, shellfish, and crustaceans], except

inland game fish, found in the Atlantic Ocean and in coastal fishing waters; all fisheries based upon such fish; all uncultivated or undomesticated plant and animal life, other than wildlife resources, inhabiting or dependent upon coastal fishing waters; and the entire ecology supporting such fish, fisheries, and plant and animal life." (G.S. 113-129).

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

Authority of Other Agencies

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

The FRA of 1997 mandated the DENR to prepare a CHPP (G. S. 143B-279.8). The legislative goal for the CHPP is long-term enhancement of the coastal fisheries associated with coastal habitats. The plan provides a framework for management actions to protect and restore habitats critical to North Carolina's coastal fishery resources. The CHPP was approved in December 2004 by CRC, EMC, and MFC and the Department in

July 2005 and implementation plans were developed for each Commission and the Department. The CRC, EMC, and the MFC must each implement the plan for it to be effective. These three Commissions have regulatory jurisdiction over the coastal resources, water, and marine fishery resources. Actions taken by all three commissions pertaining to the coastal area, including rule making, are to comply, "to the maximum extent practicable" with the plans. The CHPP will help to ensure consistent actions among these three commissions as well as their supporting DENR agencies and will be reviewed every five years.

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

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

8.4 RECOMMENDED MANAGEMENT STRATEGY

Suitable and adequate habitat is a critical element in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat may have a corresponding impact on water quality. Maintenance and improvement of suitable estuarine habitat and water quality is critical to successfully recovering and sustaining bay scallop stocks.

8.4.1 HABITAT

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

A strategy should be developed and adopted by the MFC and DENR to accomplish the actions outlined below. These actions address Objectives 2 and 4 of the Bay Scallop FMP. Actions 1, 8, 9, 11, 12, and 15 can be implemented by DMF/MFC. The other actions would need to be implemented through the cooperative efforts of the N.C. General Assembly and/or several divisions within the DENR. The involvement of federal agencies and increased funding (state and federal) may be necessary to accomplish these actions.

Strategic Habitat Areas

1. Identify and delineate Strategic Habitat Areas that will enhance protection of bay scallop.

Submerged Aquatic Vegetation

2. Completely map all SAV habitat in North Carolina.
3. Remap SAV habitat in Core and Bogue sounds and assess changes in distribution and abundance over time.
4. Restore historical distribution and acreage of SAV.
5. Aggressively reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV habitat, using regulatory and non-regulatory actions.
6. Evaluate dock criteria siting and construction to determine if existing requirements are adequate for SAV survival and growth, and modify if necessary.
7. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV and other fish habitats.

8. Evaluate and adjust as necessary dredging and trawling boundaries in Core and Bogue sounds to protect and enhance SAV habitat.
9. Seek additional resources to enhance enforcement of, and compliance with, bottom disturbing fishing gear restrictions that protect SAV and other fish habitats.
10. Work with NOAA and DWQ to determine appropriate levels of TSS, turbidity, chlorophyll a, and other water clarity parameters to achieve adequate water quality conditions for SAV growth.

Shell bottom

11. Conduct research to evaluate the role of shell hash and shell bottom in bay scallop recruitment and survival, particularly where SAV is absent.
12. Accelerate and complete mapping of all shell bottom in coastal North Carolina.

Soft bottom

13. Protect shallow soft bottom habitat through proper siting and construction of docks, marinas, and shoreline stabilization structures.
14. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.
15. Evaluate the effects of clam kicking and trawling on soft bottom habitat and bay scallops.

Wetlands

16. Prevent loss of additional riparian wetlands through the permitting process, land acquisition, and land use planning.
17. Restore coastal wetlands to enhance water quality conditions for bay scallops.

8.4.2 WATER QUALITY

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

The MFC has no regulatory authority over water quality impacts other than the effects of fishing practices. The MFC and DMF should highlight problem areas and advise other regulatory agencies (EMC, DWQ, DEH – Shellfish Sanitation, Division of Land Resources, COE, and local governments) on preferred options and potential solutions.

The MFC and DMF should continue to comment on activities (state, federal, and local permits) that may impact estuarine water quality and work with permitting agencies to minimize impacts. Additionally, the MFC and DMF should solicit and support Fishery Resource Grant (FRG) projects that may provide information necessary for protection,

management, and restoration of water quality. Water quality standards should be based on the assimilative capacity of, and impacts to, the entire system. Several plans for water quality management have recommended strategies that need to be implemented to improve water quality. A strategy should be developed and adopted by the MFC and DENR to accomplish the actions outlined in Section 10.1.2.4, and to assure that recommendations of existing and future water quality plans are addressed in a timely manner. The DENR should develop a strategy to fully support CHPP implementation with needed staff and funding. Water quality protection and restoration are essential to accomplish the goal and objectives of this plan.

Actions would need to be implemented through the cooperative efforts of the N.C. General Assembly and several divisions within the DENR. The involvement of federal agencies and funding may also be needed to accomplish these actions. Many of the following actions were taken directly from the CHPP.

1. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.
2. Increase on-site infiltration of stormwater through voluntary or regulatory measures.
3. Provide more incentives for low-impact development.
4. Work with DWQ and EMC to modify stormwater rules to more effectively reduce runoff volume and pollutant loading to coastal waters to levels that protect and enhance fish habitats vital to bay scallops.
5. Reduce impervious surfaces associated with new development as much as possible and reduce the maximum amount of impervious surfaces allowed in the absence of engineered stormwater controls.
6. Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading.

9.0 PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

9.1 NO DATA ON RECREATIONAL HARVEST OF SHELLFISH[1]

I. ISSUE

No recreational shellfish harvest data are currently being collected.

II. BACKGROUND

Despite the importance of the commercial shellfish fisheries (molluscan) to the state, very little data exists on recreational shellfish harvest. A 1991 phone survey conducted by the MRFSS indicated that 3% of households in coastal North Carolina participated in recreational shellfishing (D. Mumford, DMF, personal communication 2005). Recreational data are being collected by MRFSS for finfish, but the survey does not currently collect shellfish data. Although the Fisheries Reform Act of 1997 (FRA) created the RCGL to allow recreational fisherman to use limited amounts of commercial gear to harvest seafood for personal consumption, shellfish gear was not authorized under this license. Therefore recreational harvest data are not collected through this license. Any state resident is able to purchase a commercial shellfish license, at a lower cost than a RCGL, and use any commercial shellfishing gear to harvest shellfish in commercial quantities for recreational purposes. However, these harvests are not recorded because they are not sold. In addition, the 1997 FRA requires DMF to prepare FMPs for all of the state's commercially and recreationally significant species. Our state's shellfish fisheries are exclusively under North Carolina jurisdiction, so effective state FMPs are extremely important. This lack of recreational shellfish landings data makes it impossible to estimate the impacts of recreational harvest on shellfish.

III. DISCUSSION

The collection of shellfish recreational harvest data, along with commercial landings data available through the North Carolina Trip Ticket Program would provide a better estimate of fishing mortality and relative abundance of bay scallops. It would improve our knowledge of the variation in abundance caused by a combination of both fishing effort and environmental change. A more accurate account of landings would allow managers to examine the proportional harvest of recreational and commercial fisheries and make better decisions on management strategies for both harvest sectors. It is imperative to collect high quality recreational harvest data to address potential management issues such as harvest limits, size limits, and gear restrictions. To better manage shellfish fisheries, information on recreational harvest such as effort and size distribution for each species by area are needed.

The best way to capture recreational shellfish harvest data is to have a coastal recreational fishing license for both finfish and shellfish. This would create a sampling

[1] Presented to the Bay Scallop Advisory Committee on April 3, 2006.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.

universe of all recreational fishermen that fish in coastal waters. Within this sampling universe, those recreational fishermen who fish for shellfish can be surveyed for information such as the amount of catch, estimates of fishing effort, gear used, and area fished. Sampling strategies can be developed without having a sampling universe defined by a license, but surveys conducted that lack the advantage of contacting known participants would be both costly and less precise.

Both the Hard Clam FMP (DMF 2001) and the Oyster FMP (DMF 2001) supported the adoption of a mechanism that would provide data on recreational shellfish harvest. As a result of this recommendation, House Bill 1427 was introduced before the general assembly in 2004 to establish a recreational shellfish license. This license would have been for shellfish only and would have been instituted on a trial basis for three years. However, the bill was never passed. In 2004, House Bill 831 did pass a saltwater fishing license that mandated those individuals recreationally fishing for both finfish and shellfish obtain a license. However, the state legislature revisited the issue in 2005 and replaced the saltwater fishing license with the CRFL. The CRFL, which will be implemented January 1, 2007, will only be required when targeting finfish. It will not be required for shellfishing.

DMF has developed an optional survey to obtain additional information on shellfishing from CRFL license holders at the point of license sale. If an individual chooses to participate in the survey, one of the questions will be, "Do you harvest oysters, clams, or scallops? (Yes/No)". This survey is intended to identify a pool of individuals to survey at a later date with more specific questions regarding their harvest. However, this survey will only be presented to people who buy a CRFL from Wildlife Resources Commission (WRC) or DMF license sales offices or the Internet. Initially, it will not be presented to people who buy a CRFL from other WRC license agents (i.e., Wal-Mart, bait and tackle shops, etc.), and it is likely that the majority of people who buy a license will never be presented with the opportunity to participate in this survey. This series of optional survey questions will be assessed after April 1, 2007 and may be expanded to include all CRFL sales agents. Additionally, this survey would neglect any individuals who fish exclusively for shellfish and would therefore not purchase a CRFL.

It is believed that some recreational fishermen purchase a commercial shellfish license because the license is easy to obtain (available to any NC resident), is relatively inexpensive ($25), and allows fishermen to harvest more shellfish than the recreational limits allow. The Trip Ticket Program will only capture landings of fishermen who sell their catch to certified dealers. Therefore, identifying individuals who purchase a commercial shellfish license but do not have any record of landings within the North Carolina Trip Ticket Program will provide a pool of people to survey to determine if the license is indeed being used for recreational purposes. This is also true for fishermen who buy a SCFL with a shellfish endorsement, but do not have any record of landing shellfish. Although this approach limits the sampling universe to only recreational fishermen who bought a commercial license and eliminates those recreational fishermen who did not buy a license, it would still provide some information on recreational shellfishing that can occur without being constrained to recreational harvest limits.

Marine Patrol periodically stops fishermen that are shellfishing in North Carolina waters to assure that fishermen are not harvesting shellfish from polluted areas and to check for compliance with harvest restrictions. As a result, recreational fishermen are encountered during their stops. It is feasible that Marine Patrol could survey those fishermen that have already been stopped to get detailed information on recreational shellfish harvest.

IV. CURRENT AUTHORITY

North Carolina General Statutes

113-169.2 Shellfish license for NC residents without a SCFL

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

03K .0105 Harvest of crabs and shellfish.
03K .0501 Bay Scallops – Seasons and harvest limits.
03K .0502 Taking bay scallops at night and on weekends.

V. MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*
- \+ No additional regulation on recreational fishery
- \- Information not available for recreational harvest estimates

B. Intercept survey
- \+ Catch/effort data per species collected
- \+ Gear data collected
- \+ Species identification and size data collected
- \+ Ability to gather socioeconomic data
- \- Expensive to implement
- \- Difficult to intercept shoreline fishermen
- \- Unable to intercept fishermen originating from private residence

C. Phone survey
- \+ Kinds of species caught
- \+ Gear data collected
- \+ Some effort information (number of trips)
- \+ Ability to gather socioeconomic data
- \- Sampling universe not defined
- \- Expensive to implement
- \- Unable to get individual species data (lengths, etc)
- \- Survey dependent on recollective memory

- Intercept survey required to extrapolate trip data
- Estimates would be less precise

D. Survey fishermen that use commercial licenses for recreational harvest
+ Ability to gather socioeconomic data
+ Easily able to identify a sampling pool
- Leaves out recreational fishermen who do not buy a commercial license

E. Require a license for harvesting shellfish
+ Defines a sampling universe
+ Provides revenue for phone survey
+ Ability to gather socioeconomic data
+ Infrastructure already exists for implementation
- Additional regulation on the recreational fishery
- Additional financial burden on the recreational fisherman

F. Recreational shellfish permit
+ Defines a sampling universe
+ Ability to gather socioeconomic data
- Additional regulation on the recreational fishery
- No revenue for surveys
- Administrative burden

G. Marine Patrol survey
+ Gathers some catch data
+ No additional cost
+ Already stop shellfishermen
- Limited sampling universe
- Increased burden on law enforcement
- Haphazard sampling scheme

VI. MANAGEMENT RECOMENDATIONS

MFC selected management strategy
- Recommend produce a mechanism to obtain data on the recreational scallop harvest.

AC and DMF
- Recommend a recreational license for harvesting shellfish.
- Recommend surveying fishermen that use commercial licenses for recreational harvest.

VII. RESEARCH RECOMMENDATIONS

None

9.2 COMMERCIAL BAY SCALLOP FISHERY MANAGEMENT MEASURES[2]

I. ISSUE

Implications of different management approaches to the bay scallop commercial fishery.

II. BACKGROUND

The North Carolina bay scallop commercial fishery has had fluctuations in landings throughout its history (Figure 9.1). In the 1950s, the average annual commercial harvest was 24,708 bushels per year and increased in the 1960s to 68,406 bushels per year. The 1970s showed some decline in commercial landings from the previous decade and harvest improved in the 1980s, which increased the average annual landings to 45,595 bushels per year. A decline in the late 1980s continued into the 1990s with average annual commercial landings of 14,647 bushels per year. For the past five years, landings have been minimal each year ranging from 4,206 bushels in 2000 to less than 30 bushels in 2004. The average annual commercial landings for the last five years (2000-2004) have only been 2,282 bushels per year.

The general harvest season for bay scallops in North Carolina has remained relatively unchanged since the 1920s with a few short openings due to social or predator interaction concerns (Gutsell 1928; David Taylor, DMF, personal communication 2006). The main harvest season begins in January when peak landings occur and landings slowly diminish as the season progresses to the last Friday in May. Shorter openings in recent years included: 4 days in December of 1994 to 1998 and a limited season in a small area of Back Sound, North River, and the Straits from August 1 to September 15 in 2001 to 2003 to allow harvest before the cownose ray migration and resulting predation. A relationship between meat weights and gonadal development guides fisheries managers in setting the bay scallop season. The season allows for the completion of spawning and an increase in meat size in order to obtain the highest yield (Figure 9.2). In general, adductor meat weights are at their lowest during the fall when gonad development is high. After bay scallops begin to spawn in October, meat weights begin to increase with maximum meat weights occurring from February to May (Figure 9.2) (Spitsbergen 1979; Kellogg and Spitsbergen 1983).

[2] Presented to the Bay Scallop Advisory Committee on May 15, 2006.
Presented to the Rules Advisory Team on June 1, 2006.
Presented to the Bay Scallop Advisory Committee on June 15, 2006 with DMF proposed rule changes.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.
Presented to the Rules Advisory Team with Bay Scallop Advisory Committee proposed rule change on September 7, 2006.
Finalized Bay Scallop Advisory Committee recommendations after public review on January 5, 2007.
Finalized rules by the Rules Advisory Team on February 1, 2007.

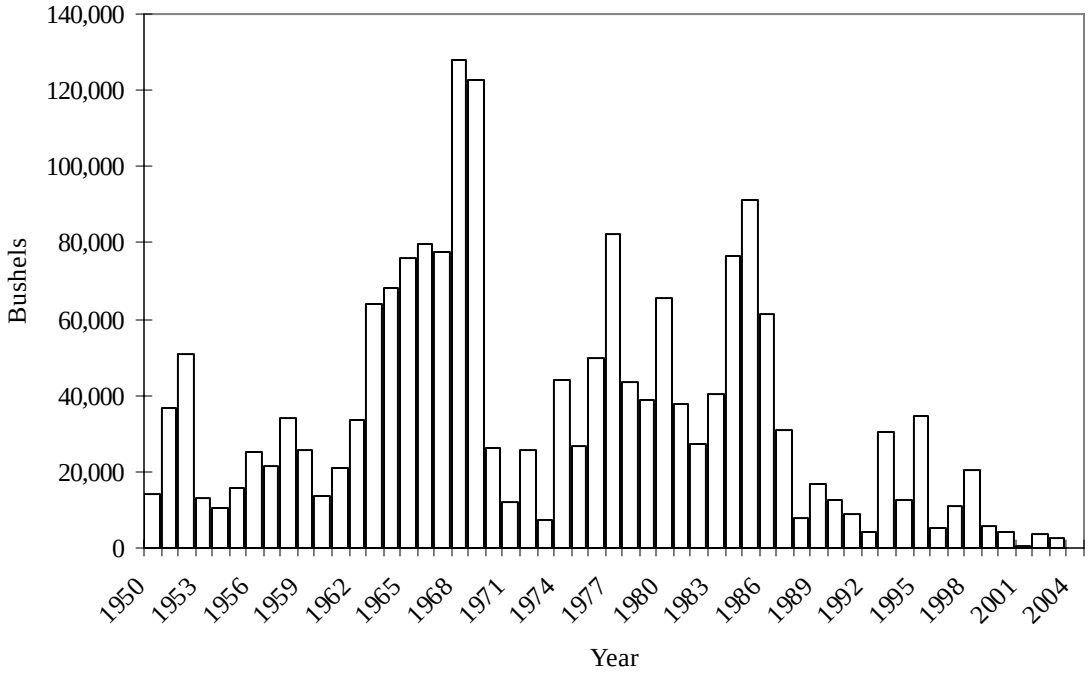


Figure 9.1. North Carolina commercial bay scallop landings (bushels), 1950-2004. DMF Trip Ticket Program.

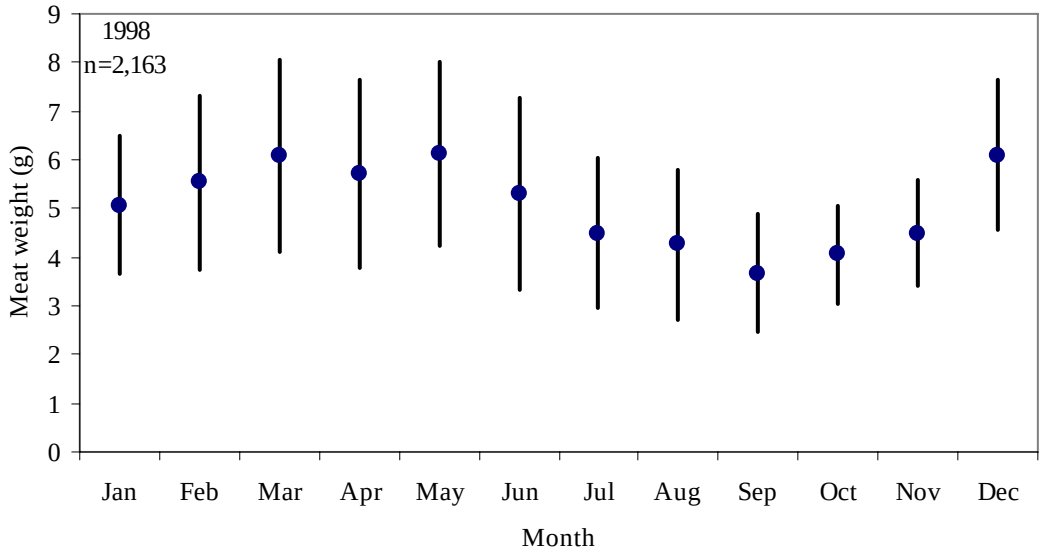


Figure 9.2. Average monthly bay scallop meat weight (g) in 1998 with one standard deviation from the mean. Using bay scallops with shell height $\geq$ 50 mm only to ensure complete maturity. DMF biological sampling.

North Carolina's bay scallop stocks are listed as concern, because of declining harvest levels. Species are designated by the DMF as concern because of incomplete or unavailable stock assessments, or because of indirect influences such as disease, habitat degradation, weather, or the nature of the fishery (i.e., roe fisheries). Since bay scallops are considered an annual crop, a stock assessment cannot be completed. The population size is regulated by environmental conditions, and although fishing effort reduces the population size over the season, fishing effort usually does not impact the subsequent year class strength unless the spawning stock is reduced below a minimum threshold level. Annual commercial landings are probably a good indication of relative abundance with variation caused by a combination of both fishing effort and environmental change.

The bay scallop population in North Carolina was decimated by a red tide event (*K. brevis*) in October of 1987. During that time the bay scallop fishery decreased to less than 15% of the historical average (1965-1986) with the largest losses occurring in Bogue Sound, followed by Back Sound and Core Sound. Slow recovery from this decline suggests that bay scallops in North Carolina are recruitment limited within the different water basins (Peterson and Summerson 1992). Recently, bay scallop populations in both Core Sound and Bogue Sound have become virtually non-existent largely due to heavy predation by cownose rays (*R. bonasus*) in the fall, (Powers and Gaskill 2005).

III. DISCUSSION

Harvest seasons, trip limits, and gear limitations have been the management measures used by DMF for bay scallops. One management approach is *status quo*, which would leave the management measures in place. The DMF currently reviews landings (commercial) and environmental factors annually for the MFC stock status report. This past year (2006), DMF took action not to open the harvest season for bay scallops both recreationally or commercially due to low abundance indices in 2005.

A stepwise tactic for management decisions is another approach for bay scallop management. The stepwise approach is two-fold: 1. requires establishing specific triggers to increase management measures if the annual landings go below a selected threshold, and ; 2. implement regulations to ensure that harvest either does not occur or remains very low over a period of time before permitting fishing to return to sustainable levels.

Step 1: Establish specific triggers for increased management measures

This option would establish a threshold based on either landings or an independent index over a particular time period. One of the biggest difficulties with this method is choosing the most accurate data collection method that is a true reflection of abundance of the species through a long enough time series. The only independent index of abundance has only had consistent sampling since 1998 and will not provide a long enough time series to determine a threshold. Commercial landings are the only information available that covers an adequate time period and are a general reflection of relative annual bay scallop abundance.

Commercial landings data collection by National Marine Fisheries Service (NMFS) began in 1972 and DMF in 1978, which collected landings from dealers only on a voluntary basis. The initiation of the trip ticket program in 1994 began mandatory reporting of landings and the collection of participation and effort information. Landings from before the red tide event in 1987-1988 show higher annual average landings with much higher variability than the period after the red tide event. Landings after the red tide event show sharp declines and do not reflect landings during a period of optimum harvest. When selecting a time period, it is most appropriate to consider the longest time period with both high and low annual landings to minimize sampling limitations.

The 1972-2004 time period provides the longest interval with an appropriate amount of high and low annual fluctuations to establish landings thresholds, but pre-1994 landings information was only collected on a voluntary basis (Figure 9.3). The average annual landings for the 1972-2004 period was 28,260 bushels with a lower threshold of 3,093 bushels based on one standard deviation below the mean. Since 2001, landings have been below the lower threshold. For a more conservative approach it may be appropriate to choose a landings threshold in between the average landings and lower threshold (i.e.: halfway point=15,465 bushels) to allow regulatory changes enough time to prevent further decline. This halfway point shows most annual landings after the red tide event were below this level (12 of 17 years). In this stepwise approach annual commercial landings below the 15,465 bu. threshold would initiate management measures to reduce fishing effort and determine other indirect factors causing the decline.

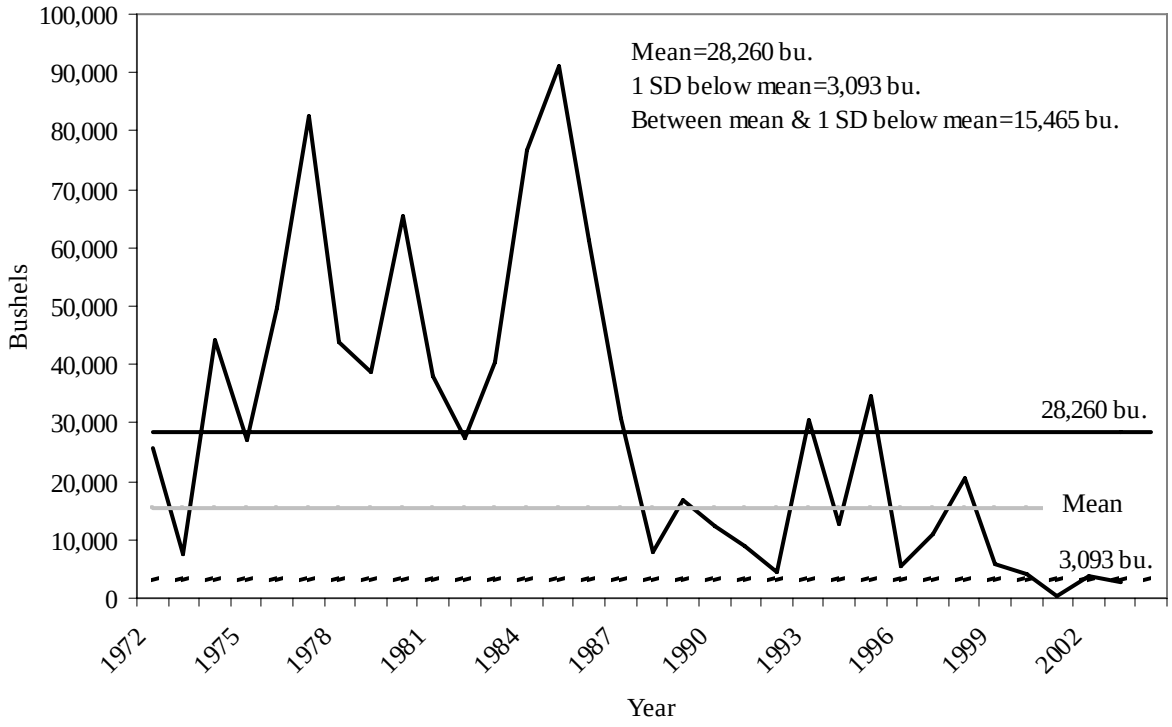


Figure 9.3. Commercial bay scallop landings (bushels) showing the mean and lower threshold as one standard deviation (SD) from the mean, 1972-2004. The gray line indicates halfway point between the mean and lower threshold at 15,465 bushels. DMF Trip Ticket Program.

Step 2: Implement regulations when commercial landings reach a minimum threshold

There are several regulatory measures that can be considered in the management of bay scallops. These are: quota, limited entry, size limits, meat counts, seasonal or area closures, trip/harvest limits, gear restrictions, prohibited take or a combination of these measures.

Quota

A quota is the maximum amount of shellfish that can be legally landed within a specified time period. The intent for implementing a quota on any fishery is to prevent further expansion and reduce or stabilize harvest. There have been a lot of fluctuations in annual landings of bay scallops in recent years and it would be difficult to establish a reasonable quota. Due to variability in recruitment, a quota may not prevent overfishing during years where there is poor recruitment. A quota has to be monitored with dealer reporting, which would be an additional burden to commercial fish house dealers and DMF.

Limited Entry

A limited entry system would prevent expansion in the commercial fishery beyond a specified level of participants. Overfishing could still occur because it would not prevent an increase in effort by those individuals allowed to participate in the fishery. Determining who is allowed to participate in the fishery is difficult when a fishery is in decline. As a fishery declines, many participants will often work only intermittently because they will have to find other sources to contribute to their income. Deciding who would have to be eliminated from the fishery becomes harder for managers to decide as landings become lower and more irregular.

Section 2.1 of the Fisheries Reform Act (G.S. 113-182.1) concerning Fishery Management Plans states that the North Carolina Marine Fisheries Commission (MFC) can only recommend that the General Assembly limit participation in a fishery if the MFC determines that sustainable harvest in the fishery cannot otherwise be achieved. Sustainable harvest cannot be determined for bay scallops at this time, therefore limited entry is not considered an option.

Size Limits

Size regulations are a management tool based on the species' reproduction and life history. Minimum size limits allow shellfish to spawn at least once, contributing to the growth of that population before capture. Spawning in North Carolina occurs primarily in the fall during decreasing water temperature. Adults reach 50% maturity by August when the gonad weight begins to increase for the spawning period. The shell height for mature bay scallops is about 40 mm (1.6 inches). Other states, including Massachusetts, Connecticut, and Rhode Island, have used an annual growth ring as the minimum size limit for the harvest of bay scallops. The annual growth ring is caused by the slow growth during the first winter of life. New York just initiated a minimum size limit of 2 ¼ inch shell height in 2005. North Carolina has never issued a minimum size limit for bay scallops.

Meat Counts

Meat counts (number of scallop adductor meats/pound) are another management tool based on the species reproduction and life history. DMF currently begins the main harvest season when meat size is increasing. In bay scallops, adductor meat weights tend to be lowest during the fall when gonad development is high. Maximizing the yield from the resource by delaying harvest until the size of the scallop meat reaches its optimum weight may increase the value of the fishery. A study conducted by Kellogg and Spitsbergen (1983) from 1975-1978 and on a smaller scale from 1980-1981 developed a predicative growth model for bay scallops meat size during the harvest season and incorporated it into a bioeconomic model. Simulation runs from the model indicate that the value of the harvest would improve by delaying harvest until January.

Seasonal or Area Closures

Seasonal closures are intended to protect a portion of the stock in order to increase spawning stock biomass with the least impact to fishermen. This management measure has been used by DMF in the past for bay scallops. The season allows for the completion of spawning and an increase in meat size in order to obtain the highest yield. Short openings have been allowed in December for "Christmas money" and August for predator interaction with cownose rays.

Area closures can provide a safe haven for shellfish to live and reproduce and can protect habitat that is essential to a portion of the life history of the species. Shellfish are particularly vulnerable to exploitation because they reoccur in specific areas that become well known to harvesters (Smith and Rago 2004). Specific spatial distribution of bay scallops in North Carolina has not been quantified. Quantifying productive scallop "beds" in North Carolina would be a positive step in identifying essential areas to protect bay scallop recruitment.

Rotational area closures have been used in the sea scallop fishery with some success in the United States beginning in 2000 (Hart 2003). This approach has also been used in the mechanical clam harvest fishery of North Carolina to allow clams to repopulate in the northern portion of Core Sound by rotating its opening with a new area in southeastern Pamlico Sound since 2002 (DMF 2001). This strategy is considered a precautionary approach to management in that it allows rotation of areas where lower productivity occurs with areas where abundance and spawning is higher. The rotational area management strategy for sea scallops has shown that it may balance higher yields of meat, maintain recruitment, and reduce habitat damage (Smith and Rago 2004). Determining high and low productive areas of bay scallop abundance is essential in establishing this strategy.

Economic impacts on fishermen from a closure will vary by area and gear type. Core, Back, and Bogue Sounds are the primary waterbodies where bay scallops are harvested in North Carolina and accounted for 97% of the landings from 1994 to 2004 Bogue Sound was the dominant waterbody for bay scallop landings from 1972 to 1981 and accounted for 53% of the total landings (Figure 9.4). From 1982 to 1993, Core Sound became the dominant waterbody for bay scallop landings, and accounted for 48% of the total landings. The highest annual bay scallop landings were 59,482 bushels from Core Sound in 1985. Landings declined in both areas in 1987 before the red tide event occurred in October. Core Sound continued to be the dominant waterbody since the initiation of the DMF Trip Ticket program in 1994 and accounted for 74% of the overall landings from 1994 to 2004. The last year with a sizable amount of landings was in 1995, when 32,798 bushels were harvested from Core Sound.

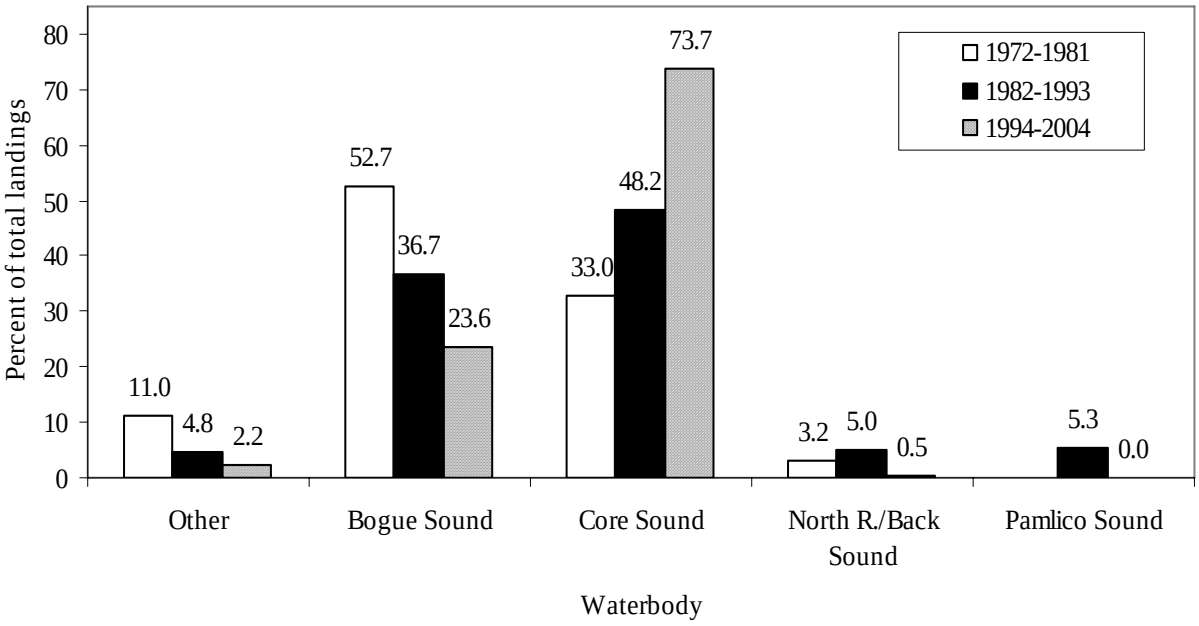


Figure 9.4. Average percentage of total bay scallop landings by waterbody for three distinct time periods: 1972-1981, 1982-1993, and 1994-2004. Other waterbodies include: Inland waterways, New River, White Oak River, Neuse River, Newport River, Stump Sound, and Topsail Sound. DMF Trip Ticket Program.

Trip/ Vessel Harvest Limits

Trip or vessel harvest limits have already been in place in the bay scallop fishery for some time. Twenty standard U.S. bushels per person per day not to exceed a total of 40 standard U.S. bushels per day is allowed during the regular January through May commercial season. When the limited season from August 1 through September 15 is open, no more than 10 standard U.S. bushels per person per day not to exceed a total of 20 standard U.S. bushels per day is allowed. Proclamation authority has issued lower trip limits in recent years.

Gear Restrictions

Gear restrictions are already in place to reduce impacts on seagrass beds where bay scallops are found. Hand rakes are limited to no more than 12 inches wide or weighing more than six pounds. Bay scallop dredges cannot weigh more than 50 pounds and cannot be equipped with teeth. Any other instrument or device designed to drag the bottom to aid in the taking of bay scallops is also prohibited. Concern for habitat loss makes scallop dredging an intensely managed portion of the fishery and typically is only allowed to harvest two days a week. No dredging was allowed in Bogue Sound from 1993 to 1997. Beginning in 2000, dredging has been delayed until later in the season after scallops have been harvested out of the shallow areas. No mechanical harvest occurred in 2001 (Figure 9.5).

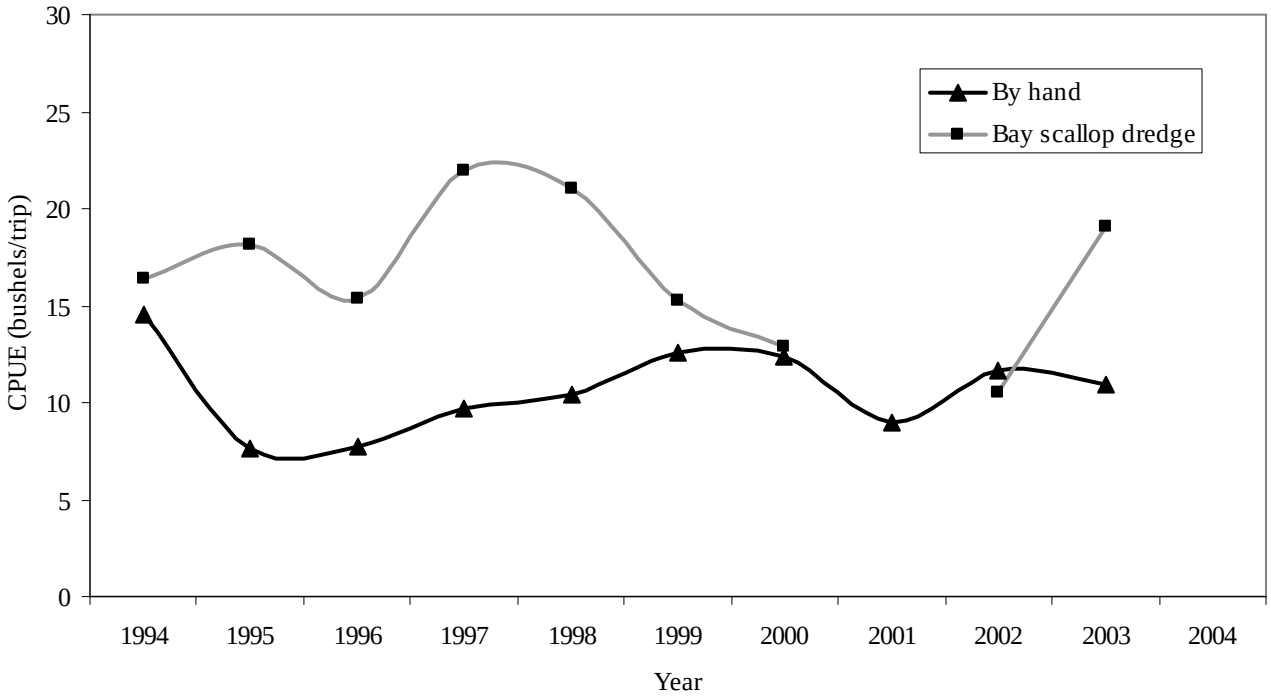


Figure 9.5. Annual catch per unit effort (CPUE, bushels/trip) for bay scallop dredges only (mechanical) and hand harvest of bay scallops in North Carolina, 1994-2004. DMF Trip Ticket Program.

Prohibited take

No action to improve the recovery of the bay scallop population will prolong the existence of a small fishery with little economic return to the participants. The most recent decrease in landings value is the lowest on record (See the Socioeconomic aspects of the bay scallop fishery section). Full recovery of the population could take a number of years and depends on many variables. The structure of the fishery during and after a recovery period will probably change based on the severity of the management measures. DMF did not open a bay scallop harvest season this past year (2006).

Prohibiting the take of bay scallops will require DMF to monitor the stock in the absence of commercial landings using a fishery independent survey(s). Stock indicators will need to be established in order to allow restricted harvest if the population level shows improvement. DMF cannot quantify a stock indicator from the current monitoring program. The most consistent fishery independent sampling has only occurred well after the red tide event of 1987-88 when commercial landings have been very low for bay scallops as compared to the rest of the time period. Historical knowledge of the independent sampling program may be the only avenue in which a stock indicator is determined at this time using this sampling design.

DMF Fishery independent sampling of bay scallops for management information in North Carolina has been conducted since 1975, and has varied from monthly

examinations at twenty stations to seasonal monitoring at fewer locations using a bay scallop dredge. Estimating scallop abundance from the survey throughout the entire time series is not possible due to tow time differences, station changes, and variations in the distance towed per station. Since 2001, DMF has consistently sampled the same stations in both Core and Bogue Sound in July and November. Increasing the survey sampling from July through February would improve estimates of annual adult and juvenile abundance and the spawning condition of the stock.

Florida has maintained a fishery independent survey for several years that has quantified specific levels of scallop densities in 600 m^2 transects (Arnold et al. 1998). Less than 5 scallops per 600 m^2 is considered a collapsed area, between 5-25 scallops per 600 m^2 is in transition, and greater than 25 scallops per 600 m^2 is considered a healthy scallop density. These densities were based on several years of sampling. Some areas will never exceed a mean density of 5 scallops per 600 m^2 (B. Arnold , Florida Fish and Wildlife Research Institute, personal communication 2006). It has also been found that low-density sites support little if any recruitment relative to high density sites (Arnold et al. 1998). Also the bay scallop population of Florida has not been historically as abundant as in North Carolina so these densities are not practical for North Carolina.

A study by Summerson and Peterson (1990) presented densities of harvestable adults and juveniles in North Carolina before and after the red tide event in 1987-88. Densities were based on the mean number found in 0.5 m^2 quadrants taken in early December from 1983-84 and 1986-1988 in six traditionally known beds. Sampling was stratified by depth and location within the depth zone and between 35 and 103 replicate samples were taken using a suction dredge to vacuum out a cylindrical quadrant within the designated area. Bay scallop recruitment after the red tide in 1988 failed to reach levels seen in the pre-red tide years in both Bogue and Back Sound (Summerson and Peterson 1990). The average density of harvestable adult bay scallops before the red tide event ranged from 0.62 to 4.56 scallops/0.5 m^2 in Bogue Sound and in 1988 were less than 0.05 scallops/0.5 m^2. The average density for harvestable adult bay scallops before the red tide event in Core Sound ranged from 0.38 to 1.21 scallops/0.5 m^2 and were less than 0.30 scallops/0.5 m^2 in 1988. Only one area in central Core Sound (Yellow Shoal) experienced normal recruitment before and after the red tide. The red tide event was slower to reach and at lower concentrations in central Core Sound.

IV. CURRENT AUTHORITY

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

03K .0102 Prohibited rakes
03K .0304 Prohibited taking
03K .0105 Harvest of crabs and shellfish
03K .0501 Bay scallops - Seasons and harvest limits
03K .0502 Taking bay scallops at night and on weekends
03K .0503 Prohibited bay scallop dredge

V. MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*
- \+ No changes in management
- \+ No additional restrictions on fishing practices
- \+ No additional burden to law enforcement
- \+ Flexibility in reacting to variable conditions
- \- Possibility of further depletion of the stock

B. Establish specific triggers for increased management measures
- \+ Proactive management measure
- \+ Addresses uncertainty in the status of the stock
- \- Uncertainty in defining effective time periods for triggers

C. Implementation of regulations

a) Quotas
- \+ Controls harvest levels
- \- Not sensitive to fluctuations in recruitment or availability of bay scallops to the fishery
- \- Additional reporting burden to commercial dealers
- \- Requires additional resources from DMF to implement
- \- May restrict harvest more or less than necessary
- \- Potential to go over quota due to short period of high landings

b) Limited entry
- \+ Prevent growth of the fishery
- \+ Protects historical participants in the fishery
- \- Will not restrict individual increases in effort
- \- Cannot be considered for action unless there is no other means of achieving sustainable harvest in the fishery

c) Size limits
- \+ Reduces the number of smaller, immature bay scallops harvested in the catch
- \+ May increase the value of the catch
- \- Increase the burden on law enforcement

d) Meat counts
- \+ Reduction in harvest of smaller bay scallops
- \+ May increase the value of the catch
- \- Counts may vary within an area

e) Closures

1) Season closure

i) Eliminate December opening

+ Ensures spawning is complete
+ Improves future economic yield
+ No additional resources required to implement
+ No reporting burden on fishermen or dealers
- Removes “Christmas money” for fishermen
- Forces fishermen to search for other sources of income

ii) Compress the main harvest season

+ Ensures spawning is complete
+ Improves future economic yield
+ No additional resources required to implement
+ No reporting burden on fishermen or dealers
- Weather may prevent fishing during open periods
- Forces fishermen to search for other sources of income

2) Permanent area closures

+ Reduce harvest impacts to some of the habitat
+ No reporting burden on fishermen or dealers
- Forces fishermen to search for other sources of income
- Increases effort in areas that remain open
- May adversely impact some fishermen more than others
- Increase the burden on law enforcement

3) Rotational area closures

+ Reduce harvest impacts to habitat at one time
+ No additional resources required to implement
+ No reporting burden on fishermen or dealers
+ Reduce impacts on some of the bay scallop population at one time
- Forces fishermen to search for other sources of income
- Increases effort in areas that are open
- May adversely impact some fishermen more than others
- Increase the burden on law enforcement

f) Trip/vessel harvest limits

+ Reduces effort in the fishery
+ No additional resources required to implement
+ Lengthens the harvest period
- May adversely impact some fishermen more than others
- Does not guarantee a reduction in harvest
- Increase the burden on law enforcement

g) Gear restrictions

+ Reduce impacts on habitat
+ No additional resources required to implement
- May adversely impact some fishermen more than others.
- Does not guarantee a reduction in harvest
- Increase the burden on law enforcement

h). Prohibited take

+ Reduce some pressure on the bay scallop population
+ No additional resources required to implement
- Loss of the commercial and recreational fisheries
- Loss of income to commercial fishermen and dealers

D. Improve the current independent sampling program

+ Provide a better independent estimate of abundance
+ Provide a better estimate of the spawning condition of population
+ Infrastructure already exists for implementation

VI. MANAGEMENT RECOMMENDATIONS

MFC selected management strategies

- Recommend continue prohibited take (started in January 2006) and evaluate the population status annually.
- Recommend sampling during the prohibited take period to define an independent sampling indicator for re-opening a harvest season.
- Recommend eliminating the December opening and compress the main season by beginning the last Monday in January.

AC and DMF

- Recommend continue prohibited take (started in January 2006) and evaluate the population status annually.
- Recommend sampling during the prohibited take period to define an independent sampling indicator for re-opening a harvest season.

AC

- Recommend eliminating the December opening, open the main bay scallop season to commercial and recreational hand harvest only on January 1, and open to mechanical harvest the last Monday in January.

DMF

- Recommend eliminating the December opening and compress the main season by beginning the last Monday in January.

Current rule

15A NCAC 03K .0501 BAY SCALLOPS - SEASONS AND HARVEST LIMITS
(a) The Fisheries Director may, by proclamation, specify open seasons for the taking of bay scallops during the following periods:

(1) During the month of December for a total of not more than four days;
(2) Between the second Monday in January and the last Friday in May; and
(3) Between August 1 and September 15 by hand harvest methods only as described by proclamation.

(b) The Fisheries Director may impose any or all of the following restrictions during any open season specified:
(1) Specify number of days;
(2) Specify areas;
(3) Specify means and methods which may be employed in the taking;
(4) Specify time period; and
(5) Limit the quantity.

(c) For any season provided from December through May, it is unlawful to take more than 20 standard U.S. bushels per person per day or to exceed a total of 40 standard U.S. bushels per day in any combined fishing operation.

(d) For any season provided from August 1 through September 15, it is unlawful to take more than ten standard U.S. bushels per person per day or exceed a total of 20 standard U.S. bushels per day in any combined fishing operation.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991.

MFC selected rule change

15A NCAC 03K .0501 BAY SCALLOPS - SEASONS AND HARVEST LIMITS

(a) The Fisheries Director may, by proclamation, specify open seasons and methods for the taking of bay scallops during the following periods:
~~(1) During the month of December for a total of not more than four days;~~
(~~2~~)(1) ~~Between~~ From the ~~second~~ last Monday in January ~~and~~ through the last Friday in May; and
(~~3~~)(2) ~~Between~~ From August 1 ~~and~~ through September 15 by hand harvest methods only as described by proclamation.

(b) The Fisheries Director ~~may~~ may, by proclamation, impose any or all of the following restrictions ~~during any~~ for any commercial or recreational open ~~season specified:~~ season:
(1) Specify number of days;
(2) Specify areas;
(3) Specify means and methods which may be employed in the taking;
(4) Specify time period; and
(5) ~~Limit~~ Specify the ~~quantity.~~ quantity, but shall not exceed possession of more than 20 standard U.S. bushels per person per day or a total of 40 standard U.S. bushels in any combined commercial fishing operation per day.

~~(c) For any season provided from December through May, it is unlawful to take more than 20 standard U.S. bushels per person per day or to exceed a total of 40 standard U.S. bushels per day in any combined fishing operation.~~

~~(d) For any season provided from August 1 through September 15, it is unlawful to take more than ten standard U.S. bushels per person per day or exceed a total of 20 standard U.S. bushels per day in any combined fishing operation.~~

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991.
Amended Eff.???????

VII. RESEARCH RECOMMENDATIONS

- Expand the current independent sampling in Carteret County to improve estimates of the population abundance and spawning condition of the stock.
- Quantify high and low productive areas of bay scallop abundance.
- Improve genetic information to determine conclusively how many separate stocks exist in North Carolina.
- Investigate other sampling designs to estimate population abundance.
- Establish a specific abundance estimate trigger to open the harvest season.
- Determine the minimum stock size needed to support the bay scallop population.

VIII. LITERATURE CITED

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9.3 EFFECTS OF TRAWLING ON BAY SCALLOP HABITAT (SUBMERGED AQUATIC VEGETATION) IN BOGUE SOUND[3]

I. ISSUE

Address the management of shrimp trawling and its effect on bay scallop habitat in Bogue Sound

II. BACKGROUND

Bogue Sound is a high salinity estuarine waterbody located in Carteret County between the state port in Morehead City to the east and the town of Emerald Isle to the west. It is one of two waterbodies that are important bay scallop harvest areas. Within Bogue Sound, there are approximately 3,606 acres of SAV consisting mainly of shoal grass (*H. wrightii*) and eelgrass (*Z. marina*) (Carroway and Priddy 1983). Both species are necessary for the growth and survival of bay scallops.

SAVs occur in both subtidal and intertidal zones and may be found as patchy or continuous meadows. In patchy areas, the estuarine bottom between the patches is also considered habitat. SAVs provide important ecosystem functions such as structural

[3] Presented to the Bay Scallop Advisory Committee on May 15, 2006.
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complexity, sediment and shoreline stabilization, primary productivity, and nutrient cycling.

Otter trawls and skimmer trawls are used to harvest shrimp from Bogue Sound. Otter trawls are conical nets towed behind vessels that are kept open by water pressure on otter boards or doors that are attached at the forward edges of the nets. Skimmer trawls have nets on each side of the boat supported by a metal frame that skims the bottom on a weighted shoe and pushed through the water (West et al. 1994). Shrimp landings in Bogue Sound from 1995 to 2005 have averaged approximately 30,451 pounds per year with the number of participants varying from 34 to 7 using otter trawls and 27 to 4 using skimmer trawls (Table 1).

There have been several studies looking at the effects of trawling on bottom habitat (MSC 1996; Auster and Langton 1999; DMF 1999; Collie et al. 2000; ASMFC 2000). However only a few studies have specifically addressed affects of trawling over SAVs, and they did not occur in North Carolina. Results from studies in other areas or similar benthic habitat types may intuitively be applied to what the effects of trawling on SAVs may be. Guillen et al. (1994) found a 45% loss of seagrass beds (*Posidonia oceanica*) in the western Mediterranean Sea. In the Gulf of Mexico, it was noted that trawling by larger vessels in deep water (2-3 m) through SAV resulted in the edges of SAV being ripped up and masses of SAV were observed floating on the surface following the opening of shrimp season. It was also noted that shallow SAV beds were not affected by trawling except during high tides when beds were more accessible (Eleuterius 1987).

Table 9.1. Shrimp landings from otter trawls and skimmer trawls fishing in Bogue Sound (1995-2005). DMF Trip Ticket Program.

Year	Gear	Pounds	Trips	Participants
1995	Otter trawl	9,367	160	28
	Skimmer trawl	1,676	11	7
1996	Otter trawl	20,457	221	24
	Skimmer trawl	4,200	30	12
1997	Otter trawl	12,065	135	18
	Skimmer trawl	791	19	4
1998	Otter trawl	17,274	134	21
	Skimmer trawl	10,813	74	14
1999	Otter trawl	13,333	118	23
	Skimmer trawl	29,720	92	27
2000	Otter trawl	8,418	108	29
	Skimmer trawl	10,340	52	16
2001	Otter trawl	6,844	82	13
	Skimmer trawl	2,150	6	5
2002	Otter trawl	3,377	24	10
	Skimmer trawl	26,351	81	19
2003	Otter trawl	66,513	165	34
	Skimmer trawl	60,719	113	21
2004	Otter trawl	10,126	66	12
	Skimmer trawl	7,920	138	10
2005	Otter trawl	5,179	56	7
	Skimmer trawl	7,333	93	6

Negative impacts from trawling over SAV may occur from the sweep of the net and the trawl doors digging into the sediment (ASMFC 2000). Trawl doors were found to penetrate the bottom more than the rest of the gear with cutting depth varying because of differences in gear weight, bottom hardness and towing warp to depth ratios (a measure of the force of the gear). Other effects include leaf shearing and uprooting in areas that are heavily trawled, resulting in the loss of blades and shoots which in turn reduces the structural complexity, coverage, and productivity of SAV beds (DMF 1999). Turbidity, especially in areas of low energy where sediment tends to be mud/silt, can reduce light levels needed for photosynthesis. However, below-ground impacts are probably minimal from trawls (Street et al. 2005; ASMFC 2000).

A change in SAV habitat condition from trawling could also have an effect on the invertebrate or fish species associated with SAV. The impact of habitat change on associated species depends on the life history of the species. For species that must complete part of their life cycle in SAV, such as bay scallop or juvenile gag, reduced productivity or other habitat changes may be more critical (DMF 1999).

III. DISCUSSION

The management of shrimp trawling in North Carolina is addressed in the Shrimp FMP (DMF 2005). Management options that were considered ranged from *status quo* to a total closure of all trawling. Recommendations in the plan propose additional closures, season restrictions, and the increased use of gears that are more habitat friendly. It was recommended to the MFC by both the Shrimp FMP advisory committee and the DMF to extend the Trawl Net Prohibited Area on the banks side of Core Sound from Wainwright Island to Drum Inlet in order to provide more formalized protection of SAVs occurring along the western side of Pamlico and Core Sounds. These areas of SAVs are historical bay scallop beds, and little to no shrimping occurs there. However, it was recommended that Bogue Sound management remain at *status quo* because the majority of shrimping occurs in the ICW where SAVs do not occur. The MFC agreed with both recommendations, therefore no management changes were made for Bogue Sound.

Because SAVs are a critical habitat to bay scallops, this issue is addressed again in order to insure that there is adequate protection of areas of SAVs in Bogue Sound that are historically important to the bay scallop fishery. One of DMF's CHPP implementation tasks is to protect SAV as well as shell bottom, and hard bottom from fishing gear effects through improved enforcement, establishment of protective buffers and further restriction of mechanical shellfish harvesting (Street et al. 2005).

Shrimp trawling is currently prohibited in Bogue Sound by proclamation on the north side of the ICW along the mainland because of SAVs and to provide additional buffers for PNAs that also occur there. Archer Creek, Broad Creek, Gales Creek, Jumping Run Creek, and Sanders Creek are designated as PNAs and are closed to trawling by rule. On the western side of Bogue Sound, there is a triangular section that is also closed to trawling by proclamation in order to protect SAVs and the bay scallops that are known to occur there (Proclamation SH-5-2006; June 20, 2006) (Figure 9.6).

The majority of Bogue Sound is shallow and hard to navigate; therefore, most shrimp trawling occurs in the ICW. However, there are a few fishermen who fish in SAV habitat along Bogue Banks from Archer Creek west to the Highway 58 Bridge as well as along the mainland side from the bridge east to Hunting Island. A few fishermen also work off of the town of Salter Path. These areas are accessible only during high tides and are fished primarily during high tide in the summer (DMF Marine Patrol, personal communication 2006).

SAV mapping in Bogue Sound last occurred in 1981 by Carraway and Priddy (1983) so current distribution and acreage of SAV in the area may have changed since that time but does provide a historical distribution. The amount of SAV mapped at that time may be underestimated due to the inability to detect SAV because of patch size and water clarity. The NOAA is scheduled to map SAV in the spring of 2006 in Core and Bogue Sounds from Drum Inlet south to Bogue Inlet. This will provide a more accurate spatial distribution of SAV in Bogue Sound and will provide a means to compare changes of SAV coverage over time.

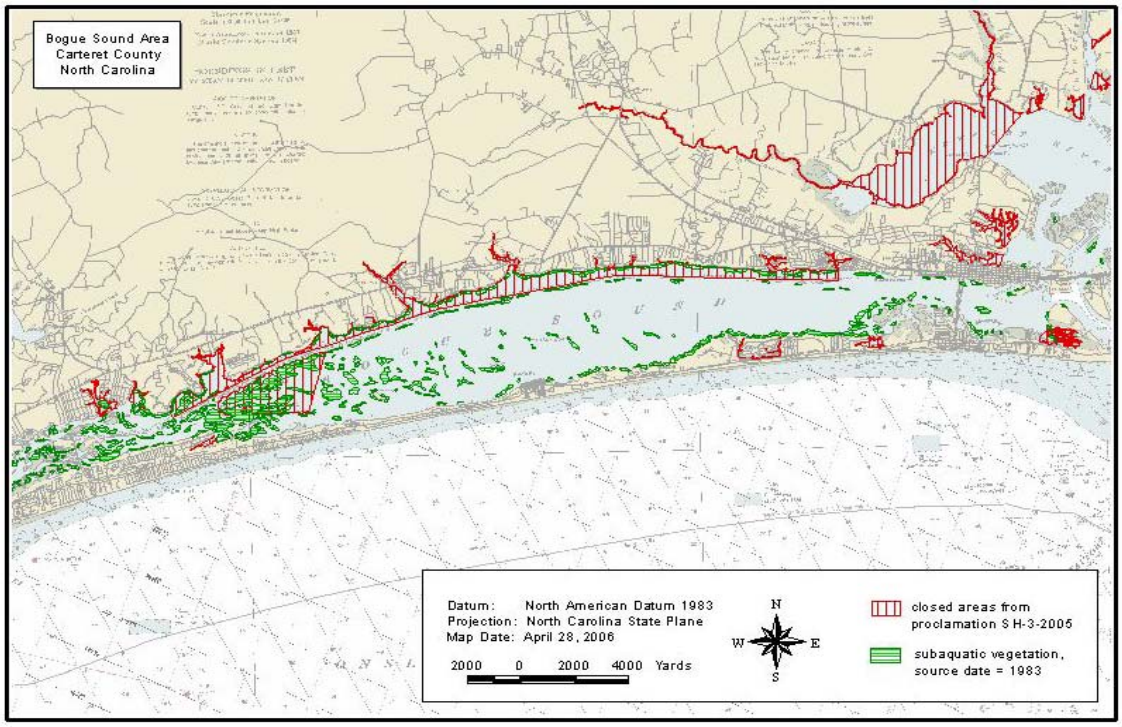

Figure 9.6. Area closed to trawling by proclamation in Bogue Sound. Shaded areas indicate presence of submerged aquatic vegetation as determined by Carraway and Priddy (1983). DMF GIS database.

Current knowledge of fishing gear impacts indicates that shrimp-trawling gear can have habitat impacts dependent on the structure and complexity of the habitat, energy regime, depth and sediment type. These impacts range from severe in highly structured, deep, low-energy environments to minimal in unconsolidated sandy shallow high-energy environments. Our current management of the shrimp trawl fishery in Bogue Sound prohibits the use of trawl nets in PNAs and in SAVs in parts of western Bogue Sound and along the mainland to minimize bottom-disturbing effects of trawling in those areas. However, some SAV habitat areas that are currently open to trawling may be disturbed during times of high tide in the summer when shrimping is at its peak.

IV. CURRENT AUTHORITY

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

03K .0103 Shellfish or seed management areas
03L .0101 Season
03N .0104 Prohibited gear, primary nursery areas
03N .0105 Prohibited gear, secondary nursery areas
03O .0211 Protection of private shellfish interest
03R .0103 Primary nursery areas

03R .0104 Permanent secondary nursery areas
03R .0105 Special secondary nursery areas

V. MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*
- \+ Continued access to resources by shrimpers
- \- Does not prevent damage to SAVs

B. Modify trawl closure lines in Bogue Sound
- \+ Decreases impact to SAV critical to bay
- \+ Minimal impact to fishermen since areas are not used extensively
- \+ Closure lines would occur by proclamation allowing for flexibility as new information becomes available
- \+ Meets CHPP implementation goal
- \- Decreases traditional trawling areas

C. Modify trawl closure lines after Bogue Sound SAVs are mapped
- \+ Manages according to current mapping data
- \+ Decreases impact to SAV critical to bay scallops
- \+ Minimal impact to fishermen since areas are not used extensively
- \+ Closure lines would occur by proclamation allowing for flexibility
- \- Decreases traditional trawling areas

VI. MANAGEMENT RECOMMENDATIONS

MFC selected management strategy
- \- Recommend modifying, if needed, the trawl closure area in Bogue Sound to protect bay scallop habitat based on all available information.

AC and DMF
- \- Recommend modifying, if needed, the trawl closure area in Bogue Sound to protect bay scallop habitat based on all available information.

VII. RESEARCH RECOMMENDATIONS

None

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9.4 MANAGEMENT OF DREDGES FOR HABITAT PROTECTION[4]

I. ISSUE

How does North Carolina manage scallop dredging to minimize effects on the habitat?

II. BACKGROUND

Numerous studies have been conducted on the effects of mobile fishing gear on the benthos. These studies include effects of gear such as scallop dredges, oyster dredges, hydraulic clam dredges and clam trawls, beam trawls and otter trawls. The impacts of these different gears have been studied on habitat types ranging from flat sand and mud bottoms to structured habitats such as piled boulders, live bottom, seagrass, kelp beds and coral reefs (Dorsey and Pederson 1998)

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

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

[4] Presented to the Bay Scallop Advisory Committee on May 15, 2006.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.

SAVs are the primary habitat for the bay scallop, and the bay scallop fishery is dependent on these SAVs for harvest. SAVs provide habitat for the life cycle of many other organisms and offer other important ecosystem functions such as structural complexity, sediment and shoreline stabilization, primary productivity and nutrient cycling.

There are numerous small fisheries that occur in North Carolina estuaries that utilize a dredge or a type of dredging gear. These fisheries include the hydraulic escalator dredge, the clam trawl, the oyster dredge and the scallop dredge. These dredge types are highly regulated using seasonal openings and closings that occur in certain areas of the state. Hydraulic escalator dredges as well as clam trawling "kicking" are allowed in certain areas that consist mostly of shallow sandy bottom areas. These areas are opened four days a week from December to March each year. Mechanical harvest of clams is not allowed in SAV beds. The oyster dredge, which consists of a metal framed basket weighing up to 100 lbs. with a toothed bar at the mouth, is managed in a similar manner in the northeastern portion of the state with the season occurring from November to March within specific areas based on criteria established in the Oyster FMP (DMF 2001).

The scallop dredge is used to harvest bay scallops from SAV beds found in North Carolina's estuarine waters. These dredges consist of a wire or nylon bag attached to a metal frame. Unlike the oyster dredge, the scallop dredge has a toothless bar at the mouth and must not weigh more than 50 lbs. This dredge is designed to ride along the surface of the bottom and scoop up bay scallops (West et al. 1994; Street et al. 2005).

Impacts from dredging in SAV may result in shearing of blades, shearing of seed and flowers, uprooting, and burial. Turbidity, which may cause a reduction in light for photosynthesis is also a concern. Below ground impacts are of great concern and can result from dredging in SAV beds especially those that are heavy and have toothed bars. The resulting disturbances from heavy toothed dredges causes extensive damage to underground roots, rhizomes, and meristems and are essential for continued growth, nutrient uptake, and anchorage to the substrate (ASMFC 2000). In order to minimize these impacts to SAVs, scallop dredges are required to be toothless and lighter in weight (< 50 lbs) than oyster dredges.

In a study to assess the impacts of clam raking and mechanical harvest of clams in seagrass beds in Back Sound, North Carolina, Peterson et al. (1987) determined that removal of seagrass biomass was highly correlated with an associated decrease in scallop density. Hsiao et al. (1987) developed a simple open-access fishery model that also demonstrated that clam kicking and clam raking had significant negative effects on the bay scallop fishery from 1961 to1976. However, there was no evidence to support negative effects from scallop dredging on the bay scallop fishery. Thayer and Stuart (1974) documented that scallop dredging reduced both bay scallop and eelgrass density in an area near Beaufort North Carolina.

Fonseca et al. (1984) describes the impact on SAVs caused by bay scallop dredges in two bottom types colonized by eelgrass. One bottom type consisted of compacted sediment dominated by sand. The other bottom type consisted of a less compact sediment with a higher silt/clay content. Two commercial scallop dredges linked together were pulled by hand to eliminate prop scour. Treatments of 15 dredge tows and 30 dredge tows were used and compared to controls where no dredging occurred. After treatments, eelgrass cores were taken and examined for biomass and shoot count. A significant decrease in shoot counts and biomass occurred with increasing dredging effort for each bottom type with greater impacts in the soft bottom type. They concluded that intense scallop dredging has the potential for immediate and long-term reduction of eelgrass beds. They hypothesized that if blades are removed or displaced by dredging, fewer adults are available to the fishery the following year. This is because during the early portion of scallop season, most early stage juveniles from the previous fall spawning are attached to seagrass blades.

Bishop et al. (2005) examined impacts of dredges and hand harvest methods on SAV biomass and whether its removal affects standing stock over time. They also tested the effects of this removal on bay scallop recruits. Experimental plots were assigned hand-harvest treatments, dredge-harvest treatments, and undisturbed treatments. Seagrass and scallops were collected from each harvest treatment. Both adult and juvenile bay scallops were counted and measured while seagrass was quantified using dry weight. Anything dislodged by the fishing method was collected from a net set up downstream of the collection site. They found that hand harvest yielded six times the harvest per unit of time compared to the dredge. There were significant differences between hand harvest and dredging impacts to SAVs. Hand harvest did not cause any displacement of seagrass or juvenile bay scallops when compared to dredging that caused significant displacement to seagrass. However, there were no significant differences in biomass between the dredged plots and the undisturbed plots, one month later. They actually saw an increase in seagrass biomass suggesting that dredging has short-term effects and may actually stimulate new production.

When comparing numbers of juvenile scallops, less than 2% were removed by dredging and none were removed by hand harvest. However, one month later, there were continued lower densities of juvenile bay scallops in the dredge plots and small increases in densities in the hand-harvested plots and the control plots. Bishop et al. (2005) suggests that migration of juvenile bay scallops into adjacent undisturbed plots may have occurred after dredging injury to seagrass. Small juveniles probably increase their chances of survival from foraging predators by emigrating from depleted grass beds to denser grass beds. However, if fishing disturbances are chronic over a season at a large scale, an indirect result would be that these small emigrating juvenile scallops are at a higher risk to predation causing a decrease in adult abundance the following year (Bishop et al. 2005).

Another physical impact that occurs in SAV beds is damage from propeller scarring (prop scarring) and has been identified nationally as a major source of SAV loss. It is believed that damage associated with prop scarring surpasses damage from shellfish

dredges (Thayer et al. 1984). Prop scarring occurs when outboard vessels travel through water shallower than the draft of the boat. The boat prop cuts leaves, roots, and stems as well as creates a narrow trench through the sediment (Street et al. 2005). Prop scarring has severely damaged seagrass beds in Florida and is an increasing problem in Chesapeake Bay. In both areas, increasing occurrences of prop scarring are associated with increasing human populations and an increasing number of registered vessels. Aerial observations of high salinity grass beds seem to indicate that damage to SAV from prop scarring is not currently a significant problem in North Carolina. However, as human populations along the coast increases, it is also expected that number of boats will increase (Street et al. 2005).

III. DISCUSSION

The area that is fished for bay scallops consists of approximately 46,000 acres of mapped SAV in eastern Pamlico, Core, Back and Bogue sounds (Street et al. 2005). Bay scallop landings from these areas have been variable for the past several years, ranging from 201,000 lbs. in 1995 to 0 in 2005. The number of scallop dredging trips has also declined from 1995 to 2005 (Table 9.2). Bay scallop dredges accounted for 86% of landings from 1972 to 1986 before red tide decimated the fishery in 1987. From 1987 to 2005, dredging still made up over 75% of landings and remains an important gear in the fishery.

No scallop dredging was allowed in Bogue Sound from 1993 to 1997. Beginning in 2000, dredging has been delayed in both Bogue Sound and Core Sound until later in the season after scallops have been harvested out of the shallow areas. No mechanical harvest occurred in 2001.

Table 9.2. Number of scallop dredge trips and bushels landed from 1995 to 2005. DMF Trip Ticket Program.

Year	Trips	Bushels
1995	1,752	31,847
1996	264	4,052
1997	357	7,850
1998	896	18,838
1999	146	2,235
2000	10	128
2001	0	-
2002	27	283
2003	23	438
2004	0	0
2005	0	0

In recent years, to reduce SAV impacts from prop scarring, that occur with bay scallop dredging, DMF allows hand harvest methods for bay scallops early in the season, followed by a proclamation to open scallop dredging later on a rising or high tide. This

management practice is based on the assumption that the majority of hand harvest has removed scallops from shallow SAV beds. By opening the first day of dredging on a rising or high tide, damage to SAVs by propeller scarring from vessels pulling dredges is minimized. Over the course of the first fishing day, dredgers will move out into deeper water to fish for bay scallops too deep for hand harvest (Street et al. 2005).

Additional ways to manage bay scallop dredging include setting up rotation areas as suggested by several researchers (Thayer and Stuart 1974; Fonseca et al. 1984; Bishop et al. 2005). This is based on the short time it takes for SAVs to recover from impacts caused by bay scallop dredges. Partitioning hand harvest areas from dredging areas based on depth would address the problem of prop scarring from bay scallop dredgers working in shallow grass beds. Closing all areas to dredging would eliminate impacts to SAVs and most likely lower impacts from prop dredging while allowing for more efficient harvest of bay scallops. Those areas too deep for hand harvest may act as potential spawner sanctuaries.

Current knowledge of bay scallop dredging as well as impacts from other gears indicate that they have impacts on SAVs which could result in indirect impacts on bay scallop juveniles. Prop scarring has the potential to have negative impacts on SAVs as coastal populations continue to grow. Our current management of dredging addresses prop scar impacts to some extent, but more management to address prop scarring and possible loss of habitat for juveniles needs to be considered.

IV. CURRENT AUTHORITY

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

03K .0501 Bay scallops-seasons and harvest limits
03K .0503 Prohibited bay scallop dredge

V. MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*
   - \+ No additional regulation
   - \- Continued possible impacts to juvenile bay scallops from reduced settlement area lost to dredging and prop scarring

B. Partition dredging activities from hand harvest activities based on water depth.
   - \+ Decreases the amount of SAV affected by dredging
   - \+ Decreases the amount of SAV affected by prop scarring
   - \+ Reduces impacts to juveniles

- Larger number of dredgers in a reduced area may increase impacts on SAVs.

C. Rotate dredge areas
+ Decreases the amount of habitat affected by dredging at one time
+ Ability for closed portions of area to recover from harvest impacts
+ Reduces impacts to juveniles
- Larger number of dredgers in a reduced area could increase impacts on SAVs

D. Eliminate all dredging
+ No further impacts by mechanical harvest gear on SAVs
+ Fewer impacts from prop scarring
- Increase in cold weather stress to older fishermen

VI. MANAGEMENT RECOMMENDATIONS

MFC selected management strategy
- Recommend *status quo*, no change.

AC and DMF - Recommend *status quo*, no change.

VII. RESEARCH RECOMMENDATIONS

- Expand our understanding of bay scallop dredging on SAV condition and bay scallop recruitment.

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9.5 RULE CHANGE TO CLARIFY WORDING TO PROTECT SCALLOP HABITAT FROM BULL RAKES AND HAND TONGS[5]

I. ISSUE

Clarification of rule language to protect habitat from bull rakes and hand tongs.

[5] Presented to the Rules Advisory Team on June 1, 2006.
Presented to the Bay Scallop Advisory Committee on June 15, 2006 with DMF proposed rule changes.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.
Finalized rules by the Rules Advisory Team on February 1, 2007.

II. BACKGROUND

Submerged aquatic vegetation is defined in the CHPP as "bottom recurrently vegetated by living structures of submerged, rooted vascular plants (roots, rhizomes, leaves, stems, or propagules), as well as temporarily unvegetated areas between vegetated patches" (Street et al. 2005). Submerged aquatic vegetation occurs in both subtidal and intertidal zones and may be colonized by estuarine species, such as eelgrass (*Z. marina*), shoalgrass (*H. wrightii*), or widgeon grass (*R. maritima*) or freshwater species, such as wild celery (*V. americana*) and sago pondweed (*P. pectinatus*). It is well established in the scientific literature that SAV is a valuable habitat for many fishery species in North Carolina, including bay scallop.

The structure of SAV grass blades provides an excellent nursery area and enhances a safe corridor between habitats, reducing predation (Micheli and Peterson 1999). Based on location and abundance of adult scallops in seagrass beds, eelgrass and shoal grass are considered the preferred settling substrate for recruiting bay scallops (Gutsell 1930; Thayer and Stuart 1974; Fay et al. 1983). Vertical attachment on grass beds above the bottom reduces threat to predation of newly settled scallops. The grass bed reduces siltation and currents, which can improve survival and growth rates of scallop spat, respectively (Castagna 1975; Kirby-Smith 1972). Bay scallops forage on microalgae such as diatoms, as well as detritus, bacteria, and other organic matter), which is abundant within SAV beds (Castagna 1975). Spawned eggs are planktonic for approximately 10 – 19 days prior to attaching to a substrate with byssal thread (Fay et al.1983). In areas having more SAV patches interspersed over a larger area, the probability of scallop larvae finding an appropriate settlement site is greater.

III. DISCUSSION

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

Damage from fishing gear varies in severity. Hand gear, such as bull rakes and large oyster tongs, can uproot SAV and cause substantial damage, but generally to smaller areas than mechanical gears (Thayer et al. 1984). Current MFC rules prohibit use of rakes more than twelve inches wide or weighing more than six pounds in SAV [MFC rule 15A NCAC 03K.0304 (a) (2)]. Use of hand rakes is allowed. Under MFC rules, SAV is a Critical Habitat Area [MFC rule 15A NCAC 03I .0100 (b)(20)]. Only high salinity grassbeds are utilized by bay scallops due to their salinity preferences.

There is some confusion in the rule 15A NCAC 3K .0304 (a) (1) over handrakes as described in 15A NCAC 3K .0102. The intent of the rules is to protect seagrass beds from bull rakes.

IV. PROPOSED RULE CHANGE

Current rules

15A NCAC 03K .0102 PROHIBITED RAKES
It is unlawful to use a rake more than 12 inches wide or weighing more than six pounds to take oysters or scallops~~.~~

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991.

15A NCAC 03K .0304 PROHIBITED TAKING
(a) It is unlawful to take clams by any method, other than by hand tongs, hand rakes, or by hand, except as provided in 15A NCAC 3K .0302 and .0303. Regardless of the areas which may be opened, it is unlawful to take clams by any method:

(1) other than hand tongs, hand rakes as described in 15A NCAC 3K .0102, or by hand in any live oyster bed, or
(2) by hand rakes as described in 15A NCAC 3K .0102, or by hand in any established bed of submerged aquatic vegetation as defined in 15A NCAC 3I .0101 or salt water cordgrass (Spartina alterniflora) that may exist together or separately.

(b) It is unlawful to possess clam trawls or cages aboard a vessel at any time, or have kick/deflector plates normally used in the mechanical harvest of clams affixed to a vessel at any time, except during the time period specified for a mechanical clam harvest season in internal waters in accordance with 15A NCAC 3K .0302(a). A period of 14 days before and after the season as specified will be allowed for the installation and removal of kick/deflector plates and clam trawls or cages. Vessels with permits for activities provided for in 15A NCAC 3K .0104, .0107, .0303(a), and .0401 shall be exempt from this Rule during the times such activities are permitted.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. May 1, 1997; July 1, 1993.

MFC selected rules change

15A NCAC 03K .0102 PROHIBITED RAKES
It is unlawful to use a rake more than 12 inches wide or weighing more than six pounds to ~~take oysters or scallops.~~ <u>take:</u>

<u>(1) oysters or scallops;</u>

(2) clams in any live oyster bed or any established bed of submerged aquatic vegetation as described in 15A NCAC 03I .0101(b)(20) or salt water cordgrass (Spartina alterniflora).

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991.
Amended Eff.???????

15A NCAC 03K .0304 PROHIBITED TAKING

(a) It is unlawful to take clams by any method, other than by hand tongs, hand rakes, or by hand, except as provided in 15A NCAC 03K .0302 and .0303. Regardless of the areas which may be opened, it is unlawful to take clams by ~~any method:~~

~~(1) other than hand tongs, hand rakes as described in 15A NCAC 03K .0102, or by hand in any live oyster bed, or~~

~~(2) by hand rakes as described in 15A NCAC 03K .0102, or by~~ hand tongs in any established bed of submerged aquatic vegetation as ~~defined~~ described in 15A NCAC 03I .0101(b)(20) or salt water cordgrass ~~(Spartina alterniflora) that may exist together or separately.~~ (Spartina alterniflora).

(b) It is unlawful to possess clam trawls or cages aboard a vessel at any time, or have kick/deflector plates normally used in the mechanical harvest of clams affixed to a vessel at any time, except during the time period specified for a mechanical clam harvest season in internal waters in accordance with 15A NCAC 03K .0302(a). A period of 14 days before and after the season as specified by proclamation will be allowed for the installation and removal of kick/deflector plates and clam trawls or cages. Vessels with permits for activities provided for in 15A NCAC 03K .0104, .0107, .0303(a), and .0401 shall be exempt from this Rule during the times such activities are permitted.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. May 1, 1997; July 1, 1993.
Amended Eff.???????

V. RULE RECOMMENDATION

MFC Rule Recommendation
- Recommend rule changes.

AC and DMF - Recommend rule changes.

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9.6 IMPACTS OF RED TIDE AND WEATHER EVENTS ON BAY SCALLOP POPULATIONS[6]

I. ISSUE

Identify significant environmental events affecting North Carolina bay scallop populations

[6] Presented to the Bay Scallop Advisory Committee on June 15, 2006.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.

II. BACKGROUND

Bay scallops are sensitive to several types of environmental disturbances such as loss of seagrass, pollution, extreme temperature changes, reductions in salinity, predation, increases in turbidity, red tides, and hurricanes (Gutsell 1930; Mercaldo and Rhodes 1982; Tettelbach et al. 1985; Peterson et al. 1989; Summerson and Peterson 1990). Burgess and Murauskas (Draft in progress) analyzed commercial landings to determine if a particular disturbance had a significant effect on the overall population of bay scallops in North Carolina. Commercial landings were used because they provide a consistent, long time series of relatively reliable data. The fishery is typically opened in December or January when bay scallops have completed spawning and reach an adequate meat weight. The harvest season generally continues until catch rates decline and it is no longer economically viable to continue fishing. Because of the nature of this fishery on an annual crop, landings are considered to be a fairly good reflection of the actual population abundance. Burgess and Murauskas (Draft) identified two large-scale environmental disturbances that caused significant negative impact to North Carolina bay scallop populations: the red tide event in 1987-88 and the 1999 hurricane season (Dennis, Floyd, and Irene).

A red tide is a harmful algal bloom that occurs when *K. brevis*, a naturally occurring microscopic planktonic organism, increases to higher than normal concentrations. *K. brevis* produces a potent neurotoxin that kills fish and bay scallops, contaminates shellfish, and can cause neurotoxic shellfish poisoning and respiratory distress in humans. In the United States, red tides occur frequently in Gulf of Mexico waters off the west coast of Florida. A red tide typically originates offshore and is occasionally driven inshore and transported into estuaries by wind and currents. When conditions are favorable, *K. brevis* can multiply rapidly reaching bloom concentrations causing the water to take on a reddish-brown color creating a “red tide” event. Red tides can last for as little as a few days or as much as several months depending on environmental conditions. In the Gulf of Mexico, they generally occur in the late summer or early fall. Red tides are most common along the southwestern coast of Florida where most blooms last from three to five months and can affect hundreds of square miles. However, they are much less common along the southeastern Atlantic Coast.

The first, and only, red tide in North Carolina’s recorded history persisted from October 1987 to February 1988. The following summary of events was taken from Tester et al. (1991) and summarized by Summerson and Peterson (1990). A warm-water Gulf Stream filament that was first detected on October 19, 1987 and likely contained *K. brevis* transported from Florida presumably seeded North Carolina’s red tide. By late October, bloom conditions were present in the Atlantic Ocean near Bogue Banks. By early November, bloom concentrations were present throughout Bogue and Back sounds from New River Inlet to Barden’s Inlet at Cape Lookout resulting in the closure of shellfish beds. For the first few weeks, the red tide was restricted to Bogue and Back sounds, particularly around ocean inlets, but it soon spread northward into Core and Pamlico sounds. The effect of the red tide was more severe in Bogue and Back sounds

versus Core Sound. *K. brevis* was not detected in the center of Core Sound until mid November. Bogue and Back sounds were consistently found to have higher bloom concentrations than Core Sound, with particularly high levels near Bogue, Beaufort, and Barden's Inlets. *K. brevis* concentrations in Core Sound were consistently lower than in Bogue or Back sounds by a factor of ten or more. As a result, the waters of Core Sound were closed to shellfishing later and opened earlier than those of Bogue and Back sounds (Tester and Fowler 1990). *K. brevis* disappeared from Core Sound by late December, while it persisted in Bogue and Back sounds until the first week of February.

Hurricanes can cause several unfavorable environmental conditions to occur simultaneously. Rainfall associated with hurricanes can lead to reductions in salinity (also referred to as freshets) that causes mortality in bay scallops (Gutsell 1930). Tettelbach et al. (1985) documented a mass mortality of bay scallops in Long Island Sound caused by reductions in salinity following a heavy rainfall event. Mercaldo and Rhodes (1982) found that bay scallops are particularly prone to reductions in salinity at high temperatures, such as those seen in the summer and fall months during the peak of hurricane season. Hurricanes can also cause destruction of seagrass habitat required by bay scallops. Additionally, Peterson et al. (1989) proposed that storms assist in increasing mortality by transporting bay scallops into shallow, non-vegetated areas where they become susceptible to predation by gulls at low tides.

The long-term average of overall statewide landings of bay scallops during typical years was 29,732 bushels (Figure 9.7). Years were considered typical if they did not exhibit a significant change from the overall mean of the series. From 1963 to 1969, there was a temporary increase of 186% above the typical average. It is not clear what caused this increase, but appears that these may have just been particularly good years for bay scallops. Landings decreased significantly following the red tide event in 1987-88 to 61% below the typical average. A further reduction in harvest was also seen following the 1999 hurricane season dropping the average landings to 93% below the typical average. During the 1999 hurricane season, Tropical Storm Dennis saturated the ground with rainfall and was closely followed by Hurricane Floyd whose additional rainfall caused massive flooding in eastern North Carolina. Even further reduction may have also occurred as of 2004 since landings were less than 30 bushels in 2004 and zero bushels in 2005. This additional reduction could be due to Hurricane Isabel which made landfall near the northern part of Core Sound in September 2003 as a category 2 storm, predation of cownose rays on bay scallops, or a combination of these factors. It is important to note that there is no way to determine if these events actually *caused* the changes in bay scallop populations, but that these events are *coincident* with significant changes in the bay scallop time series.

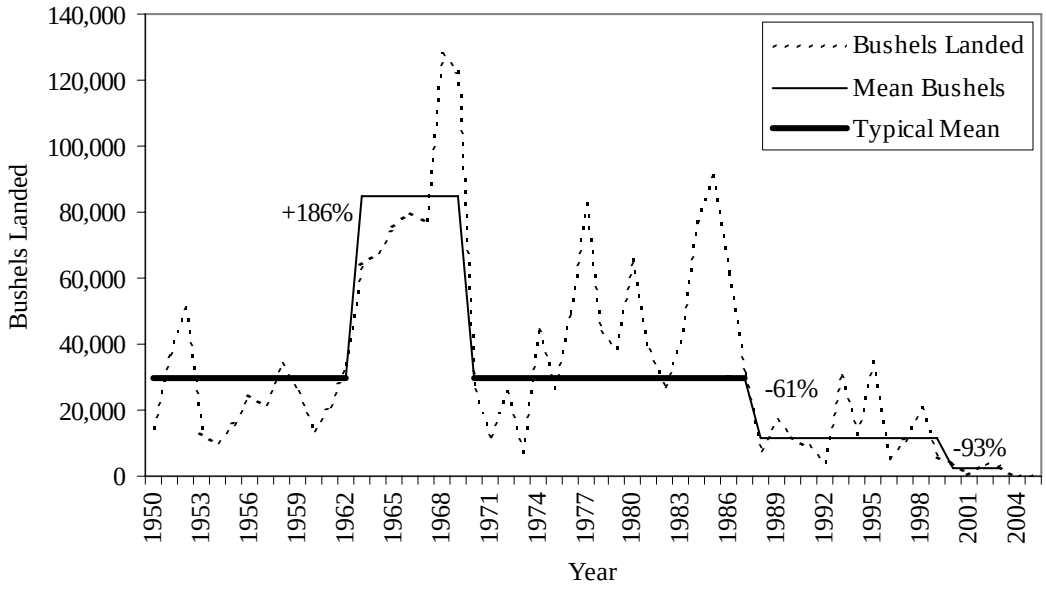

Figure 9.7. Overall statewide landings of bay scallops from 1950 to 2005 showing significant deviations from the "normal" mean of 29,732 bushels. DMF Trip Ticket Program.

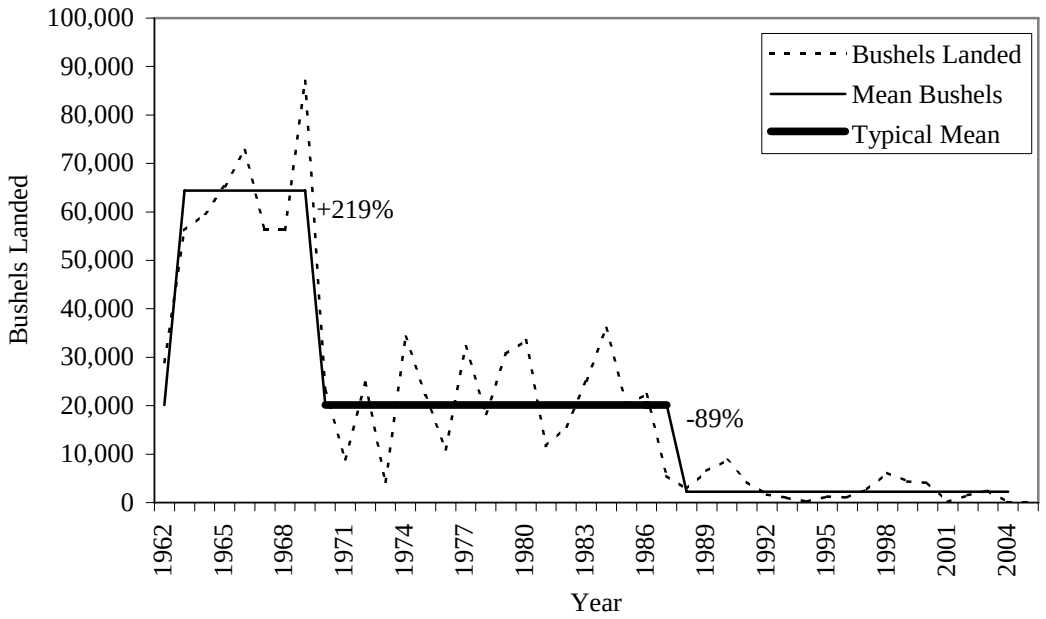

Figure 9.8. Landings of bay scallops in Bogue Sound from 1962 to 2005 showing significant deviations from the "normal" mean of 20,165 bushels. DMF Trip Ticket Program.

Landings by water body are only available back to 1962. Figure 9.8 shows a definite stair step pattern in the landings for Bogue Sound. As seen in the overall landings, there was a significant increase of 219% above the normal average for bay scallops landed from 1963 to 1969. Landings continued to be fairly stable around a typical average of 20,165 bushels for the next 16 years. A significant reduction in landings of 89% below the typical average occurred in 1988 that was likely associated with the red tide event of 1987-88. Landings in Bogue Sound never consistently returned to the level seen before the red tide. The 1999 hurricane season did not have any further significant impact on bay scallop landings in Bogue Sound as was seen in the overall landings.

Preliminary results indicate that the data for Core Sound exhibit autocorrelation. Autocorrelation is often present in time series data because a particular data point can be highly dependent on previous data points. In other words, when autocorrelation is present in the data, the catch for a particular year depends on how many were harvested the previous year(s). Therefore, the analysis done for the overall landings and Bogue Sound is not appropriate for the Core Sound data because it violates the assumption that the errors are independently distributed that is needed for the analysis. Violating this assumption increases the chance of making erroneous conclusions about the data. However, some general conclusions can be drawn by examining landings throughout the time series (Figure 9.9). Landings in Core Sound appear to be sporadic showing a boom and bust pattern. Some of this sporadic pattern may be due to harvest restrictions and may illustrate the irregular nature of their presence in Core Sound. It appears that populations in Core Sound were generally able to rebound from years in which scallops were harvested in low abundance, including a recovery after the red tide event. The red tide had a more devastating effect on Bogue Sound than Core Sound. Core Sound landings were depressed from 1987 to 1992, but appear to have rebounded in 1993. However, landings in Core Sound have not risen above 2,200 bushels since 1998, which may be due to the 1999 hurricane season.

Together, Bogue and Core sounds make up the majority of the landings averaging 92% of the total from 1962 to 2004. Historically the overall landings were driven by Bogue Sound, which made up an average of 62% of the total harvest. However, after the red tide decimated bay scallop populations in Bogue Sound, Core Sound became the dominant water body with an average of 66% of the total harvest until the 1999 hurricane season. After that time, landings in both water bodies reached extremely low levels.

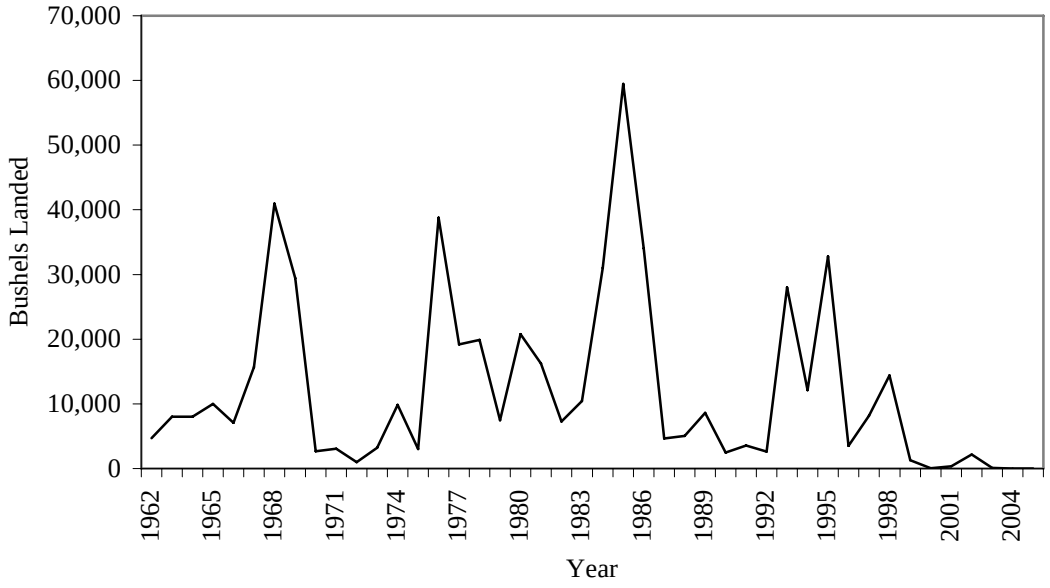

Figure 9.9. Landings (bushels) of bay scallops in Core Sound from 1962 to 2005. DMF Trip Ticket Program.

The red tide resulted in the closure of 1,480 km^2 of North Carolina waters to shellfish harvesting and an economic impact of over $24 million (Tester and Fowler 1990). Affected waters were closed to the harvest of shellfish because toxins produced by *K. brevis* accumulate in the bodies of filter feeders such as clams and oysters and can cause neurotoxic shellfish poisoning when consumed. Even though only the adductor muscle of bay scallops is eaten and this tissue does not generally retain toxins, the harvest of bay scallops was also prohibited because they were found to contain much larger concentrations of toxins in their bodies than clams or oysters (P. Fowler, DEH, personal communication 2006). The red tide had a particularly large impact on shellfishermen since waters were closed to any harvest from as early as November to as late as May.

The red tide did not cause mortality in clams or oysters, however there was a significant loss of bay scallops. Those bay scallops that remained had emaciated meats and were not getting good prices at market. The cause of bay scallop mortality is not entirely clear. The red tide killed both adult and newly recruited bay scallops resulting in a recruitment failure. Summerson and Peterson (1990) found that recruitment was virtually eliminated from Bogue and Back sounds where densities of new recruits were found to average 2% of pre-red tide years. The trend continued in the two years following the red tide, with average recruitment rates about 29% of normal in Back Sound and about 5% of normal in Bogue Sound (Peterson and Summerson 1992). A similar problem was found during a brown tide event in Long Island Sound, NY that caused mortality and severe reduction in tissue weights of adult bay scallops and a subsequent recruitment failure (Kuenster and Bricelj 1988). Summerson and Peterson (1990) found that juvenile densities during the red tide were near normal in central Core Sound, and a later study found that recruitment rates remained normal in Core Sound

(Peterson and Summerson 1992). The bay scallop population in Core Sound had sufficient recruitment to recover from the red tide by 1993. However, Core Sound population levels were reduced following the 1999 hurricane season and have not yet shown recovery as of 2005.

Low population abundances are likely to continue until the spawning stock increases. Peterson and Summerson (1992) stated that Bogue Sound may be slow to recover from the effects of the red tide because the spawning stock for that basin was too depleted to provide an adequate supply of larvae for population recovery. They further suggested that recruitment limitation exists on a basin scale for bay scallop populations in North Carolina. This means that larvae from Core Sound may not be able to replenish populations in Bogue Sound because of hydrological and geographical isolation and a relatively short planktonic larval stage (5-11 days). Further research is needed to determine if Core and Bogue sounds are genetically distinct populations.

Other events such as severe winter freezes and previous hurricanes were also examined but found not to have a significant impact. Prior to the red tide, some localized reductions in abundance may have occurred, however either the events were not severe enough or of a large enough scale to affect the overall population abundance. Prior to the red tide, it appears that there was enough spawning stock to overcome any noteworthy events.

III. DISCUSSION

The red tide of 1987-88 decreased bay scallop population levels below a minimum stock size threshold that is needed to maintain recruitment levels large enough to supply adequate numbers of larvae for the next generation. Further research is needed to determine this minimum stock size threshold. Populations in Bogue Sound were affected more severely by the red tide than those in Core Sound. Recruitment levels in Core Sound were found to be near normal following the red tide. However, it appears that bay scallop populations in North Carolina may be recruitment limited on a basin scale, and the spawning stock from Core Sound was not able to replenish populations in Bogue Sound. Populations in Core Sound were further reduced by the 1999 hurricane season and are continuing to have low levels as of 2005. Bay scallop populations are likely at such low levels that they are very vulnerable to any external influence such as hurricanes, habitat loss, poor water quality, or predators. They may continue to be negatively affected by environmental disturbances until the spawning stock can reach large enough levels to overcome these events as they have in the past.

Given this evidence, it appears that bay scallop populations may not become sustainable again until there is enough spawning stock to repopulate traditional bay scallop beds in Bogue Sound and Core Sound. Management should support research methods to restore the spawning stock as discussed in prior issue papers in this FMP such as stock enhancement, temporary prohibition of harvest, and protection from cownose ray predation until an adequate spawning stock returns.

The Shellfish Sanitation and Recreational Water Quality Section of the North Carolina Division Environmental Health (DEH) and the National Oceanic and Atmospheric Administration (NOAA) monitor oceanic conditions for future red tide blooms that have the potential to move into North Carolina waters. The current DEH red tide contingency plan states that they will recommend that the Division of Marine Fisheries (DMF) close shellfish harvesting waters when cell counts of *K. brevis* exceed 5,000 cells per liter (bloom conditions). To provide an early warning system for fishery managers before blooms occur and areas are closed, DMF can collaborate with NOAA and DEH when conditions are favorable for potential future outbreaks and they are actively monitoring *K. brevis* concentrations.

If DMF is aware that a future red tide is imminent in areas known to have bay scallops, a potential option for mitigation is to relay scallops from these areas to other suitable areas that are not likely to be affected by the red tide. Transferring some scallops to unaffected areas may help preserve live spawning stock that can later be used to accelerate recovery of red tide affected areas. Small-scale relays have been successful in transporting scallops, but these occurred when no red tide was present. The optimum number of scallops that would need to be relayed in order to save a significant portion of the scallops is unknown. In addition, current population levels are very low, and it may be difficult to find an adequate number of scallops to transport prior to infection of the source area. It is also possible that relay of scallops from an infected area could contaminate the new location further spreading the outbreak over a wider area. Furthermore, there is concern that some fishermen may become upset if we move a significant number of scallops from their traditional harvest areas. Finally, bay scallops are found in such a small area of the state (primarily from Bogue Sound to Core Sound with some along the inside waters of Cape Hatteras) there may not be a suitable location in which to deposit relayed scallops where they would be safe from the red tide. Currently, it is not clear whether a relay would result in a successful outcome, and it is possible that it could have an unfavorable result.

IV. CURRENT AUTHORITY

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

03I .0119 Prohibited fishing activity due to public health or safety
03K .0501 Bay scallops – seasons and harvest limits

V. MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*
- \+ No changes in management
- \+ No additional restrictions on fishing practices
- \+ No additional burden to law enforcement

+ Flexibility in reacting to variable conditions
- Possibility of further depletion of the stock

B. Collaborate with DEH and NOAA to monitor potential future red tide outbreaks
+ Will know as soon as organism is detected
+ Allow for quick decisions to be made for closures or other potential actions
- Not much managers can do to save scallops

C. Scallop relay as mitigation for future red tide events
+ Spawning stock may be preserved for recovery of red tide affected areas
+ Proactive contingency plan
+ Scallops known to survive transfer
- Do not know optimum number of scallops to move
- Possible contamination of new areas
- May upset fishermen if scallops are moved from their traditional harvest areas
- Limited in appropriate areas to move scallops to
- May not be able to respond quickly enough to avoid damage to scallops

VI. MANAGEMENT RECOMMENDATIONS

MFC selected management strategy
- Collaborate with DEH and NOAA to monitor potential future red tide outbreaks.

AC and DMF - Collaborate with DEH and NOAA to monitor potential future red tide outbreaks.

VII. RESEARCH RECOMMENDATIONS

- Understand complex combination of physical, chemical, and biological factors that cause red tide blooms, and support research to predict future outbreaks.
- Planning for future red tide outbreaks.

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9.7 COWNOSE RAY INTERACTIONS AND THEIR EFFECTS ON THE BAY SCALLOP POPULATIONS[7]

I. ISSUE

Decline of bay scallop populations from predation by cownose rays (*R. bonasus*).

[7] Presented to Bay Scallop Advisory Committee April 3, 2006.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.

II. BACKGROUND

There are several species that prey on bay scallops. It has been hypothesized that overwintering ring-billed gulls (*L. delawarensis*) and herring gulls (*L. argentatus*) may contribute to declines in bay scallop abundances in North Carolina (Peterson et al. 1989; Prescott 1990). Field experiments by Prescott (1990) showed that predation intensity by gulls varied with water depth and habitat type. Gull predation was more intense on intertidal scallops than subtidal scallops (< 5.0 cm of water) and also less intense on scallops in shoal grass (*H. wrightii*) compared to sand bottom. Gulls are known to dive for prey such as fish and crabs. But if gulls are visual predators that rely on movement, it is possible that gulls have a difficult time seeing scallops due to their sedentary nature. Other species known to prey on scallops include several whelks (*Busycon sp.*), the oyster drill (*Urosalpinx cinerea*), stone crabs (*Menippe mercenaria*), banded tulips (*Fasciolaria sp.*) and cownose rays (*R bonasus*). In North Carolina cownose rays have recently been blamed for the demise of the bay scallop population.

Cownose rays are large stingrays that can reach a disc width of 100 cm and weigh up to 23 kg. They occur along the east coast of the United States from southern New England to Florida and throughout the Gulf of Mexico. During summer, cownose rays are very abundant in lower Chesapeake Bay and migrate south in fall, with schools occurring off Cape Hatteras by mid-October and northern Florida by early December. Juveniles are the last to leave and can remain in Chesapeake Bay until late October. As coastal waters begin to warm, cownose rays migrate north with schools of adults arriving near Cape Lookout by mid-April and back into Chesapeake Bay in early May (Smith and Merriner 1987). Cownose rays are euryhaline and can be found in salinities ranging from 8 to 30 ppt. and are known to go into coastal rivers.

Cownose rays feed mostly on bivalve mollusks and crustaceans, crushing them with their terrazzo-like tooth plates and powerful jaws (Smith and Merriner 1985; Powers and Gaskill 2005). Schools of rays move onto shoals with the rising tide and retreat during the last half of ebb tide. Cownose rays feed by probing the bottom with subrostral fins, perhaps using electroreceptive ampullary pores to detect excurrent flow from burrowed bivalves while the pectoral fins perform stirring motions. They are known to feed on clams, large gastropods, lobsters and crabs off southern New England, soft-shelled clams (*Mya arenaria*) in New York and sun ray venus clams *(Macrocallista nimbosa*) off the west coast of Florida. Gut analysis of cownose rays from lower Chesapeake Bay by Smith and Merriner (1985) showed they fed mostly on soft-shell clams. The cownose diet also included macoma clams (*Macoma sp.*), stout razor clam (*Tagelus plebeius*), eastern oyster, (*Crassostrea virginica*), hard clam (*Mercenaria mercenaria*), ribbed mussel (*Geukensia demissa*) dwarf surf clam (*Mulinia lateralis*), blue mussel (*Mytilus edulis*) and Atlantic jackknife clam (*Ensis directus*) (Merriner and Smith 1979). Powers and Gaskill (2005) found bay scallop remains in 26 cownose rays (n=72) that were collected in North Carolina.

Cownose ray predation on oysters has been a problem in Chesapeake Bay since the 1970s when several Rappahannock River oyster growers reported great losses of seed

and harvestable oysters to cownose rays. In 1975, several Virginia oyster growers asked for aid in reducing ray predation. Evidence addressing the possibility of an increase in cownose ray populations seemed to exist at the time, based on literature by Hildebrand and Schroeder (1928) who noted them as rare in Chesapeake Bay and later by Musick (1972), who listed them as abundant to common in the Bay (Merriner and Smith 1979). Pound net gear and haul seines had also decreased in number resulting in reduced fishing mortality on rays and increased survival. It was also noted that the preferred food of the cownose ray is soft-shelled clam whose numbers may have plummeted in the Rappahannock River after Tropical Storm Agnes in June 1972 (Andrews 1973). The combination of reduced fishing mortality along with a decrease in its preferred food item may have caused a shift in predation toward oysters in the Rappahannock River (Merriner and Smith 1979).

Otwell and Lanier (1978) also described the rays as a nuisance to scallop fishermen in North Carolina because they uprooted eelgrass and fed on scallops. They tried to establish markets for cownose rays because of their high abundance, predation on bay scallops, and destruction of eelgrass beds in North Carolina. European markets were explored where there was an established market for various species of skates. Frozen wing samples of cownose rays from Core Sound were shipped to England and distributed to France, Sweden, Germany, and Italy but met with disappointing responses. Apparently, they were marketed as 'skate', which has a white flesh, compared to the cownose ray, which has a red bloody flesh. Taste tests and experimental harvesting of rays by long haul seines around Barden Inlet were conducted. Harvested rays were iced, processed (wings cut from the body and bled), packaged and frozen manually at the seafood house. It was concluded that there were potential foreign and domestic markets and that processors were willing to handle the product if there was enough profit to allow dealing through international brokers. However, further work was needed in their utilization technology (i.e., product quality, handling problems, etc.)

Peterson et al. (2001) and Powers and Gaskill (2005) suggest that cownose rays feed in areas where bay scallops occur in high densities (greater than 70 scallops/m^2). Areas in Back Sound and the mouth of North River where high densities of scallops occur are reduced to 0.00 scallops/m^2 in a period of two to four weeks. This period of high mortality occurs during the summer before scallops spawn and has been detected in most years since the early 1990s (Peterson et al 2001; Powers and Gaskill 2005). Since this mortality occurs before the scallops spawn, these scallops do not contribute to the population the following year. The site-specific selection of grassbeds in these areas by large schools of rays may be related to a highly efficient feeding behavior as they migrate south resulting in a large number of scallops being lost to the fishery. Mortality occurs between August 15 and September 15 and corresponds with the southerly migration of cownose rays (Peterson et al. 2001; Powers and Gaskill 2005). Experiments where cownose rays were excluded from these areas of high bay scallop densities further demonstrated that rays are the cause of the high mortality that occurs at this time. Independent gill net survey data taken in Pamlico Sound by DMF also indicates increased number of rays during this time period (Figure 9.10). Bogue Sound, however, where scallop densities were lower than Core Sound, experienced lower mortality (Powers and

Gaskill 2005). Density thresholds appear to be between 2 and 5 scallops/m^2. Sites where scallop densities were greater than 3 scallops per square meter experienced almost 100% mortality.

Beginning in August 2002, the DMF opened areas around Harkers Island where high ray predation occurred in order to increase harvest of those scallops likely to suffer heavy mortality. The first year of harvest during this summer season yielded 3,446 pounds of scallop meat. However, no landings were made during subsequent years and no summer season opening occurred in 2005.

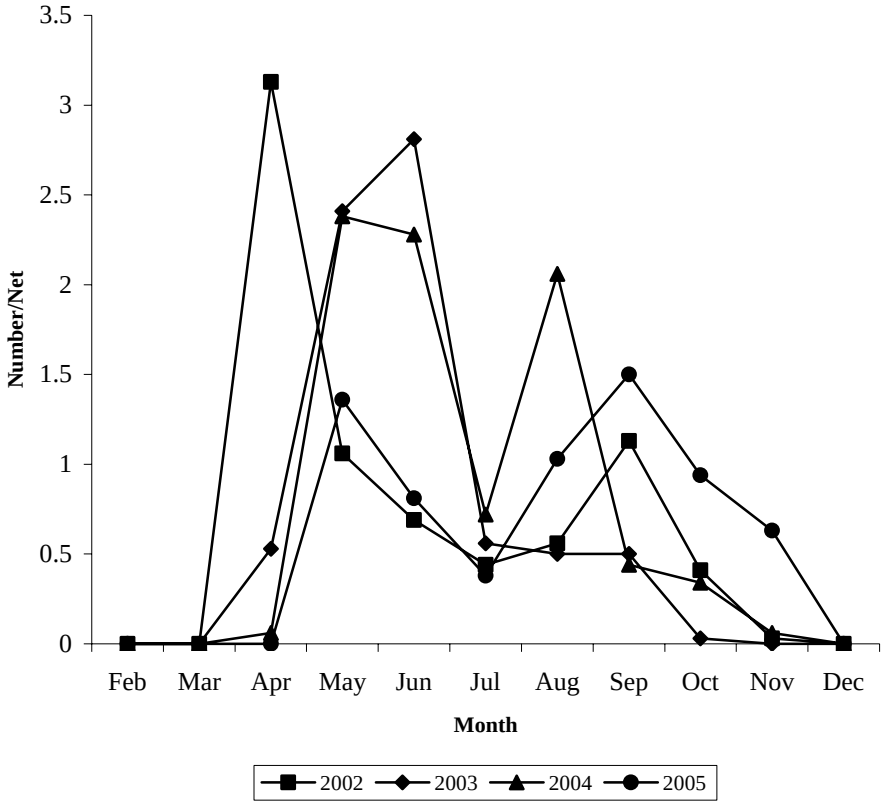

Figure 9.10. Monthly CPUE (number/net) of cownose rays in Pamlico Sound independent gill net survey. DMF biological sampling.

III. DISCUSSION

There has been a growing concern in North Carolina about predation on bay scallops by cownose rays. This situation can be compared to problems experienced in Chesapeake Bay with ray predation on oyster beds. Some scientists and fishermen believe that the number of cownose rays is rising. Indices of long-term abundances suggest that cownose rays are increasing in number as abundances of large sharks (predators of cownose rays) decrease (R. Meyers, Dalhousie University, Canada, personal communication 2006). However, other scientists believe that cownose rays have always been abundant. There are no quantitative data for abundance of cownose rays in Chesapeake Bay; however, the species has been abundant in the Bay since the 1970s as

evident from Merriner and Smith (1979). Claims that cownose rays have "exploded" are not justified because their intrinsic rate of population increase is limited due to late maturity and low fecundity. Independent gill net survey data collected by DMF since 2001 show a level abundance of cownose rays in the Pamlico Sound area (Figure 9.11). In Chesapeake Bay, aggregations of rays are dynamic in that their foraging locations will change with time over the summer. In dry summers they penetrate farther up into the tributaries because of higher salinities while in wet years they may be more concentrated in the lower Bay, so periodic local shellfish damage in Chesapeake Bay is more a function of this ray movement rather than abundance (J. A. Musick, Virginia Institute of Marine Science, personal communication 2006).

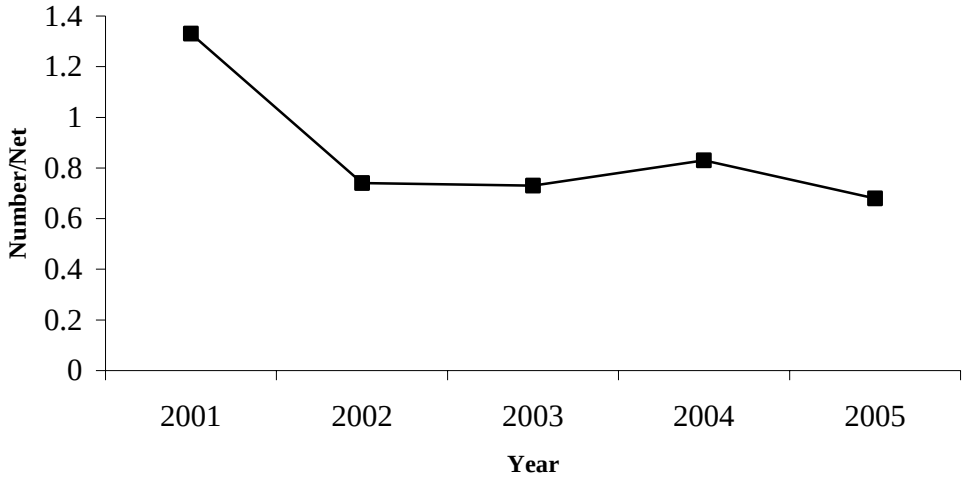

Figure 9.11. Average CPUE (number/net) of cownose rays in the independent gill net survey in Pamlico Sound. DMF biological sampling.

Major declines in sharks occurred in the 1980s, but some populations have rebounded to at least 50% of their former abundance (J. A. Musick, Virginia Institute of Marine Science, personal communication 2006). The DMF's 2006 stock status report on sharks states that the large coastal complex is not overfished. (DMF 2006).

Effort to restore the bay scallop fishery should consider the potential of large-scale mortality of high-density patches of bay scallops by cownose rays. Various options to explore controlling cownose ray predation include: 1) the use of stake-fencing using large mesh net fences or stockades as a short-term method of protecting bay scallops, or 2) to develop a fishery for cownose rays (Merriner and Smith 1979; Peterson et al. 2001; Powers and Gaskill 2005). Transplantation of scallops from areas of high density to areas of low densities is another possible solution worth exploring. Transplanted scallops should be placed in low densities (less than $3/m^2$) or protected by stockades until cownose rays have migrated out of the area (Peterson et al. 2001; Powers and Gaskill 2005).

Potential problems of fencing or stockading scallop beds include hazards to navigation, maintenance, and monitoring of beds. Areas that would need protection

would be fairly large and potentially unmanageable. Transplantation of scallops from areas of high densities to small areas may be more manageable. Additionally, this approach would provide a better chance for successful fertilization when the scallops spawn. Transplantation of scallops with low-density broadcasting without fencing may decrease chances of successful fertilization.

The development of a commercial fishery for cownose rays is another option that may be considered in addressing the predation problem. However, in order to develop a profitable fishery, there must first be a market. Possible markets may include the bait industry, food industry (pet and human), the supplement industry (pet and human), and the fertilizer industry. There were experiments in the 1970s on the use of cownose ray wings as bait in the crab pot industry in Virginia. Compared to menhaden as bait, the ray wings lasted longer and caught as many crabs as menhaden bait (J. Smith NOAA, NMFS Beaufort Laboratory, personal communication 2006). The food industry may benefit from cownose rays as both a protein source and a supplement source of chondroitin sulfate, glucosamine, and oil. For any ingredient to be pursued by a pet food manufacturer consistency of supply is crucial and ingredients that may vary by season are not often of interest. Pet food is the most highly regulated food product in the world; so stable inputs of quality ingredients are needed year round (N. Cook, Pet Food Institute, personal communication 2006). Another concern would be if cownose rays would fit any of the current feed ingredient definitions used by the NC Department of Agriculture (S. Jordan, NC Department of Agriculture, personal communication 2006).

Recently, Virginia has made an effort to address the use of cownose rays as human food. The Virginia Marine Products Board (VMPB) has begun pursuing the possibility of a commercial fishery for the cownose ray and markets in South Korea. The VMPB recently dispatched a trade mission to South Korea to determine whether cownose rays could be marketed in that country (S. Estes Virginia Marine Products Board, personal communication 2006). In the meantime, according to Scott Harper with the Virginian-Pilot (December 30, 2005), local appetites were tested at the Hampton Bay Days festival where the VMPB barbecued the ray wings and labeled them as "Chesapeake rays".

A proactive management plan for cownose rays would need to be implemented if a fishery was developed. This plan would need to establish management strategies such as quotas, seasons, size limits, trip limits, etc. to prevent overfishing and allow for adequate recruitment. Cownose rays, like other elasmobranches are most likely vulnerable to overfishing because they are slow to mature and have low fecundity. Establishing a recreational fishery through fishing tournaments and derbies for sport fishermen as well as adding the cownose ray to the list of citable fish is another option to consider. However, a proactive management plan would still be required.

IV. CURRENT AUTHORITY

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

03K.0501 Bay scallop Seasons and Harvest Limits

V. MANAGEMENT OPTIONS/IMPACTS

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

A *Status quo*
- \+ No extra expenses
- \+ No navigation hazards
- \- No increase in scallop population

B. Construction of fencing or stockade around the most productive grass beds
- \+ Protects bay scallops from predation by cownose rays
- \- Hazards to navigation
- \- Maintenance of fencing

C. Transplantation of scallops from areas of high densities to areas of low densities
- \+ Removal of scallops from population sinks to areas that may be repopulated
- \+ Reduced chance of predation by rays
- \+ Increase in scallop population
- \- Expensive to move and monitor
- \- May not result in higher populations
- \- Chance of high mortality during transportation

D. Transplantation of scallops from areas of high densities to areas with low densities protected by fencing
- \+ Removal of scallops from population sinks to areas that may be repopulated
- \+ Reduced chance of predation by rays
- \+ Increase in scallop population
- \- Expensive to move, and monitor
- \- May not result in higher populations
- \- Chance of high mortality during transportation
- \- Possible navigational hazard

E. Development of a commercial cownose ray fishery
- \+ Decrease in population feeding on bay scallops
- \+ Another source of income for commercial fishermen
- \- Still may have high predation rates on scallops

- Must establish a market
- Must establish a fishery management plan on a species whose stock status is unknown

F. Development of a recreational cownose ray fishery
+ Decrease in population feeding on bay scallops
+ Provide economic benefits from recreational fishermen to the community
- Still may have high predation rates on scallops
- Must establish a fishery management plan on species whose stock status is unknown

VI. MANAGEMENT RECOMMENDATIONS

MFC selected management strategy
- Recommend pilot research into various approaches to control cownose ray predation on bay scallops.

AC
- Recommend developing a fishery with investigation into markets for cownose rays.
- Recommend research into various approaches to control the cownose ray population.

DMF
- Recommend pilot research into various approaches to control cownose ray predation on bay scallops.

VII. RESEARCH RECOMMENDATIONS

- Collect population information on cownose rays.
- Investigate uses of cownose rays for food in the industrial reduction and the human food industries.
- Investigate uses of cownose rays as a source of chondroitin/glucosamine or oil for pet and human supplements.
- Investigate market development for cownose rays.

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9.8 PROHIBITED SHELLFISH AREA/ACTIVITIES SUGGESTED RULE CHANGE[8]

I. ISSUE

Modification of the current prohibited shellfish area rule to require scallops to be tagged and to address the possession of scallops intended for sale as whole or roe-on that are harvested from a polluted area.

[8] Presented to the Rules Advisory Team on June 1, 2006.
Presented to the Bay Scallop Advisory Committee on June 15, 2006 with DMF proposed rule changes.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.

II. BACKGROUND

The National Shellfish Sanitation Program (NSSP) is the federal/state cooperative program recognized by the U. S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC) for the sanitary control of shellfish produced and sold for human consumption. The DEH Shellfish Sanitation Section and DMF are participants in the NSSP. DEH developed rules that are consistent with the NSSP guide for the control of molluscan shellfish commonly known as the Model Ordinance. This Ordinance provides minimum guidelines that states must follow to participate in the NSSP. This insures that the public health of consumers are protected by assuring the sale and distribution of shellfish are from safe sources and by assuring shellfish have not been adulterated during cultivating, harvesting, processing, shipping, or handling.

Scallops are regulated as shellfish under DEH rules only if the final form of the product is the whole scallop. Because scallops have traditionally been shucked for the adductor muscle, shellfish sanitation no longer regulates these processors. However, whole or roe-on scallops are becoming a more popular food commodity in the United States and have sustained the development of scallop aquaculture in other states like Massachusetts, New York and Florida where they are currently offered for sale. As this market develops, either from wild harvest or by aquaculturists, dealers will be required by DEH to meet all requirements governing whole scallops including harvest from approved growing areas, tagging/labeling and dealer certification.

III. DISCUSSION

Scallops, unlike oysters, clams and mussels are not likely to be a vector for disease because the adductor muscle is the most common food product. Pathogens are typically consumed when the whole shellfish is ingested. However, because of an apparent growing market for whole and roe-on scallops and other bivalves, there is an increased risk of food product contamination. DEH rules that are currently in place are sufficient for regulation of scallops intended for sale as a whole or roe-on product. However the DMF prohibited shellfish rules are not consistent with DEH rules for harvest of whole or roe-on scallops.

IV. PROPOSED RULE CHANGE

Current rule

15A NCAC 03K .0101 PROHIBITED SHELLFISH AREAS/ACTIVITIES

(a) It is unlawful to possess, sell, or take oysters, clams or mussels from areas which have been designated as prohibited (polluted) by proclamation by the Fisheries Director except as provided in 15A NCAC 03K .0103, .0104, .0107, and .0401. The Fisheries Director shall issue such proclamations upon notice by the Division of Environmental Health that duly adopted criteria for approved shellfish harvest areas have not been met. The Fisheries Director may reopen any such closed area upon notification from the Division of Environmental Health that duly adopted criteria for approved shellfish

harvest areas have been met. Copies of these proclamations and maps of these areas are available upon request at the Division of Marine Fisheries, 3441 Arendell St., Morehead City, NC 28557; (252) 726-7021.

(b) The Fisheries Director may, by proclamation, close areas to the taking of oysters, clams, scallops and mussels in order to protect the shellfish populations for management purposes or for public health purposes not specified in Paragraph (a) of this Rule.

(c) It is unlawful to possess or sell oysters, clams, or mussels taken from polluted waters outside North Carolina.

(d) It is unlawful to possess or sell oysters, clams, or mussels taken from the waters of North Carolina except as provided in G. S. 113-169.2 (i) without a harvest tag affixed to each container of oysters, clams or mussels. Harvest tags shall be affixed by the harvester and shall meet the following criteria:

(1) Tags shall be identified as harvest tags. They shall be durable for at least 90 days, water resistant, and a minimum of two and five-eighths inches by five and one-fourth inches in size.

(2) Tags shall be securely fastened to the outside of each container in which shellstock is transported. Bulk shipments in one container and from the same source may have one tag with all required information attached. Harvesters who are also certified shellfish dealers may use only their dealers tag if it contains the required information. The required information shall be included on all lots of shellfish subdivided or combined into market grades or market quantities by a harvester or a certified shellfish dealer.

(3) Tags shall contain legible information arranged in the specific order as follows:

(A) The harvester's name, address and shellfish license or standard or retired standard commercial fishing license with shellfish endorsement number.

(B) The date of harvest.

(C) The most precise description of the harvest location as is practicable (e.g., Long Bay, Rose Bay) that can be easily located by maps and charts.

(D) Type and quantity of shellfish.

(E) The following statement in bold, capitalized type: "THIS TAG IS REQUIRED TO BE ATTACHED UNTIL CONTAINER IS EMPTY AND THEREAFTER KEPT ON FILE FOR 90 DAYS".

History Note: Authority G.S. 113-134; 113-168.5; 113-169.2; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. July 1, 1993;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2003.

MFC Proposed Recommendation

The Rules Advisory Team found that the only practical way to implement rules to prohibit the sale of scallops for whole or roe-on consumption from polluted waters would be to make scallops subject to the same shellfishing closures as those for oyster, clams and mussels. Since the consumption of whole scallops is currently practiced by only a very few consumers and the risk to those persons is exceedingly small, no change is recommended at this time.

V. RULE RECOMMENDATION

MFC selected management strategy
- Recommend no rule change.

AC and DMF - Recommend no rule change.

9.9 SOAKED OR SWELLED BAY SCALLOPS PROHIBITED SUGGESTED RULE CHANGE[9]

I. ISSUE

Whether to retain the current rule, which prohibits the soaking or swelling of bay scallop meats

II. BACKGROUND

The practice of soaking bay scallop meats in water to allow them to absorb water and "swell" to gain weight has been illegal since at least 1917. Evidently the soaking of bay scallops was a recurring problem over the years. The DEH - Shellfish Sanitation Section used to require that shucking of bay scallop meats could only be conducted in a certified shucking establishment with minimum sanitary standards. During that time, Marine Patrol Officers had the ability to visit these facilities, located primarily on Harkers Island and Salter Path, and inspect the bay scallops as they were shucked and packaged in plastic bags or tins. They could ensure that the scallops were properly washed yet not left standing in water for a long period of time. The officers even had the ability to test bay scallops suspected of being soaked with a blue solution of copper sulfate. A sample of suspect scallops would be placed in the blue liquid solution and if it floated, that was evidence that the scallops had been soaked based on the specific gravity of the solution.

[9] Presented to the Rules Advisory Team on June 1, 2006.
Presented to the Bay Scallop Advisory Committee on June 15, 2006 with the DMF proposed rule changes.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.
Finalized the rule by the Rules Advisory Team on February 1, 2007.

In the mid-1980s, the DEH rules were relaxed allowing the shucking of bay scallops to be conducted in the private homes of fishermen. This limited the Marine Patrol's access to the shucking sites and made enforcement difficult or impossible. The copper sulfate solution is no longer available. Complaints dropped off and the soaking of bay scallops no longer seems to be a problem. In fact, in the sea scallop industry, soaking scallop meats in sodium tripolyphosphate is commonly practiced according to the Shellfish Sanitation Section, North Carolina Department of Agriculture and the federal FDA. The soaking gives the product a better color and helps it retain water. The view of state and federal regulatory agencies is that the issue as an economic one, not a public health hazard.

III. DISCUSSION

The inability to gain easy access to the shucking sites and the lack of a solution to test the condition of scallop meats makes the enforcement of this rule very difficult. The context of this rule is not biological, but rather an issue of fraudulent measure and quality of meats. A pound of bay scallops would contain fewer scallops than a pound of non-soaked scallops and the soaked scallops will spatter and pop when placed in hot oil, but these are "truth in marketing" problems under the jurisdiction of Department of Agriculture, not the Division of Marine Fisheries.

IV. PROPOSED RULE CHANGE

Current rule

15A NCAC 03K .0506 SOAKED OR SWELLED BAY SCALLOPS PROHIBITED
It is unlawful to possess, sell, or take part in the production of soaked or swelled bay scallops that have been shucked. It is unlawful to permit bay scallops to be placed in still or standing water.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. July 1, 1993

MFC selected rule change

15A NCAC 03K .0506 SOAKED OR SWELLED BAY SCALLOPS PROHIBITED
~~It is unlawful to possess, sell, or take part in the production of soaked or swelled bay scallops that have been shucked. It is unlawful to permit bay scallops to be placed in still or standing water.~~

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. July 1, 1993
Repealed Eff. Month, Date, Year?

V. RULE RECOMMENDATION

MFC rule recommendation
- Repeal the rule.

AC and DMF - Repeal the rule.

9.10 BAY SCALLOP ENHANCEMENT OPTIONS[10]

I. ISSUE

Consideration of bay scallop enhancement strategies to increase bay scallop populations

II. BACKGROUND

Currently, there is no enhancement program for bay scallops in North Carolina. Historically, some enhancement work has been done in North Carolina, but these enhancement activities only occurred at an experimental level and were short-term. However, with low population levels coast wide, many states such as Florida have considered stock enhancement and sanctuaries as management strategies to revive depleted fisheries.

Concerted efforts to develop responsible methods for the mass-production of larval and juveniles for release into ocean and estuarine waters are now beginning to provide new options for the management of inshore resources (Howell et al. 1999). Restocking and stock enhancement through cultured and wild harvest are two management options. Restocking is the release of juveniles to restore severely depleted stocks to levels where they can once again provide substantial regular yields (Bell 1999). Stock enhancement, on the other hand, is the process used to overcome the common phenomenon of recruitment limitation, which occurs when the natural supply of juveniles fails to fill the carrying capacity of the habitat (Bell 1999; Doherty 1999). Although these two options can achieve the common goal of more scallops, the management can be different. Restocking suggests severely depleted stocks, and requires protection of wild and released animals by strict management, which could evolve into a moratorium on the fishery. Stock enhancement however, proposes recruitment is limited and introduction of additional seed could increase stocks.

[10] Presented to the Bay Scallop Advisory Committee on April 3, 2006.
Presented to the Rules Advisory Team on June 1, 2006.
Presented to the Bay Scallop Advisory Committee on June 15, 2006 with DMF proposed rule changes.
Finalized Bay Scallop Advisory Committee recommendations on August 21, 2006.
Finalized rules by the Rules Advisory Team on February 1, 2007.

Restocking and stock enhancement are achieved through hatchery reared seed and/or collection and redistribution of natural spatfall. Since natural mortality in the early life stages is high and only a small percentage survive to adulthood, spawning and rearing juveniles in a hatchery or collecting spat for grow out could potentially offset these high rates of mortality by introducing individuals to the wild at an age beyond which this high mortality occurs. One major concern with restocking through hatchery reared techniques is the possibility of genetic diversity declining, thereby causing genetic bottlenecks within the stock. The state of Florida along with the University of South Florida initiated a study where they developed techniques to capture bay scallops, spawn those animals in a laboratory setting, raise their offspring in a nursery setting (Blake 1998) and plant the resulting offspring in cages and raise them to adulthood (Arnold et al. 2005). Rather than directly releasing large numbers of cultured scallops into suitable habitats, they implemented a two-staged approach that involved planting juvenile scallops in protective cages and allowing them to grow to adulthood, at which time they spawned at high density (Arnold et al. 2005). Overall results of this 3-year project suggest that planting cultured scallops in cages can be a successful strategy for increasing the local spawner stock density of bay scallops in depleted populations and, ultimately, for increasing larval supply to the population (Arnold et al. 2005).

Spawning sanctuaries and spawner transplant sanctuaries are other potential enhancement options for rebuilding spawning stock. Spawning sanctuaries are areas of historical importance that are protected from harvest. Spawner transplant sanctuaries incorporate adult brood stock that may be hatchery reared or wild stock. These adult brood stocks are placed in areas of historical abundance at the time of spawning. Peterson et al. (1996) transplanted pre-spawning adult bay scallops to areas and measured the recruitment to the population. The success of this restoration of bay scallops and its low cost suggest that the technique of transplanting pre-spawning adults scallops might be applied elsewhere where populations have disappeared (Peterson et al. 1996). However, if no nearby sources of adults exist, locally collected juveniles may need to be spawned and cultured in a shellfish hatchery and nursery to provide a genetically adapted spawner stock (Peterson et al. 1996). This study concluded that wherever the sea grass habitat is adequate and where historical data show abundant bay scallops, it would be appropriate for shellfish managers to consider application of this restoration method (Peterson et al. 1996). These studies coupled with designating spawning sanctuaries may set the framework for future enhancement methods as well as incorporating other strategies to restore the North Carolina bay scallop population.

III. DISCUSSION

Restocking of bay scallops and enhancement through spawner transplants by cultured release would be difficult and expensive without the ability to produce and raise them in a state hatchery. Currently, there are no state operated hatcheries for shellfish restoration in North Carolina. In 2005 the state legislation approved funding of $600,000 annually for two years to investigate options for incorporating oyster hatcheries at the North Carolina aquariums. The use of hatcheries for species other than oysters has

been discussed. These hatcheries could allow for small scale seeding projects and public education for future programs.

Enhancement through spawner transplants by wild harvest stocks and the establishment of spawning sanctuaries may be a more viable means to consider. Brood stocks can be transplanted and deployed in cages that offer protection from predators and then retrieved after spawning or relayed with no protection. This may increase spawning potential in areas during times of low adult abundance. Spawning can be monitored with spatbags placed around the deployed areas to gauge spawning success.

Spawning sanctuaries have already been established for oysters and provide a protected haven from harvest. These sanctuaries promote growth and enhance survivability and the potential to establish populations beyond the sanctuary boundaries. The DMF currently has nine oyster sanctuaries encompassing 5.7 – 58.6 acres each, totaling 201.9 acres. These oyster sanctuaries have been designated under North Carolina Marine Fisheries Rule 15A NCAC 3K .0103 as oyster management areas and prohibits harvest of oysters or clams and the use of trawls, long haul seine, and swipe nets. This rule could be amended to allow for language to include bay scallops. With the introduction of bay scallop sanctuaries, traditional fishing grounds could be impacted. It is still unknown how many acres of bottom need to be protected to create a sanctuary that will function properly. Valuable input from commercial watermen is needed in the development of these areas. Designated sanctuaries would provide a platform to introduce spawners to an area where habitat and harvest would be protected.

Funding for DMF bay scallop programs is limited. Additional funding would be needed to generate restoration programs, which may include stock enhancement, hatcheries, sanctuaries, and sampling plans. The potential loss of fishing grounds due to bay scallop sanctuaries may need to be addressed through public hearings to minimize user conflicts and impacts on other fisheries while still allowing brood stock to populate surrounding harvest locations.

IV. CURRENT AUTHORITY

North Carolina General Statutes

113-202 New and renewal leases for shellfish cultivation; termination of leases issued prior to January 1, 1966.
113-202.1 Water column leases for aquaculture.
113-202.2 Water column leases for aquaculture for perpetual franchises.
113-208 Protection of private shellfish rights.
113-269 Robbing or injuring hatcheries and other aquaculture operations.

North Carolina Session Laws

S.L. 1997-443 Section 15.42. Renamed the Oyster Rehabilitation Program to the Shellfish Rehabilitation Program. Allowed rehabilitation funds to be appropriated to include all shellfish.

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

03K .0103 Shellfish or Seed Management Areas

V. MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*
   + No changes in management or fishing practices
   - No programs designed especially for bay scallop enhancement
   - Continued possibility of low stocks

B. Restocking bay scallops
   + Mass release of bay scallops
   - Genetic diversity may decline
   - No state hatchery to produce shellfish
   - Closes stocking areas to protect from harvest
   - Need to protect bay scallops from predators
   - Costly

C. Enhancement through spawner transplants by cultured release
   + Potential increase in spawning stock
   + No take of wild stock for enhancement
   - No state hatchery to produce shellfish
   - Genetic diversity may decline
   - Increased expense due to culture
   - Need to protect bay scallops from predators

D. Enhancement through spawner transplants by wild harvest stocks
   + Potential increase in spawning stock
   + Bypasses costly culture phase
   - Dependent on availability on wild stock
   - Depletes wild stock for enhancement
   - Need to protect bay scallops from predators

E. Establish designated bay scallop sanctuaries
   + Provides protected habitat for spawning bay scallops
   + Provides protected habitat for spawner transplants
   + Provides protected areas for DMF/Academia programs

- Potential loss of traditional fishing grounds
- Increase Marine Patrol enforcement
- Need to protect bay scallops from predators

VI. MANAGEMENT RECOMMENDATIONS AND PROPOSED RULE CHANGES

MFC selected management strategies

- Recommend enhancement through spawner transplants of wild harvest stocks and by cultured release.
- Recommend to the Oyster Hatchery Planning Advisory Team consider multiple uses of the demonstration oyster hatchery facilities for different shellfish species.

Note: The MFC approved the second recommendation and submitted a letter in April 2006 to the Oyster Hatchery Planning Advisory Team asking that the planning stages for the hatchery consider all shellfish species. The letter is included in Appendix 12.4.

AC and DMF - Recommend to the MFC that the Oyster Hatchery Planning Advisory Team consider multiple uses of the demonstration oyster hatchery facilities for different shellfish species.

AC - Recommend enhancement through seeding by cultured release.

DMF - Recommend enhancement through spawner transplants of wild harvest stocks and by cultured release.

Current rule

15A NCAC 03K .0103 SHELLFISH OR SEED MANAGEMENT AREAS

(a) The Fisheries Director may, by proclamation, designate Shellfish Management Areas which meet any of the following criteria. The area has:

(1) Conditions of bottom type, salinity, currents, cover or cultch necessary for shellfish growth;

(2) Shellfish populations or shellfish enhancement projects which may produce commercial quantities of shellfish at ten bushels or more per acre;

(3) Shellfish populations or shellfish enhancement projects which may produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas.

(b) It is unlawful to use a trawl net, long haul seine, or swipe net in any designated Shellfish or Seed Management area. These areas shall be marked with signs or buoys. Unmarked and undesignated tributaries shall be the same designation as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the designation of any such body of water or portion thereof, nor shall any such unauthorized removal or

relocation or the absence of any marker affect the applicability of any rule pertaining to any such body of water or portion thereof.
(c) It is unlawful to take oysters or clams from any Shellfish Management Area which has been closed and posted, except that the Fisheries Director may, by proclamation, open specific areas to allow the taking of oysters or clams and may designate time, place, character, or dimensions of any method or equipment that may be employed.
(d) It is unlawful to take oysters from Seed Management Areas for planting on shellfish leases or franchises without first obtaining a Permit to Transplant Oysters from Seed Management Areas from the Fisheries Director. The procedures and requirements for obtaining permits are found in 15A NCAC 03O .0500.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1994;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2003.

MFC selected rule change

15A NCAC 03K .0103 SHELLFISH OR SEED MANAGEMENT AREAS
(a) The Fisheries Director may, by proclamation, designate Shellfish Management Areas which meet any of the following criteria. The area has:

(1) ~~Conditions~~ conditions of bottom type, salinity, currents, cover or cultch necessary for shellfish growth;
(2) ~~Shellfish~~ shellfish populations or shellfish enhancement projects ~~which may produce commercial quantities of shellfish at ten bushels or more per acre;~~ that may:
  (A) produce commercial quantities of shellfish at ten bushels or more per acre;
  (B) produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas; or
  (C) serve as sanctuaries to increase spawning and disease resistance or to prevent predation.
~~(3) Shellfish populations or shellfish enhancement projects which may produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas.~~

(b) It is unlawful to use a trawl net, long haul seine, or swipe net in any designated Shellfish or Seed Management area. These areas shall be marked with signs or buoys. Unmarked and undesignated tributaries shall be the same designation as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the designation of any such body of water or portion thereof, nor shall any such unauthorized removal or relocation or the absence of any marker affect the applicability of any rule pertaining to any such body of water or portion thereof.
(c) It is unlawful to take ~~oysters or clams~~ shellfish from any Shellfish Management Area which has been closed and posted, except that the Fisheries Director may, by

proclamation, open specific areas to allow the taking of ~~oysters or clams~~ shellfish and may designate time, place, character, or dimensions of any method or equipment that may be employed.
(d) It is unlawful to take oysters from Seed Management Areas for planting on shellfish leases or franchises without first obtaining a Permit to Transplant Oysters from Seed Management Areas from the Fisheries Director. The procedures and requirements for obtaining permits are found in 15A NCAC 03O .0500.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1994;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2003.
Amended Eff.???????

VII. RESEARCH RECOMMENDATIONS

- Investigate the start up cost for a bay scallop hatchery.
- Determine the amount of seed required to restore the bay scallop population.
- Determine placement, size, and impacts to the local fishing grounds for bay scallop sanctuaries.

VIII. LITERATURE CITED

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10.0 RECOMMENDED MANAGEMENT STRATEGIES AND RESEARCH RECOMMENDATIONS

10.1 MANAGEMENT STRATEGIES

The management strategies and research needs listed below are organized according to the General Problem Statements (Section 4.2) as recommended by the MFC. Each strategy is followed by a reference to the Principal Issue(s) and Management Options from Section 9.0 and indicated in parentheses that supports it, followed by which Goal(s) and Objective(s) it addresses from Subsection 3.1. An overall discussion of the environmental factors is in Section 8.0 with recommended management strategies for habitat and water quality found in Subsection 8.4.

10.1.1 INSUFFICIENT DATA

DMF will only be able to approximate management that prevents overfishing and achieves sustainable harvest until necessary data are collected. Data are lacking from both the recreational and commercial bay scallop fisheries to provide a stock assessment. Socioeconomic surveys for both the commercial and recreational bay scallop fisheries are necessary to determine the economic impacts and demographics of the user groups.

[(Section 7.0, Issues 9.1 and 9.2), (Objectives 1, 3, 4, 5, and 6)]

10.1.1.1 ISSUE: NO DATA ON RECREATIONAL HARVEST OF SHELLFISH

MFC Selected Management Strategy

- Recommend produce a mechanism to obtain data on the recreational scallop harvest.

10.1.1.2 ISSUE: COMMERCIAL FISHERY MANAGEMENT MEASURES

MFC Selected Management Strategies

- Recommend continue prohibited take (started in January 2006) and evaluate the population status annually.
- Recommend sampling during the prohibited take period to define an independent sampling indicator for re-opening a harvest season.
- Recommend eliminating the December opening and compress the main season by beginning the last Monday in January.

MFC Selected Rule Change

15A NCAC 03K .0501 BAY SCALLOPS - SEASONS AND HARVEST LIMITS

(a) The Fisheries Director may, by proclamation, specify open seasons and methods for the taking of bay scallops during the following periods:

~~(1)~~ ~~During the month of December for a total of not more than four days;~~

(~~2~~)(1) ~~Between~~ From the ~~second~~ last Monday in January ~~and~~ through the last Friday in May; and

(~~3~~)(2) ~~Between~~ From August 1 ~~and~~ through September 15 by hand harvest methods only as described by proclamation.

(b) The Fisheries Director ~~may~~ may, by proclamation, impose any or all of the following restrictions ~~during any~~ for any commercial or recreational open ~~season specified:~~ season:

(1) Specify number of days;

(2) Specify areas;

(3) Specify means and methods which may be employed in the taking;

(4) Specify time period; and

(5) ~~Limit~~ Specify the ~~quantity.~~ quantity, but shall not exceed possession of more than 20 standard U.S. bushels per person per day or a total of 40 standard U.S. bushels in any combined commercial fishing operation per day.

~~(c) For any season provided from December through May, it is unlawful to take more than 20 standard U.S. bushels per person per day or to exceed a total of 40 standard U.S. bushels per day in any combined fishing operation.~~

~~(d) For any season provided from August 1 through September 15, it is unlawful to take more than ten standard U.S. bushels per person per day or exceed a total of 20 standard U.S. bushels per day in any combined fishing operation.~~

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991.
Amended Eff.???????

10.1.2 ENVIRONMENTAL CONCERNS

Suitable and adequate habitat are critical elements in the ecology and productivity of bay scallops. The extent to which extreme weather and water quality events impact bay scallop survival is still poorly understood. The gear issues deal with the use of bottom disturbing fishing gears that have the potential to destroy or damage SAV. Fishery restrictions already exist for most of the gears used in North Carolina that are potentially damaging to SAV.

[(Section 8.0 and Issues 9.3, 9.4, and 9.5), (Objectives 1, 2, 3, 4, and 6)]

10.1.2.1 ISSUE: HABITAT

Habitat protection, conservation, and restoration are essential to accomplish the goal and objectives of this plan. The MFC, CRC, and EMC should adopt rules to protect

critical habitats for bay scallop as outlined in the CHPP. The DENR should develop a strategy to fully support CHPP implementation with additional staff and funding. The MFC and DMF should continue to comment on activities that may impact aquatic habitats and work with permitting agencies to minimize impacts and promote restoration and research. Research must be conducted to investigate the impacts of trawling on various habitats.

A strategy should be developed and adopted by the MFC and DENR to accomplish the actions outlined below. These actions address Objectives 2 and 4 of the Plan. Actions 1, 8, 9, 11, 12, and 15 can be implemented by DMF/MFC. The other actions would need to be implemented through the cooperative efforts of the N.C. General Assembly and/or several divisions within the Department of Environment and Natural Resources. The involvement of federal agencies and increased funding (state and federal) may also be necessary to accomplish these actions. Also included in subsection 8.4.1.

MFC Selected Management Strategies

Strategic Habitat Areas

1. Identify and delineate Strategic Habitat Areas that will enhance protection of bay scallop.

Submerged Aquatic Vegetation (SAV)

2. Completely map all SAV habitat in North Carolina.
3. Remap SAV habitat in Core and Bogue sounds and assess change in distribution and abundance over time.
4. Restore historical distribution and acreage of SAV wherever necessary.
5. Aggressively reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV habitat, using regulatory and non-regulatory actions.
6. Evaluate dock criteria to determine if existing requirements are adequate for SAV survival and growth and modify if necessary.
7. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV and other habitats.
8. Evaluate and adjust as necessary dredging and trawling boundaries in Core and Bogue sounds to protect and enhance SAV habitat.
9. Seek additional resources to enhance enforcement of and compliance with bottom disturbing fishing gear restrictions that protect SAV and other habitats.
10. Work with NOAA and DWQ to determine appropriate levels of TSS, turbidity, chlorophyll a, and other water clarity parameters to achieve adequate water quality conditions for SAV growth.

Shell bottom

11. Conduct research to evaluate the role of shell hash and shell bottom in bay scallop recruitment and survival, particularly where SAV is absent.
12. Accelerate and complete mapping of all shell bottom in North Carolina.

Soft bottom

13. Protect shallow soft bottom habitat through proper siting of docks, marinas, and shoreline stabilization structures.
14. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.
15. Evaluate the effects of clam kicking and trawling on soft bottom habitat and bay scallops.

Wetlands

16. Prevent loss of additional riparian wetlands through the permitting process, land acquisition, or land use planning.
17. Restore coastal wetlands to enhance water quality conditions for bay scallops.

10.1.2.2 ISSUE: WATER QUALITY

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

The MFC has no regulatory authority over water quality impacts. The MFC and DMF should highlight problem areas and advise other regulatory agencies (EMC, DWQ, DEH – Shellfish Sanitation, Division of Land Resources, COE, and local governments) on preferred options and potential solutions.

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

Actions would need to be implemented through the cooperative efforts of the N.C. General Assembly and several divisions within the DENR. The involvement of federal agencies and funding may also be needed to accomplish these actions. Many of the following actions were taken directly from the CHPP. Also included in subsection 8.4.2.

MFC Selected Management Strategies

1. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.
2. Increase on-site infiltration of stormwater through voluntary or regulatory measures.
3. Provide more incentives for low-impact development.
4. Work with DWQ and EMC to modify stormwater rules to more effectively reduce runoff volume and pollutant loading to coastal waters to levels that protect and enhance fish habitats vital to bay scallops.
5. Reduce impervious surfaces associated with new development as much as possible and reduce the maximum amount of impervious surfaces allowed in the absence of engineered stormwater controls.
6. Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading.

10.1.2.3 ISSUE: EFFECTS OF TRAWLING ON BAY SCALLOP HABITAT (SUBMERGED AQUATIC VEGETATION) IN BOGUE SOUND

MFC Selected Management Strategy

- Recommend modifying, if needed, the trawl closure area in Bogue Sound to protect bay scallop habitat based on all available information.

10.1.2.4 ISSUE: MANAGEMENT OF DREDGES FOR HABITAT PROTECTION

MFC Selected Management Strategy

- Recommend *status quo*, no change.

10.1.2.5 ISSUE: RULE CHANGE TO CLARIFY WORDING TO PROTECT SCALLOP HABITAT FROM BULL RAKES AND HAND TONGS

There is some confusion in the rule 15A NCAC 3K .0304 (a) (1) over handrakes as described in 15A NCAC 3K .0102. Clarification of the rule with new language is added below. The intent of the rules is to protect seagrass beds from bull rakes.

MFC Selected Management Strategy

- Recommend rule change.

MFC Selected Rule Change

15A NCAC 03K .0102 PROHIBITED RAKES

It is unlawful to use a rake more than 12 inches wide or weighing more than six pounds to ~~take oysters or scallops.~~ take:

(1) oysters or scallops;
(2) clams in any live oyster bed or any established bed of submerged aquatic vegetation as described in 15A NCAC 03I .0101(b)(20) or salt water cordgrass (Spartina alterniflora).

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991.
Amended Eff.???????

15A NCAC 03K .0304 PROHIBITED TAKING

(a) It is unlawful to take clams by any method, other than by hand tongs, hand rakes, or by hand, except as provided in 15A NCAC 03K .0302 and .0303. Regardless of the areas which may be opened, it is unlawful to take clams by ~~any method:~~

~~(1) other than hand tongs, hand rakes as described in 15A NCAC 03K .0102, or by hand in any live oyster bed, or~~

~~(2) by hand rakes as described in 15A NCAC 03K .0102, or by~~ hand tongs in any established bed of submerged aquatic vegetation as ~~defined~~ described in 15A NCAC 03I .0101(b)(20) or salt water cordgrass ~~(Spartina alterniflora) that may exist together or separately.~~ (Spartina alterniflora).

(b) It is unlawful to possess clam trawls or cages aboard a vessel at any time, or have kick/deflector plates normally used in the mechanical harvest of clams affixed to a vessel at any time, except during the time period specified for a mechanical clam harvest season in internal waters in accordance with 15A NCAC 03K .0302(a). A period of 14 days before and after the season as specified by proclamation will be allowed for the installation and removal of kick/deflector plates and clam trawls or cages. Vessels with permits for activities provided for in 15A NCAC 03K .0104, .0107, .0303(a), and .0401 shall be exempt from this Rule during the times such activities are permitted.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. May 1, 1997; July 1, 1993.
Amended Eff.???????

10.1.3 HARVEST CONCERNS

Low landings in recent years due to a red tide event in 1987, numerous hurricanes, and predation by cownose rays is a concern because of the large number of bay scallops lost to the fishery as well as limiting recruitment into the bay scallop population. These low landings are also a socioeconomic concern.

[(Issue 9.6, 9.7, 9.8, and 9.9), (Objectives 1, 3, 4, 5, and 6)]

10.1.3.1 ISSUE: IMPACTS OF RED TIDE AND WEATHER EVENTS ON BAY SCALLOP POPULATIONS

MFC Selected Management Strategy

- Recommend collaborate with DEH and NOAA to monitor potential future red tide outbreaks.

10.1.3.2 ISSUE: COWNOSE RAY INTERACTIONS AND THEIR EFFECTS ON THE BAY SCALLOP POPULATIONS

MFC Selected Management Strategy

- Recommend pilot research into various approaches to control cownose ray predation on bay scallops.

10.1.3.3 ISSUE: PROHIBITED SHELLFISH AREAS/ACTIVITIES SUGGESTED RULE CHANGE

Investigation into the modification of the current prohibited shellfish area rule to require scallops to be tagged and to address the possession of scallops intended for sale as whole or roe-on that are harvested from a polluted area.

The Rules Advisory Team found that the only practical way to implement rules to prohibit the sale of scallops for whole or roe-on consumption from polluted waters would be to make scallops subject to the same shellfishing closures as those for oyster, clams and mussels. Since the consumption of whole scallops is currently practiced by only a very few consumers and the risk to those persons is exceedingly small, no change is recommended at this time.

MFC Selected Management Strategy

- Recommend no rule change.

10.1.3.4 ISSUE: SOAKED OR SWELLED BAY SCALLOPS PROHIBITED SUGGESTED RULE CHANGE

The issue is whether to retain the current rule which prohibits the soaking or swelling of bay scallop meats. This rule is no longer enforced since ruling in the 1980's allowed people to shuck scallops in their own home. Also the Shellfish Sanitation Section, North Carolina Department of Agriculture and the federal Food and Drug Administration approve the soaking of scallops in a special solution for sanitary reasons.

MFC Selected Management Strategy

- Repeal the rule.

MFC Selected Rule Change

15A NCAC 03K .0506 SOAKED OR SWELLED BAY SCALLOPS PROHIBITED
~~It is unlawful to possess, sell, or take part in the production of soaked or swelled bay scallops that have been shucked. It is unlawful to permit bay scallops to be placed in still or standing water.~~

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. July 1, 1993
Repealed Eff. Month, Date, Year?

10.1.4 STOCK ENHANCEMENT

The enhancement issue acknowledged that bay scallops are often left out of many of the rules and planning procedures for hatcheries and sanctuaries. Recommendations were made to consider bay scallops in the allocation of enhancement resources, see Appendix 12.3 for details.

[(Issue 9.10), (Objectives 4 and 5)]

10.1.4.1 ISSUE: BAY SCALLOP ENHANCEMENT OPTIONS

MFC Selected Management Strategy

- Recommend enhancement through spawner transplants of wild harvest stocks and by cultured release.
- Recommend to the Oyster Hatchery Planning Advisory Team consider multiple uses of the demonstration oyster hatchery facilities for different shellfish species.

Note: The MFC approved the second recommendation and submitted a letter in April 2006 to the Oyster Hatchery Planning Advisory Team asking that the planning stages for the hatchery consider all shellfish species. The letter is included in Appendix 12.4.

MFC Selected Rule change

15A NCAC 03K .0103 SHELLFISH OR SEED MANAGEMENT AREAS
(a) The Fisheries Director may, by proclamation, designate Shellfish Management Areas which meet any of the following criteria. The area has:

(1) ~~Conditions~~ conditions of bottom type, salinity, currents, cover or cultch necessary for shellfish growth;

(2) ~~Shellfish~~ shellfish populations or shellfish enhancement projects ~~which may produce commercial quantities of shellfish at ten bushels or more per acre;~~ that may:

(A) produce commercial quantities of shellfish at ten bushels or more per acre;

(B) produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas; or

(C) serve as sanctuaries to increase spawning and disease resistance or to prevent predation.

~~(3) Shellfish populations or shellfish enhancement projects which may produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas.~~

(b) It is unlawful to use a trawl net, long haul seine, or swipe net in any designated Shellfish or Seed Management area. These areas shall be marked with signs or buoys. Unmarked and undesignated tributaries shall be the same designation as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the designation of any such body of water or portion thereof, nor shall any such unauthorized removal or relocation or the absence of any marker affect the applicability of any rule pertaining to any such body of water or portion thereof.

(c) It is unlawful to take ~~oysters or clams~~ shellfish from any Shellfish Management Area which has been closed and posted, except that the Fisheries Director may, by proclamation, open specific areas to allow the taking of ~~oysters or clams~~ shellfish and may designate time, place, character, or dimensions of any method or equipment that may be employed.

(d) It is unlawful to take oysters from Seed Management Areas for planting on shellfish leases or franchises without first obtaining a Permit to Transplant Oysters from Seed Management Areas from the Fisheries Director. The procedures and requirements for obtaining permits are found in 15A NCAC 03O .0500.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1994;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2003.
Amended Eff.???????

10.2 SUMMARY OF RESEARCH RECOMMENDATIONS

The following research recommendations were compiled from Section 7.0 and issue papers listed in the Principal Issues and Management Options Section 9.0. The list is presented in no particular order. Proper management of the bay scallop resource cannot occur until some of these research needs are met.

1. Complete a socioeconomic survey of participants and processors in the commercial bay scallop fishery.

2. Identify and survey participants of the recreational bay scallop fishery.
3. Expand the current independent sampling in Carteret County to improve estimates of the population abundance and spawning condition of the stock.
4. Quantify high and low productive areas of bay scallop abundance.
5. Improve genetic information to determine conclusively how many separate stocks exist in North Carolina.
6. Investigate other sampling designs to estimate population abundance.
7. Establish a specific abundance estimate trigger to open the harvest season.
8. Expand on our understanding of bay scallop dredging on SAV condition and bay scallop recruitment.
9. Determine minimum stock size needed to support bay scallop population.
10. Understand complex combination of physical, chemical, and biological factors that cause red tide blooms, and support research to predict future outbreaks.
11. Planning for future red tide outbreaks.
12. Collect population information on cownose rays.
13. Investigate uses of cownose rays for food in the industrial reduction and the human food industries.
14. Investigate uses of cownose rays as a source of chondroitin/glucosamine or oil for pet and human supplements.
15. Investigate market development for cownose rays.
16. Investigate the start up cost for a bay scallop hatchery.
17. Determine the amount of seed required to restore the bay scallop population.
18. Determine placement, size, and impacts to the local fishing grounds for bay scallop sanctuaries.

10.3 REVIEW CYCLE

As provided in the FRA of 1997, the Bay Scallop Fishery Management Plan will be reviewed and revised at least every five years with the support of advisors.

11.0 LITERATURE CITED

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12.0 APPENDICES

12.1 PUBLIC INFORMATION BROCHURE

Presented to the Shellfish Advisory Committee on November 7, 2005 and the Marine Fisheries Commission with approval on November 17, 2005 to go out to the public.

Purpose

The Fisheries Reform Act of 1997 (FRA) requires the NCDMF to prepare FMPs for adoption by the NC Marine Fisheries Commission for all commercially and recreationally significant species or fisheries that comprise state marine or estuarine resources. The goal of these plans is to ensure long-term viability of these fisheries. 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 of multi-year species, fishery habitat and water quality considerations consistent with the Coastal Habitat Protection Plans, social and economic impact of the fishery to the State, and user conflicts.
b. Recommend management actions pertaining to the fishery or fisheries.
c. Include conservation and management measures that prevent overfishing, while achieving, on a continuing basis, the sustainable harvest for each fishery.
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. The 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 fishing or achieving a sustainable harvest within 10 years impracticable.

Sustainable Harvest

The concept of sustainable harvest is central to the FMP process and is defined 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.

Definition of the management unit

The management unit includes the bay scallop (*Argopecten irradians)* and its fisheries in all waters of coastal North Carolina.

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North Carolina
Division of Marine Fisheries

Bay Scallop
Fishery Management Plan

North Carolina MARINE FISHERIES
Dept. of Environment and Natural Resources

The FMP Process
This document provides information concerning the upcoming fishery management plan (FMP) for bay scallops. The FMP will be developed by the North Carolina Division of Marine Fisheries (NCDMF), with the aid of an advisory committee (AC) consisting of representatives from the commercial and recreational fishing, and the scientific communities.

The initial draft FMP will include a list of issues associated with the fishery and possible solutions to resolve those issues. As this draft is completed, there will be AC meetings held to discuss these issues as well as provide the public an opportunity to comment. The NCDMF and the AC will then review and incorporate comments received, as necessary, and produce a final draft of the FMP. A series of public meetings will be held to invite public review and comment on the final draft prior to adoption by the N.C. Marine Fisheries Commission. Public hearings will be held to comment on proposed rules to implement the final FMP recommendations.

Goals and Objectives
The goals of the 2007 N.C. Bay Scallop FMP are to implement a management strategy that restore the stock, maintain sustainable harvest, maximize the social and economic value, and consider the needs of all user groups.

To achieve these goals, it is recommended the following objectives be met:

1. Develop an objective management program that restores and maintains sustainable harvest.
2. Promote the protection, restoration, and enhancement of habitats and water quality necessary for enhancing the fishery resource.
3. Identify, enhance, and initiate studies to increase our understanding of bay scallop biology, predator/prey relationships, and population dynamics in North Carolina.
4. Investigate methods for protecting and enhancing the spawning stock.
5. Address social and economic concerns of all user groups.
6. Promote public awareness regarding the status and management of the North Carolina bay scallop stock.

Stock Status
Bay scallops (*Argopecten irradians*) are estuarine dependent mollusks found in grass beds. Bay scallops are a hermaphroditic (contain both sex cells) bivalve, which mature and spawn in a year. Their lifespan is only 12-26 months. In North Carolina, bay scallops spawn predominantly from August through October and again in March through May. The larvae go through several swimming stages before attaching to a suitable substrate such as seagrass. Upon reaching a size of approximately 1 inch (20-30 mm), bay scallops drop to the bottom. Although other benthic structures can be utilized for attachment, bay scallops utilize seagrass beds almost exclusively, and are therefore highly dependent on this habitat for successful recruitment. Bay scallops are filter feeders and feed on benthic diatoms. Predators of the bay scallop include cownose rays, blue crabs, starfish, whelks, and herring gulls.

North Carolina's bay scallop stocks are listed as ***concern***[1], because of declining harvest levels (Figure 1). They are considered an annual crop; therefore, there is no stock assessment. The bay scallop FMP is being initiated a year earlier (2005) than originally planned (2006) because landings have decreased significantly over the past several years.

Bay scallops are harvested from January to May using dredges, dip nets, or by hand, in Core, Back and Bogue sounds, in the lower portion of New River, and in eastern Pamlico Sound. Limited seasons may occur in December for social and economic reasons and in August and September, only in Core Sound, to allow harvest before the cownose ray migration occurs.

[1] Stocks designated as ***concern*** are those for which an assessment is incomplete or unavailable, show increased effort and landings, or truncated distribution. The bay scallop has been classified as a species of concern since 2000.

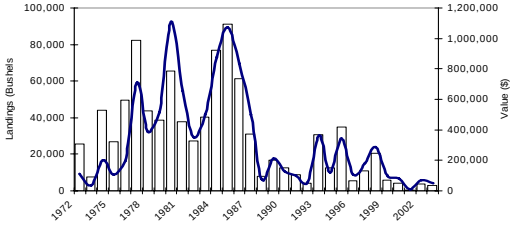

Figure 1. North Carolina bay scallop commercial landings (bushels) and value (dollars), 1972-2004.

* Landings are confidential for 2004, less than 150 lbs. harvested.

Current Management
Twenty standard U.S. bushels per person per day not to exceed a total of 40 standard U.S. bushels per day is allowed during the regular January through May commercial season. When the limited season from August 1 through September 15 is open, no more than 10 standard U.S. bushels per person per day not to exceed a total of 20 standard U.S. bushels per day is allowed. Proclamation authority has issued lower trip limits in recent years. Recreational harvest limits are one-half bushel per day, not to exceed 1 bushel per vessel per day.

Management Issues
Management recommendations for restoration and maintaining sustainable harvest of bay scallops are the most important issues to be addressed in the FMP. Management options such as area closures, rotation of fishing areas, trip limits, and seasons will be considered. Research on spawning sanctuaries, bay scallop culture, and population enhancement is also needed. Issues on predation by cownose rays, as well as other predators, will be explored. Other management issues include socioeconomic concerns, protection and enhancement of habitat and water quality, fishing gear, weather events, red tide, and the reappearance of local populations of bay scallops in the Hatteras and Avon area.

12.2 REGULATIONS OF OTHER STATES, 2005

State	Fishery	Gear limit	Size limit	Trip limit	Season	Area	Website address
Massachusetts	Commercial	Subject to change controlled by towns.	Well defined growth ring	10 bu./day. Subject to modification by towns.	Apr. 1 – Oct. 1	Only designated clean waters.	www.mass.gov/dfwele/dmf/commercialfishing/shellfish
	Recreational	Subject to change controlled by towns.	Well defined growth ring	Subject to change controlled by towns.	Subject to change controlled by towns.	Only designated clean waters.	
Rhode Island	Commercial	No take allowed by use of SCUBA. Dredges cannot exceed 6 in number or 28" in width and the bag no more than 36" in length.	Well defined growth ring.	10 bu./person/day	Prohibited between sunset and sunrise. Oct. 1 – Dec. 31	Only designated waters.	www.dem.ri.gov/programs/bnatres/fishwild/mfsizes
	Recreational	By hand only.	Well defined growth ring.	1 bu./person/day	Prohibited between sunset and sunrise. Oct. 1 – Dec. 31	Only designated waters.	
Connecticut	Commercial	No SCUBA or wading allowed. May only be taken from a drifting boat. Cannot be taken with rakes, dredges, drags, or other devices drawn along the surface of the bottom. Scoop nets with an opening no greater than 16" in width is allowed for use by hand.	Well defined growth ring.		Closed from Apr. 1 – Oct. 1 except for Little Nargansett Bay which is closed from Apr. 1- Sep. 15	Only designated areas.	www.dep.state.ct.us
	Recreational	Restricted by local laws and vary on a town-by-town basis.	Well defined growth ring.	Restricted by local laws and vary on a town-by-town basis.	Restricted by local laws and vary on a town-by-town basis.	Only designated areas.	

State	Fishery	Gear limit	Size limit	Trip limit	Season	Area	Website address
New York	Commercial	36” maximum width on dredges and mechanical means for retrieval of the dredge is prohibited.	2 ¼-inch length from mid-hinge to mid-bill.	10 bu./ person/day not to exceed 20 bu./boat.	Prohibit use of dredges on Sunday. Open season from first Monday in Nov. – Mar. 31.	Only open areas.	www.dec.state.ny.us/website/dfwmr/marine/sflaws.htm
	Recreational	Vary on a town-by-town basis.		1 bu./person/day	First Monday in Nov. – Mar. 31.	Only open areas.	
New Jersey	Commercial	Restricted to hand implements only.	None	None	No nighttime fishing or on Sundays.	Only from approved waters.	www.njfishandwildlife.com
	Recreational					No fishing allowed on leased areas.	
Delaware	Commercial	?	None	None	Closed season from Memorial Day to Labor Day. Shellfish cannot be taken between sunrise and sunset and on Sundays during open season.	Only from authorized waters.	www.delcode.state.de.us/title7
	Recreational	?	None	None		Only from authorized waters.	
Maryland		No specific regulations to bay scallops. The definition of shellfish did not include scallops.					www.maryland.gov
Virginia		Began a moratorium on the harvest of bay scallops on February 1, 1999.					www.mrc.virginia.gov/notices/nobscall.shtm
South Carolina		No regulations were found specific to bay scallops.					www.mysc.gov
Georgia		No regulations were found specific to bay scallops. Shellfish were identified only as oysters and clams.					www.gofishgeorgia.com and www.georgia.gov
Florida	Commercial	All commercial fishing banned in state waters since 1994.					www.myfwc.com/marine/bayscallops.htm
(Atlantic coast)	Recreational	Recreational harvest limited to small areas in the Gulf region.					

12.3 TYPES OF FISHING LICENSES PERTAINING TO BAY SCALLOPS

Standard Commercial Fishing License (SCFL)

- Allows the fisherman to harvest and sell fish, shrimp, crabs, or any marine species, except menhaden (captured by purse seine) and shellfish.
- To harvest shellfish, fishermen must elect a shellfish endorsement to the SCFL.
- The Shellfish Endorsement includes harvest of scallops, clams, conchs, whelks, oysters, and mussels in North Carolina waters.
- Only individual North Carolina residents are eligible for this endorsement.
- The SCFL is a personal license issued to an individual or business entity.
- It is not a vessel license. If a vessel is to be used, the vessel must have a Commercial Fishing Vessel Registration.

Retired Standard Commercial Fishing License (RSCFL)

- An RSCFL is exactly the same as a SCFL, only a fisherman must be age 65 or older..

Shellfish License

- Allows the commercial harvest and sale of shellfish.
- The shellfish license holder does not need a SCFL or RSCFL to harvest and sell commercial quantities of shellfish.
- Shellfish includes scallops, clams, conchs, whelks, oysters, and mussels.
- If a vessel is to be used, the vessel must have a Commercial Fishing Vessel Registration.

Commercial Fishing Vessel Registration (CFVR)

- Designates a vessel that can be used in commercial fishing operations.
- A CFVR is requested if a vessel is going to be used with a SCFL, RSCFL, Shellfish License, or Menhaden License for Non-Residents.
- The decal must be adhered to the port side of the vessel.

Fish Dealer License

- Authorizes a North Carolina resident entity (individual or business) with a physical location within North Carolina to buy fish for resale from any person who holds a valid SCFL, RSCFL, Shellfish License, Land or Sell License,

Menhaden License for Non-Residents Without a SCFL or Recreational Fishing Tournament License to Sell Fish.

- Fishermen who sell their own harvested catch to the public are required to have a Fish Dealer License, as well as a SCFL, RSCFL, Shellfish License, Land or Sell License, or Menhaden License for Non-Residents Without a SCFL.
- A person who buys fish for resale from another licensed Fish Dealer does not need to buy a Fish Dealer License.
- The dealers can only deal in each category designated (i.e., finfish, crab, scallop, etc.) on the license.
- Any fish or shellfish harvested and landed in North Carolina must go through a North Carolina licensed Fish Dealer (either the fisherman has a Fish Dealer License or transfers fish to a licensed dealer).
- A Fish Dealer License is required for each location.
- If the dealer sells to the public from a different location from that where fish were purchased from fishermen, this is considered resale and the dealer does not need a separate Fish Dealer license for that location, but must have documentation (i.e., bill or sale, bill or laden) that shows where the fish were purchased.
- The license must be displayed at each location for public viewing.

Number of Licenses Issued

(NOTE: Fiscal Year (FY) is July 1 – June 30)

Table 1. Total number of Standard Commercial Fishing Licenses (SCFL) and Endorsements issued for FY2000-FY2005.

Fiscal year	# of licenses	# of licenses w/ shellfish endorsement
2000	6,990	6,481
2001	6,783	6,191
2002	6,632	6,092
2003	6,505	5,984
2004	6,421	5,923
2005	6,300	5,847

Table 2. Total number of Retired Standard Commercial Fishing Licenses (RSCFL) and Endorsements issued for FY2000-FY2005.

Fiscal Year	# of Licenses	# of Licenses w/ shellfish endorsement
2000	515	480
2001	630	601
2002	676	656
2003	727	704
2004	754	733
2005	754	742

Table 3. Total number of Shellfish Licenses issued for FY2000-FY2005.

Fiscal Year	# of Licenses
2000	2,098
2001	2,176
2002	2,304
2003	2,131
2004	1,835
2005	1,623

Table 4. Total number of Commercial Fishing Vessel Registrations (CFVR) issued by vessel length category for FY2000-FY2005.

Fiscal year	0-18 ft.	>18 to 38 ft.	>38 to 50 ft.	>50 ft.	Total
2000	4,361	4,003	298	281	8,943
2001	4,650	4,191	300	316	9,457
2002	4,584	4,262	314	312	9,472
2003	4,489	4,333	309	324	9,455
2004	4,328	4,311	303	318	9,260
2005	4,078	4,332	304	306	9,020

Table 5. Total number of Fish Dealer Licenses for FY1994-FY2005 and number of Fish Dealer license categories for FY2000-FY2005.

Fiscal year[1]	Total number of licenses	Category[2]							
		Finfish	Shrimp	Crab	Oyster	Scallop	Clam	Menhaden/dehydrate	Consolidated
1994	846	-	-	-	-	-	-	-	-
1995	849	-	-	-	-	-	-	-	-
1996	918	-	-	-	-	-	-	-	-
1997	851	-	-	-	-	-	-	-	-
1998	853	-	-	-	-	-	-	-	-
1999	883	-	-	-	-	-	-	-	-
2000	850	508	338	378	139	28	76	1	64
2001	836	492	339	365	139	28	79	1	72
2002	844	497	352	361	142	35	83	1	66
2003	874	498	383	334	145	31	82	1	74
2004	872	504	374	345	131	33	82	1	70
2005	832	511	380	370	108	27	69	1	41

[1]1994-1999 data derived from hard copy sales reports housed in the Historical License Statistics Book located within the L&S Library.
[2]Summing categories will not equal total number of licenses. One license can have multiple categories listed.

12.4 MFC LETTER TO THE OYSTER HATCHERY PLANNING ADVISORY TEAM TO CONSIDER ALL SHELLFISH IN THE HATCHERY FACILITY

History: The Bay Scallop Advisory Committee and DMF recommended to the MFC that the Oyster Hatchery Planning Advisory Team consider multiple uses of the oyster hatchery facility for different shellfish species. Since plans for the hatchery will be completed before implementation of the Bay Scallop FMP, a letter to endorse this recommendation was written by the MFC in April 2006 for the Oyster Hatchery Planning Advisory Committee to consider this item. This is a copy of the letter.

April 28, 2006

Mr. J.P. McCann, Director
N.C. Aquarium on Roanoke Island
Oyster Hatchery Planning Advisory Committee
P.O. Box 967
Airport Road
Manteo, NC 27954-0967

Dear Sir,

At its April 3, 2006 meeting, the Bay Scallop Fishery Management Plan Advisory Committee recommended that the Oyster Hatchery Planning Advisory Committee consider multiple use of the demonstration oyster hatchery facilities to include other species of shellfish.

The Marine Fisheries Commission would like to endorse that recommendation and urge the Committee to look into the production of hard clam and bay scallop larvae and seed for research and possible enhancement of natural stocks.

Sincerely,

Mac Currin, Chairman
Marine Fisheries Commission

Follow up: The May 2006 Interim Report from the Oyster Hatchery Planning Advisory Committee indicated that language is incorporated into the planning document so that consideration may be given to designing the shellfish hatchery(s) that are flexible and can be used for the production of several species throughout the year (North Carolina Aquariums 2006).

North Carolina Aquariums. 2006. North Carolina Oyster Hatchery Program. Interim Report May 2006. North Carolina Oyster Hatchery Planning Advisory Team.

12.5 MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGIES AND RESEARCH RECOMMENDATIONS WITH ESTIMATED COST

Subsections in FMP	Issue/Section	MFC Management Strategies	MFC Research Recommendations	Estimated Cost to DMF
7.3.4 10.2	Socioeconomic Section		Complete a socioeconomic survey of participants and processors in the commercial bay scallop fishery.	$10,000 one-time
9.1 10.1.1.1	No data on recreational harvest of shellfish	Recommend produce a mechanism to obtain data on the recreational scallop harvest.		$300,000 start up for a recreational shellfish license $50,000 for a one-time survey

MS = Management Strategies and RR = Research Recommendations.

Subsections in FMP	Issue/Section	MFC Management Strategies	MFC Research Recommendations	Estimated Cost to DMF
9.2 10.1.1.2 10.2	Commercial bay scallop fishery management measures	Recommend continue prohibited take (started in January 2006) and evaluate the population status annually.	Expand the current independent sampling program in Carteret County to improve estimates of the population abundance and spawning condition of the stock.	MS - No cost; already completed. RR - No cost; expand on current sampling.
		Recommend sampling during the prohibited take period to define an independent sampling indicator for re-opening a harvest season.	Quantify high and low productive areas of bay scallop abundance.	MS and RR – Request funds for 1 new technician for 3 years. $40,000/year**
		Recommend eliminating the December opening and compress the main season by beginning the last Monday in January.	Improve genetic information to determine conclusively how many separate stocks exist in North Carolina.	MS – No cost. RR – Other organizations.
			Investigate other sampling designs to estimate population abundance.	MS – No cost. RR - Request funds for 1 new technician for 3 years. $40,000/year**
			**Establish a specific abundance estimate trigger to open the harvest season.	RR - Request funds for 1 new technician for 3 years. $40,000/year**
			Determine the minimum stock size needed to support the bay scallop population.	RR – Other organizations.

** Request state funds for 1 technician for 3 years to delineate historical traditional and current productive scallop beds, expand current independent program, and investigate other sampling designs to estimate population abundance.

MS = Management Strategies and RR = Research Recommendations

Subsections in FMP	Issue/Section	MFC Management Strategies	MFC Research Recommendations	Estimated Cost to DMF
8.4.1 10.1.2.1	Habitat recommended management strategies	17 total recommendations		Implemented through CHPP
8.4.2 10.1.2.2	Water quality recommended management strategies	6 total recommendations		Implemented through CHPP
9.3 10.1.2.3	Effects of trawling on bay scallop habitat (submerged aquatic vegetation) in Bogue Sound	Recommend modifying, if needed, the trawl closure area in Bogue Sound to protect scallop habitat based on all available information.		MS – No cost.
9.4 10.1.2.4 10.2	Management of dredges for habitat protection	Recommend *status quo*, no change.	Expand on our current understanding of bay scallop dredging on SAV condition and bay scallop recruitment.	MS – No cost. RR – Other organizations.
9.5 10.1.2.5	Rule change to clarify wording to protect scallop habitat from bull rakes and hand tongs	Recommend rule change.		MS – No cost.
9.6 10.1.3.1 10.2	Impacts of red tide and weather events on the bay scallop population	Recommend to collaborate with DEH and NOAA to monitor potential future red tide outbreaks.	Understand complex combination of physical, chemical, and biological factors that cause red tide blooms, and support research to predict future outbreaks.	MS – No cost RR – Other organizations.
			Planning for future red tide outbreaks.	RR – No cost.

MS = Management Strategies and RR = Research Recommendations

Subsections in FMP	Issue/Section	MFC Management Strategies	MFC Research Recommendations	Estimated Cost to DMF
9.7 10.1.3.2 10.2	Cownose ray interactions and their effects on the bay scallop populations	Recommend pilot research into various approaches to control cownose ray predation on bay scallops.	Collect population information on cownose rays.	MS - Other organizations. RR - Very little completed now, not considered a high priority species.
			Investigate uses of cownose rays for food in the industrial reduction and human food industries.	MS - Other organizations. RR - Other organizations.
			Investigate uses of cownose rays as a source of chondroitin/glucosamine or oil for pet and human supplements.	RR - Other organizations.
			Investigate market development for cownose rays.	RR – Other organizations.
9.8 10.1.3.3	Prohibited shellfish area/activities suggested rule change	Recommend *status quo*, no change.		MS – No cost.
9.9 10.1.3.4	Soaked or swelled bay scallop prohibited suggested rule change	Repeal the rule.		MS – No cost.

MS = Management Strategies and RR = Research Recommendations

Subsections in FMP	Issue/Section	MFC Management Strategies	MFC Research Recommendations	Estimated Cost to DMF
9.10 10.1.4.1 10.2	Bay scallop enhancement options	Recommend enhancement through spawner transplants of wild harvest stocks and by cultured release.	Investigate the start up cost for a bay scallop hatchery.	MS and RR - Oyster hatchery planning Committee.
		Recommend the Oyster Hatchery Planning Advisory Team consider multiple uses of the demonstration facilities for different shellfish species. Note: The MFC approved this recommendation and submitted a letter in April 2006 to the Oyster Hatchery Planning Advisory Team asking that the planning stages for the hatchery consider all shellfish species. The letter is included in Appendix 12.4.	Determine the amount of seed required to restore the bay scallop population.	MS – No cost; see Appendix 12.4 for follow up. RR - Other organizations.
			Determine placement, size, and impacts to the local fishing grounds for bay scallop sanctuaries.	RR - Refer to Subsection 9.2. $40,000/year for 3 years **

MS = Management Strategies and RR = Research Recommendations

12.6 OVERVIEW OF MFC SHELLFISH AND REGIONAL COMMITTEES RECOMMENDATIONS OF THE DRAFT BAY SCALLOP FMP

Recommendations	**Shellfish**	**Southeast**	**Central**	**Northeast**	**Inland**
Insufficient Data					
Recommend a recreational license for harvesting shellfish		AC/DMF		AC/DMF	AC/DMF
Recommend surveying fishermen that use commercial licenses for recreational harvest		AC/DMF	AC/DMF	AC/DMF	AC/DMF
**Recommend status quo for no license for recreational harvest of shellfish*	*Shellfish*				
**Recommend attaching shellfish to the upcoming CRFL license*			*Central*		
**Recommend a survey on recreational shellfishermen*	*Shellfish*				
Recommend continue prohibited take and evaluate the population annually	AC/DMF	AC/DMF	AC/DMF	AC/DMF but concerned about no trigger or a time period for opening	AC/DMF
Recommend sampling during the prohibited take period to define an independent sampling indicator for re-opening a harvest season	AC/DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF
Recommend open the main bay scallop season to commercial and recreational hand harvest only on January 1 and open to mechanical harvest the last Monday in January		AC		No recommendation	
Recommend eliminating the December opening and compress the main season by beginning the last Monday in January			DMF	No recommendation	DMF

* *Additional recommendations from the committees.*

Recommendations	Shellfish	Southeast	Central	Northeast	Inland
Insufficient Data					
**Leave the harvest season in rule as is or status quo*	*Shellfish*				
Envionmental Concerns					
All CHPP Habitat and Water Quality Recommendations pertaining to Bay Scallops (23 total)	AC/DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF
Recommend modifying , if needed, the trawl closure area in Bogue Sound to protect bay scallop habitat based on the most recent available information		AC	No recommendation	No recommendation	
Recommend modifying the trawl closure area in Bogue Sound to protect bay scallop habitat	DMF		No recommendation	No recommendation	DMF
Recommend *Status quo* in management of dredges	AC/DMF	AC/DMF	No recommendation	AC/DMF	AC/DMF
Recommend rule change in Bull Rake/Hand Tong in SAV Rules	AC/DMF	AC/DMF	No recommendation	AC/DMF	AC/DMF
Harvest Concerns					
Recommend collaborating with DEH and NOAA to monitor potential future red tide outbreaks	AC/DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF
Recommend developing a fishery with investigation into markets for cownose rays			AC	No recommendation	
Recommned research into various approaches to control the cownose ray population			AC	No recommendation	

** Additional recommendations from the committees.*

Recommendations	Shellfish	Southeast	Central	Northeast	Inland
Harvest Concerns					
Recommend pilot research into various approaches to control cownose ray predation on bay scallops	DMF	DMF		No recommendation	DMF
Recommend no rule change of prohibited shellfish area/activities	AC/DMF	AC/DMF	No recommendation	AC/DMF	AC/DMF
Recommend repeal the soaked/swelled scallop prohibited rule	AC/DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF(6-1)
Stock Enhancement					
Recommend enhancement through seeding by cultured release	AC	AC		No recommendation	
Recommend enhancement through spawner transplants by wild harvest stocks and by cultured release			DMF	No recommendation	DMF
Recommend to the MFC that the Oyster Hatchery Planning Advisory Team consider multiple uses of the demonstration oyster hathery facilities for different shellfish species	AC/DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF
Research Recommendations					
Socioeconomic research recommendations	AC/DMF	AC/DMF	No recommendation	AC/DMF	AC/DMF
All other research recommendations	AC/DMF	AC/DMF	No recommendation	AC/DMF	AC/DMF
AC recommendation for spawning sanctuaries	AC	AC	No recommendation	No recommendation	AC
DMF recommendation for any type of sanctuary	DMF		No recommendation	No recommendation	DMF

* *Additional recommendations from the committees.*

12.7. MARINE FISHERIES COMMISSION PROPOSED RULE CHANGES

15A NCAC 03K .0102 PROHIBITED RAKES

It is unlawful to use a rake more than 12 inches wide or weighing more than six pounds to ~~take oysters or scallops.~~ take:

(1) oysters or scallops;
(2) clams in any live oyster bed or any established bed of submerged aquatic vegetation as described in 15A NCAC 03I .0101(b)(20) or salt water cordgrass (Spartina alterniflora).

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991.
Amended Eff.???????

15A NCAC 03K .0103 SHELLFISH OR SEED MANAGEMENT AREAS

(a) The Fisheries Director may, by proclamation, designate Shellfish Management Areas which meet any of the following criteria. The area has:

(1) ~~Conditions~~ conditions of bottom type, salinity, currents, cover or cultch necessary for shellfish growth;
(2) ~~Shellfish~~ shellfish populations or shellfish enhancement projects ~~which may produce commercial quantities of shellfish at ten bushels or more per acre;~~ that may:
    (A) produce commercial quantities of shellfish at ten bushels or more per acre;
    (B) produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas; or
    (C) serve as sanctuaries to increase spawning and disease resistance or to prevent predation.
~~(3) Shellfish populations or shellfish enhancement projects which may produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas.~~

(b) It is unlawful to use a trawl net, long haul seine, or swipe net in any designated Shellfish or Seed Management area. These areas shall be marked with signs or buoys. Unmarked and undesignated tributaries shall be the same designation as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the designation of any such body of water or portion thereof, nor shall any such unauthorized removal or relocation or the absence of any marker affect the applicability of any rule pertaining to any such body of water or portion thereof.

(c) It is unlawful to take ~~oysters or clams~~ shellfish from any Shellfish Management Area which has been closed and posted, except that the Fisheries Director may, by proclamation, open specific areas to allow the taking of ~~oysters or clams~~ shellfish and

may designate time, place, character, or dimensions of any method or equipment that may be employed.

(d) It is unlawful to take oysters from Seed Management Areas for planting on shellfish leases or franchises without first obtaining a Permit to Transplant Oysters from Seed Management Areas from the Fisheries Director. The procedures and requirements for obtaining permits are found in 15A NCAC 03O .0500.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1994;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2003.
Amended Eff.???????

15A NCAC 03K .0304 PROHIBITED TAKING

(a) It is unlawful to take clams by any method, other than by hand tongs, hand rakes, or by hand, except as provided in 15A NCAC 03K .0302 and .0303. Regardless of the areas which may be opened, it is unlawful to take clams by ~~any method:~~

~~(1) other than hand tongs, hand rakes as described in 15A NCAC 03K .0102, or by hand in any live oyster bed, or~~

~~(2) by hand rakes as described in 15A NCAC 03K .0102, or by~~ hand tongs in any established bed of submerged aquatic vegetation as ~~defined~~ described in 15A NCAC 03I .0101(b)(20) or salt water cordgrass ~~(Spartina alterniflora) that may exist together or separately.~~ (Spartina alterniflora).

(b) It is unlawful to possess clam trawls or cages aboard a vessel at any time, or have kick/deflector plates normally used in the mechanical harvest of clams affixed to a vessel at any time, except during the time period specified for a mechanical clam harvest season in internal waters in accordance with 15A NCAC 03K .0302(a). A period of 14 days before and after the season as specified by proclamation will be allowed for the installation and removal of kick/deflector plates and clam trawls or cages. Vessels with permits for activities provided for in 15A NCAC 03K .0104, .0107, .0303(a), and .0401 shall be exempt from this Rule during the times such activities are permitted.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. May 1, 1997; July 1, 1993.
Amended Eff.???????

15A NCAC 03K .0501 BAY SCALLOPS - SEASONS AND HARVEST LIMITS

(a) The Fisheries Director may, by proclamation, specify open seasons and methods for the taking of bay scallops during the following periods:

~~(1) During the month of December for a total of not more than four days;~~

(~~2~~)(1) ~~Between~~ From the ~~second~~ last Monday in January ~~and~~ through the last Friday in May; and

(~~3~~)(2) ~~Between~~ From August 1 ~~and~~ through September 15 by hand harvest methods only as described by proclamation.

(b) The Fisheries Director ~~may~~ may, by proclamation, impose any or all of the following restrictions ~~during any~~ for any commercial or recreational open ~~season specified:~~ season:

(1) Specify number of days;
(2) Specify areas;
(3) Specify means and methods which may be employed in the taking;
(4) Specify time period; and
(5) ~~Limit~~ Specify the ~~quantity.~~ quantity, but shall not exceed possession of more than 20 standard U.S. bushels per person per day or a total of 40 standard U.S. bushels in any combined commercial fishing operation per day.

~~(c) For any season provided from December through May, it is unlawful to take more than 20 standard U.S. bushels per person per day or to exceed a total of 40 standard U.S. bushels per day in any combined fishing operation.~~

~~(d) For any season provided from August 1 through September 15, it is unlawful to take more than ten standard U.S. bushels per person per day or exceed a total of 20 standard U.S. bushels per day in any combined fishing operation.~~

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991.
Amended Eff.???????

15A NCAC 03K .0506 SOAKED OR SWELLED BAY SCALLOPS PROHIBITED

~~It is unlawful to possess, sell, or take part in the production of soaked or swelled bay scallops that have been shucked. It is unlawful to permit bay scallops to be placed in still or standing water.~~

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. July 1, 1993
Repealed Eff. Month, Date, Year?

12.8. TIMELINE FOR THE 2007 BAY SCALLOP FISHERY MANAGEMENT PLAN

TASK	TARGET DATE
Form PDT	July 2005
Identify initial issues	August 2005
Develop draft timeline, goals and objectives	August 2005
Prepare draft PIB	September 2005
Present draft PIB to Shellfish Committee	November 2005
Approval of goals and objectives by MFC	November 2005
Appointment of Bay Scallop FMP AC	November 2005
Initial AC/PDT meeting	November 2005
Present draft PIB to AC	November 2005
Formulate issues concerning the resource	August 2005-January 2006
Development of draft FMP with AC and PDT	September 2005–July 2006
Prepare draft rule language for DMF and AC preferred options	September 2005-July 2006
Present updated FMP to MFC and select preferred management options	August-September 2006
Public meetings for the draft FMP*	Fall 2006
Address public comments in FMP	Fall 2006
MFC approves draft FMP and submit to Secretary for review by the SA within 30 days	Winter 2006
Incorporate SA, Secretary and MFC comments	Spring 2007
Submit final draft FMP to DMF Director	Summer 2007
Present final draft with proposed rule language to MFC	Summer 2007
Public hearing(s) on proposed rules	Summer 2007
Submit final draft FMP to MFC for final approval	Summer 2007

*Public meetings for the FMP will be held in each of the regional districts (Northeast, Central, Southeast, and Inland)

AC	-	Advisory Committee for the Fishery Management Plan
DMF	-	Division of Marine Fisheries
FMP	-	Fishery Management Plan
MFC	-	Marine Fisheries Commission
PDT	-	Plan Development Team (DMF staff)
PIB	-	Public Information Brochure
Secretary	-	Of the Department of Environment and Natural Resources
SA	-	Joint Legislative Commission on Seafood and Aquaculture