North Carolina
Fishery Management Plan

Amendment 2
Bay Scallop

March 2015

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By

North Carolina Division of Marine Fisheries

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July 2012	Timeline begins
July 2013	Internal review comments
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February 2014	MFC selects preferred management options
March 2014	Reviewed by DENR Secretary
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August 2014	Draft rules approved for Notice of Text
February 2015	Plan amendment and rules adopted by the MFC

1.0 ACKNOWLEDGEMENTS

The 2015 North Carolina Bay Scallop Fishery Management Plan (FMP) Amendment 2 was developed by the North Carolina Department of Environment and Natural Resources Division of Marine Fisheries (NCDMF) under the direction of the North Carolina Marine Fisheries Commission (MFC) with advice from the Bay Scallop Advisory Committee (AC), 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 AMENDMENTS

2.1 AMENDMENT 1

Table 2.1 The Marine Fisheries Commission selected management strategies, objectives followed, and required actions in the 2010 Amendment 1 to the Bay Scallop FMP.

MANAGEMENT STRATEGY	OBJECTIVES	OUTCOME
1. Select adaptive management measures of 50%, 75% and 125% of the selected target of lnCPUE 1984-1985 (Oct-Dec) for Back, Bogue, and Core sounds to open the fisheries with progressive harvest levels.	1, 5, and 6	Accomplished; Use proclamation authority to open the harvest season based on annual abundance sampling estimates in October in these areas each year.
2. Consider adaptive management measures using of 50%, 75%, and 125% of the selected target of lnCPUE from January 2009 for Pamlico Sound to open the fisheries with progressive harvest levels.	1, 5, and 6	Accomplished; Use proclamation authority to open the harvest season based on annual abundance sampling estimates in January for this area each year.
3. Use pre-determined target and progressive triggers from Bogue Sound for opening areas south of Bogue Sound and the progressive harvest levels for each trigger.	1, 5, and 6	Accomplished; Use proclamation authority to open the harvest season based on annual abundance sampling estimates in October from Bogue Sound each year. A re-evaluation of the sampling conducted in areas south of Bogue Sound cannot occur until after 2011.

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3.3 LIST OF ACRONYMS

AC – Advisory Committee

ASMFC – Atlantic States Marine Fisheries Commission

BRACO – North Carolina Blue Ribbon Advisory Committee for Oysters

CHPP – Coastal Habitat Protection Plan

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

DEM – North Carolina Department of Environmental Management

DENR – North Carolina Department of Environment and Natural Resources

DWQ- North Carolina Division of Water Quality

EDC – Endocrine Disrupting Chemicals

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

GIS – Geographic Information System

GS – General Statute

HAC – Hatchery Advisory Committee

HQW- High Quality Waters

ICW – Intracoastal Waterway

lnCPUE – Natural Log Catch Per Unit Effort

MFC – North Carolina Marine Fisheries Commission

MRFSS- Marine Recreational Fisheries Statistical Survey

MSC – Moratorium Steering Committee

NCAC – North Carolina Administrative Code

NCDMF – North Carolina Division of Marine Fisheries

NMFS – National Marine Fisheries Service

NOAA – National Oceanic and Atmospheric Administration

NSW – Nutrient Sensitive Waters

NWP – Nationwide Permit

ORW – Outstanding Resource Waters

PDT – Plan Development Team

PNA – Primary Nursery Area

PPB – Parts Per Billion

PPM – Parts Per Million

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

SRH – Shellfish Research Hatchery

TSS – Total Suspended Solids

UNCW – University of North Carolina Wilmington

USACE – United States Army Corp of Engineers

USFWS – United States Fish and Wildlife Service

USGS – Unites States Geological Survey

WS – Water Supply

4.0 EXECUTIVE SUMMARY

The goal of the North Carolina Bay Scallop Fishery Management Plan (FMP) is to implement a management strategy that restores the stock, maintains sustainable harvest, maximizes the social and economic value, and considers 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 improvement 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; investigate methods and implications of bay scallop aquaculture; 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 also 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 demand. When bay scallops are available, commercial fishermen can get a good price, 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 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 it is a source of personal enjoyment. In recent years, harvest has decreased to essentially no landings because of recruitment limitations resulting from a red tide event in 1987, several hurricanes in the 1990's, and predation.

Management options such as area and season closures, trip limits, gear restrictions, and prohibited take were considered. Research needs for socioeconomic surveys, further genetic analyses, effects of harvest methods on juveniles, and the value of the spring spawn to the population are included. Issues on impacts of treading on submerged aquatic vegetation (SAV), harvest management, regulations for private culture, and stock enhancement are explored. Other issues include expansion of fishery independent sampling statewide and commercial and recreational socioeconomic and fishery data limitations.

The current management strategy for the bay scallop fisheries is to allow the NCDMF Director to open a region to limited bay scallop harvest when sampling indicates bay scallop abundance is at 50 percent of the natural logarithm of the Catch Per Unit Effort (lnCPUE) level it was in 1984-85 in the main harvest areas. A separate sampling indicator for re-opening was develoed in 2009 for Pamlico Sound and areas south of Bogue Sound are opened based on reaching the triggers for the Bogue Sound region. Trip limits and fishing days will progressively increase if sampling shows bay scallop abundance is at 75 percent or 125 percent of 1984-85 lnCPUE levels. The open season may only occur from the last Monday in January through April 1 to ensure spawning is complete and the economic yield is at an optimum for fishermen. Improving data collection on the biology, harvest, environment, enhancement, and socioeconomic aspects relative to bay scallops is recommended throughout Amendment 2 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) management; 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 only been sampled consistently statewide since 2009 and still needing further expansion. 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 for all regions in the state. Very little data exists on recreational bay scallop harvest. NCDMF developed a small optional survey to obtain additional information on shellfish harvest from Coastal Recreational Finfish License (CRFL) holders at the point of license sale but it is limited to only people who purchase a CRFL license and would not include participants who recreationally shellfish exclusively. A more accurate account of recreational 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. 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. All information and recommendations for habitat and water quality are derived directly from the Coastal Habitat Protection Plan. The extent to which habitat alterations and water quality impacts bay scallop survival is still poorly understood.

3) Management: Low landings in the past twenty-five or more years due to a red tide event in 1987, numerous hurricanes, and predation by many different species are concerns because of the large number of bay scallops no longer present to the fisheries as well as limiting recruitment of the population. The selected management strategy is to continue limited harvest at progressive levels of abundance using fishery independent sampling specific to each region in the state to determine the re-opening triggers and expand sampling in all areas. An increased interest in bay scallop culture in North Carolina has been observed in recent years. With bay scallop populations being low, fishermen are seeking alternative methods to produce bay scallops. Bay scallops are absent in the rules and planning procedures for shellfish leases and aquaculture operations. The selected management strategy is to modify rules for bottom culture and aquaculture operations to be consistent with rules for other shellfish species.

4) Stock enhancement: Stock enhancement is achieved through different methods depending on the limiting factors of the stock. Limiting factors could include recruitment, habitat or elements that limit survival from spawn to juvenile or juvenile to adult. Currently, there is no enhancement program for bay scallops in North Carolina. Considerable effort has been invested in bay scallop enhancement to increase populations in several states along the east coast. Most applications involve research through universities to develop methods for accomplishing this endeavor. A Shellfish Research Hatchery was established in 2008 at University of North Carolina Wilmington (UNCW) Center for Marine Science. While the Shellfish Research Hatchery currently is not producing bay scallop seed for industry, seed is being produced for research. The framework in the mission and objective has been set for the

Shellfish Research Hatchery to aid in future development of bay scallop enhancement programs which could supply individuals for spawner transplants and larval release. The selected management strategy for stock enhancement is to establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms and contingent on results to distribute seed on private bottom, expand the pilot program to include public bottom.

4.1 GOAL AND OBJECTIVES

The goal of the North Carolina Bay Scallop Fishery Management Plan (FMP) is to implement a management strategy that restores the stock, maintains sustainable harvest, maximizes the social and economic value, and considers the needs of all user groups. To achieve this goal, 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. Investigate methods and implications of bay scallop aquaculture.

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

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

4.2 MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGY

The MFC selected management strategy for bay scallops is to allow the NCDMF director to open a region to limited bay scallop harvesting when sampling indicates bay scallop abundance is at 50 percent of the target set specifically to a region. Trip limits and fishing days will progressively increase if sampling shows bay scallop abundance is at 75 percent or 125 percent the target abundance specific to each region. The open season may only occur from the last Monday in January through April 1 to ensure spawning is complete before harvest and the economic yield is at an optimum for fishermen. Improving data collection on the biology, harvest, environment, enhancement, and socioeconomic aspects relative to bay scallops is recommended throughout Amendment 2 to provide more comprehensive information for assisting in future management decisions. Proposed rule changes to implement the potential management strategies are found in Appendix 15.6.

4.2.1 SUSTAINABLE HARVEST STRATEGY

The statutory obligation to manage bay scallops according to sustainable harvest cannot be met until the appropriate data are collected. Data on bay scallops are limited to landings from the commercial fishery and an independent survey that has only been sampled consistently statewide since 2009 and still needs further expansion for long-term monitoring.

The current management strategy for the bay scallop fisheries is to allow the NCDMF director to open a region when sampling indicates abundance is at an acceptable level for limited harvest. Trip limits and fishing days will progressively increase if sampling shows bay scallop abundance improves.

4.2.2 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 4.1) and the research recommendations are summarized in Section 13.2. An overview of the MFC Shellfish/Crustacean, Habitat and Water Quality, and Regional Advisory Committees selected management and research recommendations and public comments are provided in Appendix 15.5. Improving bay scallop management in North Carolina includes all strategies required to produce the best management plan possible, which includes expanding sampling for estimating annual abundance, stock enhancement, incorporate rules for bay scallops to be grown out on bottom leases or aquaculture operations, and maintaining and improving habitat and water quality conditions for bay scallops.

Table 4.1 The Marine Fisheries Commission selected management strategies, objectives followed, and required actions.

MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
ENVIRONMENTAL CONCERNS		
Status quo (manage fishing gear based on scallop densities)	2 and 4	No action required
Continue to support CHPP recommendations that enhance protection of existing bay scallop habitat	2	No action required
Support programs that enhance bay scallop habitat by planting sea grass or other suitable settlement substrate	2	No action required
Identify and designate SHAs that will enhance protection of the bay scallop	2	Existing authority through CHPP implementation plan
Remap and monitor SAV coverage in North Carolina to assess distribution and change over time.	2 and 3	Existing authority through CHPP implementation plan
Restore coastal wetlands to compensate for previous losses and enhance water quality conditions for the bay scallop	2	Existing authority through CHPP implementation plan
Work with CRC to revise shoreline stabilization rules to adequately protect riparian wetlands and shallow water habitat and significantly reduce the rate of shoreline hardening	2	Existing authority through CHPP implementation plan
Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV and other fish habitats	2	Existing authority through CHPP implementation plan
Evaluate dock criteria siting and construction to determine if existing requirements are adequate for SAV survival and growth, and modify if necessary	2	Existing authority through CHPP implementation plan
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 through CHPP implementation plan
Shallow areas where trawling is currently allowed should be re-examined to determine if additional restrictions are necessary	2	Existing authority through CHPP implementation plan
Accelerate and complete mapping of all shell bottom in coastal North Carolina	2	Existing authority through CHPP implementation plan

Table 4.1 (Continued) The Marine Fisheries Commission selected management strategies, objectives followed, and required actions.

MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
ENVIRONMENTAL CONCERNS		
Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry	2	Existing authority through CHPP implementation plan
Reduce impervious surfaces and increase on-site infiltration of stormwater through voluntary or regulatory measures	2	Existing authority through CHPP implementation plan
Provide more incentives for low-impact development	2	Existing authority through CHPP implementation plan
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 through CHPP implementation plan
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	Existing authority through CHPP implementation plan
Provide proper disposal of unwanted drugs, reduce insecticide and heavy metal run-off, and develop technologies to treat wastewater for antibiotics and hormones	2	Existing authority through CHPP implementation plan
Discourage use of detergents in coastal waters, especially detergents with antimicrobial components	2	Existing authority through CHPP implementation plan
INSUFFICIENT DATA		
Support improving the reliability of the data for the recreational scallop harvest	1	Existing authority
MANAGEMENT		
Eliminate the August 1 through September 15 season open period in rule	1 and 4	Rule change required to 15A NCAC 03K .0501
Expand sampling in all regions and manage harvest conditionally in areas south of Bogue Sound until adequate sampling can determine a harvest trigger for management.	1 and 3	Existing authority

Table 4.1 (Continued) The Marine Fisheries Commission selected management strategies, objectives followed, and required actions.

MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
MANAGEMENT		
Continue current progressive triggers with adaptive harvest levels in all areas, except areas south of Bogue Sound, and modify harvest management measures as shown in Table 12.7 and Table 12.8 in the issue paper. And continue to improve the statistical rigor of the abundance index.	1	Existing proclamation authority.
Keep dredges at the 75% trigger harvest level in Table 12.7	1 and 6	Existing proclamation authority.
Modify the daily commercial harvest possession limit in Rule 15A NCAC 03K .0501 to a quantity of no more than 15 standard U.S. bushels per person per day not to exceed 30 standard U.S. bushels in any combined commercial fishing operation per day to be consistent with the adaptive management measures trip limits.	1 and 7	Requires rule change to rule 15A NCAC 03K .0501
Exempt bay scallop harvest from leases from the regular season and harvest limits	1, 5, and 6	Requires rule change to rules 15A NCAC 03K .0111,
Support an exemption from G.S. 113-168.4 (b) (3) when the sale is to lease or Aquaculture Operations permit holders for further rearing	1, 5, and 6	Requires statutory change to G,S, 113-168.4
STOCK ENHANCEMENT		
Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms	1, 4, 5, and 6	Existing authority
Contingent on results to distribute seed on private bottom, expand the pilot program to include public bottom	1, 4, and 5	Existing authority

5.0 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 predation. The goal of this plan is to implement a management strategy that restores the stock, maintains sustainable harvest, maximizes the social and economic value, and considers the needs of all user groups

5.1 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 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 NCDMF is the branch of the DENR that carries out this responsibility. G.S. 113-136 provides enforcement authority for NCDMF Marine Patrol officers. 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 NCDMF 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 fishing licenses and a cap on 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 amendment of the FRA in 2010 required FMPs to specify time periods for ending overfishing and achieving a sustainable harvest and include as standard of at least fifty percent probability of achieving a sustainable harvest. 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 two years from the date of the adoption of the plan, to end overfishing. This subdivision shall not apply if the Fisheries Director determines that the biology of the fish, environmental conditions, or lack of sufficient data make implementing the requirements of this subdivision incompatible with professional standards for fisheries management.

e. Specify a time period, not to exceed 10 years from the date of the adoption of the plan, for achieving a sustainable harvest. This subdivision shall not apply if the Fisheries Director determines that the biology of the fish, environmental conditions, or lack of sufficient data make implementing the requirements of this subdivision incompatible with professional standards for fisheries management.

f. Include a standard of at least fifty percent (50%) probability of achieving sustainable harvest for the fishery or fisheries. This subdivision shall not apply if the Fisheries Director determines that the biology of the fish, environmental conditions, or lack of sufficient data make implementing the requirements of this subdivision incompatible with professional standards for fisheries management.

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)).

5.2 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 the past twenty-five years resulting from red tide, hurricanes and predation are a major concern. When bay scallops are available, commercial fishermen can get a good price, 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 of the state, limitations in the population are felt strongly for all user groups in this region. Recreational harvest is allowed at the same time as the commercial season and is also managed with minimum daily trip limits. No data are available on recreational harvest at this time.

Management options such as area and season closures, trip limits, gear restrictions, and prohibited take are considered. Research needs for socioeconomic surveys, further genetic analyses, effects of harvest methods on juveniles, and the value of the spring spawn to the population are included. Issues on impacts of treading on SAV, harvest management, regulations for bottom culture and aquaculture operations, and stock enhancement are explored. Other issues include expansion of fishery independent sampling statewide and commercial and recreational socioeconomic and fishery data limitations.

5.2.1 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 only been sampled consistently statewide since 2009 and still needs further expansion. 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 for all regions in the state. Very little data exists on recreational bay scallop harvest. NCDMF developed a small optional survey to obtain additional information on shellfish harvest from Coastal Recreational Finfish License (CRFL) holders at the point of license sale but it is limited to only people who purchase a CRFL license and would not include participants who recreationally shellfish exclusively. A more accurate account of recreational 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. The selected management strategy is to improve the reliability of the data for the recreational scallop harvest. 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.

Specific issues, management options, and potential actions are outlined in Sections 10.0, 11.0, 12.0 and 13.0.

5.2.2 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). Suitable and adequate habitat is a critical element in the ecology and productivity of bay scallops. The use of bottom disturbing fishing gear has the potential to destroy or damage SAV. The Coastal Habitat Protection Plan (CHPP) implementation plan calls for protective buffers from bottom-disturbing gears. The extent to which habitat alterations and water quality impacts bay scallop survival is still poorly understood.

Specific issues, options, and potential actions are outlined in Sections 11.0, 12.0, and 13.0.

5.2.3 MANAGEMENT

Low landings in the past twenty-five or more years due to a red tide event in 1987, numerous hurricanes, and predation by many different species are concerns because of the large number of bay scallops no longer present to the fisheries. Recommendations were made to continue limited harvest at progressive levels of abundance using fishery independent sampling across all regions in the state to determine the re-opening triggers and expand sampling in all areas. An increased interest in bay scallop culture in North Carolina has been observed in recent years. With bay scallop populations low, fishermen are seeking alternative methods to produce bay scallops. Bay scallops are often absent in the rules and planning procedures for shellfish leases and aquaculture operations. Recommendations were made to modify rules for bottom leases and aquaculture operations to be consistent with rules for other shellfish species.

Specific issues, options, and potential actions are outlined in Sections 12.0 and 13.0.

5.2.4 STOCK ENHANCEMENT

Stock enhancement is achieved through different methods depending on the limiting factors of the stock. Limiting factors could include recruitment, habitat or elements that limit survival from spawn to juvenile or juvenile to adult. Currently, there is no enhancement program for bay scallops in North Carolina. Considerable effort has been invested in bay scallop enhancement to increase populations in several states along the east coast. Most applications involve research through universities to develop methods for accomplishing this endeavor. Spawner transplants and larval release are stock enhancement options worthy of expanded investigations. These strategies have been implemented mostly in the research arena and have yielded promising but not definitive results. A Shellfish Research Hatchery was established in 2008 at University of North Carolina Wilmington (UNCW) Center for Marine Science. While the Shellfish Research Hatchery currently is not producing bay scallop seed for industry, seed is being produced for research. The framework in the mission and objectives has been set for the Shellfish Research Hatchery to aid in future development of bay scallop enhancement programs which could supply individuals for spawner transplants and larval release.

Specific issues, options, and potential actions are outlined in Sections 11.0, 12.0, and 13.0.

5.3 DEFINITION OF THE MANAGEMENT UNIT

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

5.4 EXISTING PLANS, STATUTES, AND RULES FOR BAY SCALLOPS IN NORTH CAROLINA

5.4.1 PLANS

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

5.4.2 STATUTES [From Selected North Carolina General Statutes (August 2013)]

G.S. 113-168.2 Standard Commercial Fishing License

A $250 license to commercially harvest and sell finfish, crabs, and shrimp to licensed seafood dealers for state residents. 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 $1.25 to $7.50 per foot.

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

There is an annual $31.25 license for individuals to commercially harvest shellfish taken by hand methods. This license is available only to residents of North Carolina.

G.S. 113-169.3 License for fish dealers.

This General Statute establishes a license requirement and establishes a $62.50 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 North Carolina Environmental Management Commission (EMC), North Carolina Coastal Resources Commission (CRC), and MFC to adopt and follow the plans.

5.4.3 RULES [All references are from Title 15A Environment and Natural Resources Chapter 3 Marine Fisheries of the NC Administrative Code (NCAC)]

5.4.3.1 GENERAL

Definitions (03I .0101)

- Aquaculture operation: an operation that produces artificially propagated stocks of marine and estuarine resources or obtains such stocks from authorized sources for the purpose of rearing in a controlled environment.
- Shellfish marketing from leases and franchises. The harvest of oysters, clams, scallops, mussels, from privately held shellfish bottoms and lawful sale of those shellfish to the public at large or to a licensed shellfish dealer.
- Shellfish production on leases and franchises: (i) The culture of oysters, clams, scallops, and mussels, on shellfish leases and franchises from a sublegal harvest size to a marketable size. (ii) The transplanting (relay) of oysters, clams, scallops and mussels from areas closed due to pollution to shellfish leases and franchises in open waters and the natural cleansing of those shellfish.
- Dredge: a device towed by engine power consisting of a frame, tooth bar, or smooth bar, and catch bag used in the harvest of oysters, clams, crabs, scallops, or conchs.
- Shellfish producing habitats. Those areas in which shellfish, such as clams, oysters, scallops, mussels, and whelks, whether historically or currently, reproduce and survive

because of such favorable conditions as bottom type, salinity, currents, cover, and cultch. Included are those shellfish producing areas closed to shellfish harvest due to pollution.

5.4.3.2 SHELLFISH, GENERAL

Prohibited Shellfish Areas/Activities (03K .0101)

- The Fisheries Director may, by proclamation, close areas to the taking of scallops in order to protect the population for management or public health purposes.

Prohibited Rakes (03K .0102)

- The size of a rake used to take scallops is limited to no more than 12 inches in width or weighing more than six pounds.

Shellfish/Seed Management Areas (03K .0103)

- Proclamation authority is established to close and open shellfish management areas and designate time, place, character, or dimensions of harvest methods.

Introduce, Transfer or Hold Imported Marine or Estuarine Organisms (03K .0104)

- A requirement to obtain a permit with specific conditions to protect the marine and estuarine resources of North Carolina from unacceptable risks from predators, pests, parasites, and diseases from introduced, transferred or imported live marine and estuarine organisms not native or native but which originated outside the State's boundaries.

Recreational Harvest of Shellfish (03K .0105)

- This rule allows harvest of recreational quantities of scallops without a commercial license during regular open seasons including Saturday and Sunday.

5.4.3.3 SCALLOPS

Bay Scallops - Seasons and Harvest Limits (03K .0501)

- Proclamation authority is established for the number of days, areas, means and methods, time period with a specified allowable open season, and maximum daily harvest quantity for any combined commercial fishing operation.

Taking Bay Scallops at Night and on Weekends (03K .0502)

- Makes it unlawful to take bay scallops at night.

Prohibited Bay Scallop Dredge (03K .0503)

- Prohibits the use of dredges with teeth and weighing no more than 50 pounds to take scallops.

Standards for Shellfish Bottom and Water Column Leases (03O .0201)

- Standards are established for obtaining a new shellfish lease and meeting lease utilization requirements. Proposed lease sites cannot contain 10 or more bushels of shellfish per acre, impinge upon riparian rights within 100 feet of a developed shoreline, or exceed certain acreage guidelines without justification. Shellfish bottom leases must produce 10 bushels of shellfish per acre per year and plant 25 bushels of seed shellfish or 50 bushels of cultch per acre per year to meet requirements. Water column amendment requirements are four times the bottom use requirements. Shellfish franchise utilization requirements are also included. Conversion factors and specific situations are covered.

Shellfish Bottom and Water Column Lease Applications (03O .0202)

- Application information, maps, management plans and marking of the proposed site are specified.

Shellfish Lease Application Processing (03O .0203)

- Inspection for compliance with standards, modification of sites, notification of approval, and surveying requirements are specified.

Marking Shellfish Leases and Franchises (03O .0204)

- Specifications for making poles, signs, spacing of markers, and removal of markers is given.

Lease Renewal (03O .0205)

- Management plan, survey, application of standards, and appeal-of-denial information is given for lease renewals.

Lease Protest (03O .0206)

- Commenting and formal protest procedures on lease applications are specified.

Production Report (03O .0207)

- Production information requirements and reporting dates are given.

Cancellation (03O .0208)

- States that cancellation proceedings will begin for failure to meet production requirements and interfering with public trust rights. Corrective action and appeal information is given.

Transfer of Interest (03O .0209)

- Minimum size of transfers, 30-day notification requirement, prohibition on water column transfers and resident requirements for transfers are given.

Shellfish Franchises (03O .0210)

- Survey requirements, management plans, and production requirements for recognized franchises are specified.

Permit Conditions; Specific (03O .0503)

- Aquaculture Operations/Collection Permit - Requires an Aquaculture Operation Permit to conduct aquaculture operations.

6.0 STATUS OF THE STOCK

6.1 LIFE HISTORY

6.1.1 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 Chandeleur islands in the Gulf of Mexico, and *A. irradians amplicostatus* (Dall 1898) from Galveston, Texas to Laguna Madre, Texas (Fay et al. 1983). 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 6.1 and Figure 6.2). There may be more than one discrete stock of bay scallops in North Carolina waters. Mitochondrial DNA data demonstrated low ($\leq$4 migrants/generation) larval exchange between Topsail, Bogue, Back, and Pamlico sounds (Marko and Barr 2007).

6.1.2 HABITAT TOLERANCES AND PREFERENCES

In North Carolina, bay scallops are found almost exclusively in estuarine waters. 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 and hot temperatures (Gutsell 1930; Spitsbergen 1979).

Appropriate substrates for settlement, attachment, and feeding are crucial for bay scallop survival. Bay scallops are associated with submerged aquatic vegetation (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; Fonseca and Uhrin 2008). 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). More detailed habitat and water quality information is available in Section 10.0: Environmental Factors.

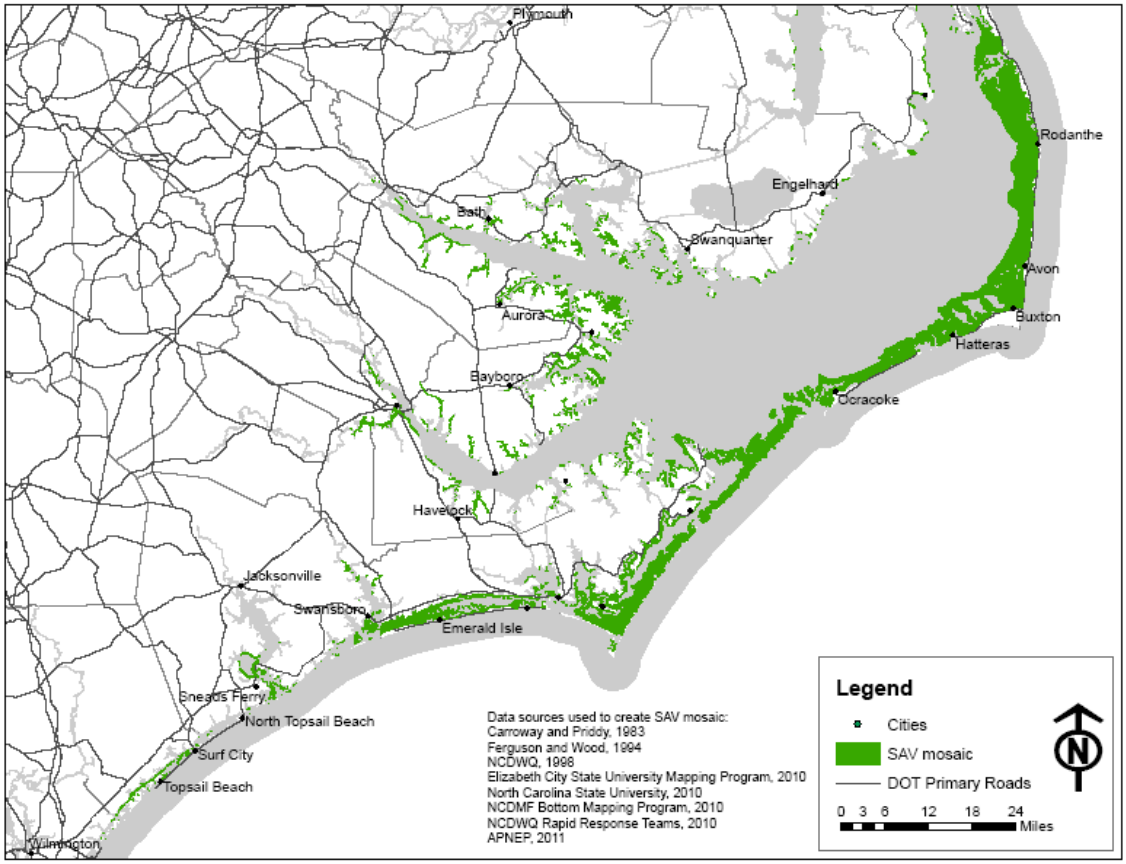


Figure 6.1 Submerged aquatic vegetation mapped between 1981 to 2012 within the range of the bay scallop in North Carolina. Note: Absence of SAV beds in a given area does not suggest actual presence/absence of SAV because surveys have not been conducted in all areas. NCDMF Geographic Information System (GIS) database.

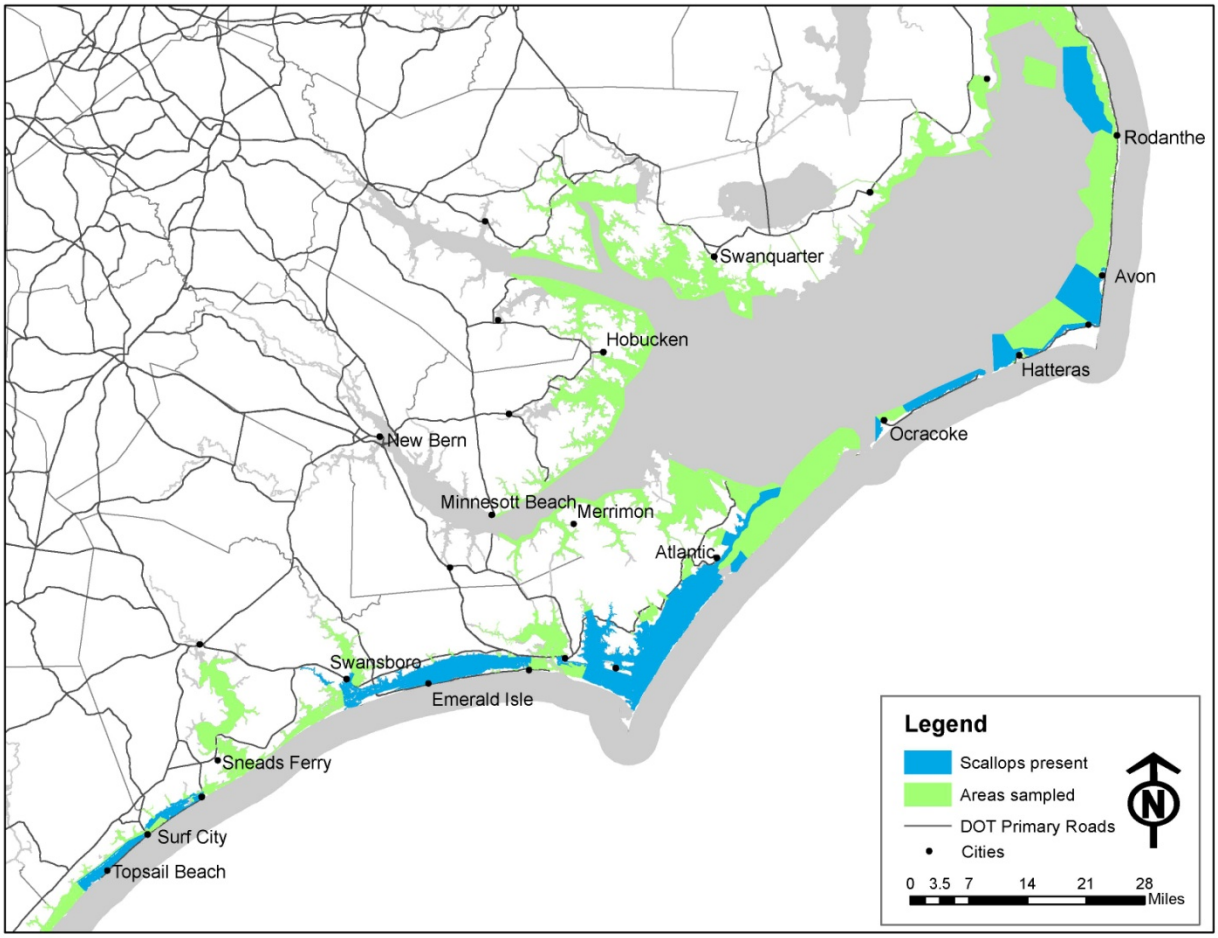


Figure 6.2 Presence of bay scallops found by NCDMF Bottom Mapping Program data, 1988-2012.

6.1.3 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 6.3). 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.

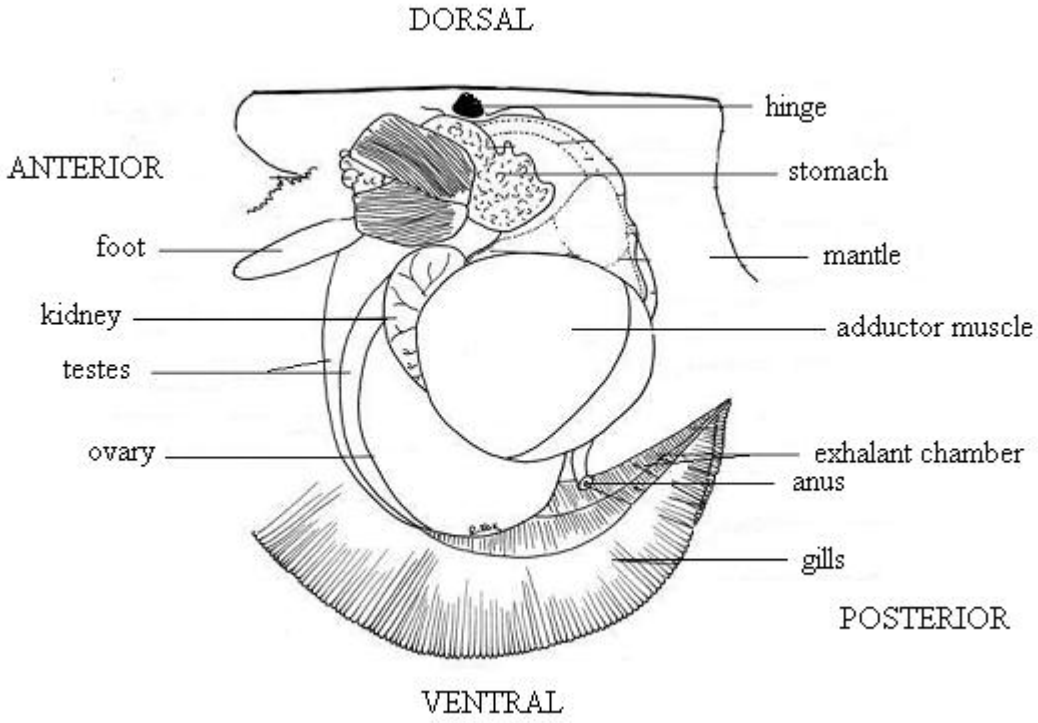


Figure 6.3 The left side of *Argopecten irradians*. The left valve, mantle skirt, and gill have been removed to reveal the organs underneath (Fox 2004).

6.1.4 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 6.4).

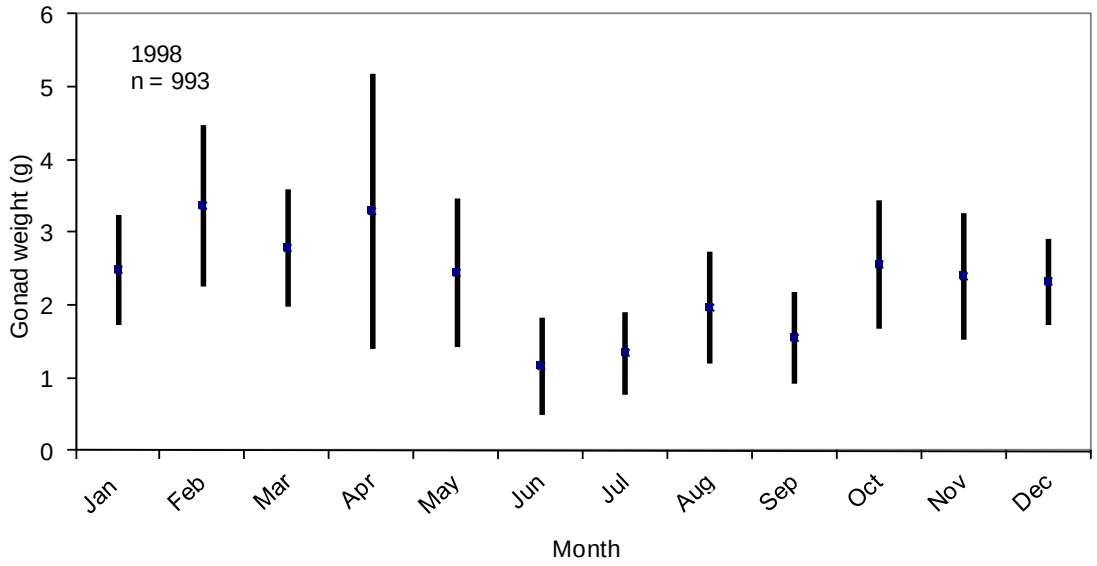


Figure 6.4 Average monthly bay scallop gonad weight (g)(wet) in 1998 with one standard deviation from the mean. NCDMF biological sampling.

Fertilization occurs in the water column and fertilized eggs settle to the bottom (Gutsell 1930; Sastry 1965) (Figure 6.5). 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 (~3 mm). 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 to 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 6.4). 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 to 20 days (Gutsell 1930; Sastry 1965; Fay et al. 1983).

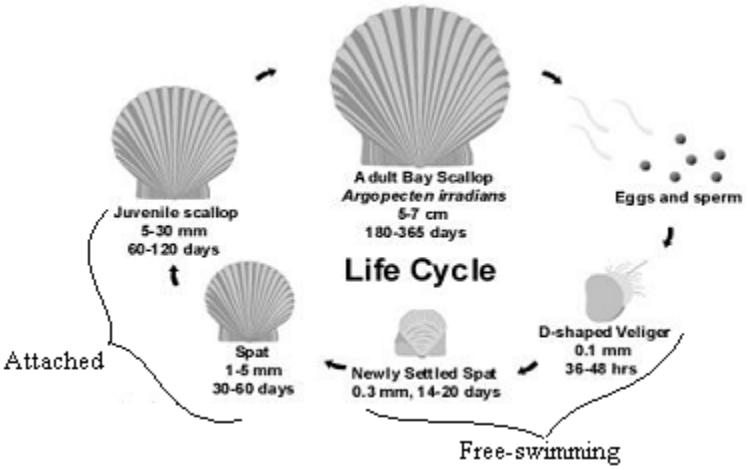


Figure 6.5 Life cycle of the bay scallop (*Argopecten irradians*). (From: Florida Fish and Wildlife Commission. Fish and Wildlife Research Institute. http://research.myfwc.com/features)

Juvenile bay scallops prefer to be suspended off the bottom during the attached stage in their development (Fay et al. 1983) (Figure 6.5). Young scallops cannot tolerate highly silted substrates, and attachment to epibenthic surfaces 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; MacKenzie 2008). 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; Fonseca and Uhrin 2008). Juveniles remain attached until they grow to 20 mm to 30 mm and then drop to the bottom (Figure 6.5). Juvenile bay scallops (< 50 mm shell height; based on Spitsbergen 1977 and 1979) were present year-round in NCDMF sampling (Figure 6.6). Juveniles were most abundant from May to July with peak abundance in June.

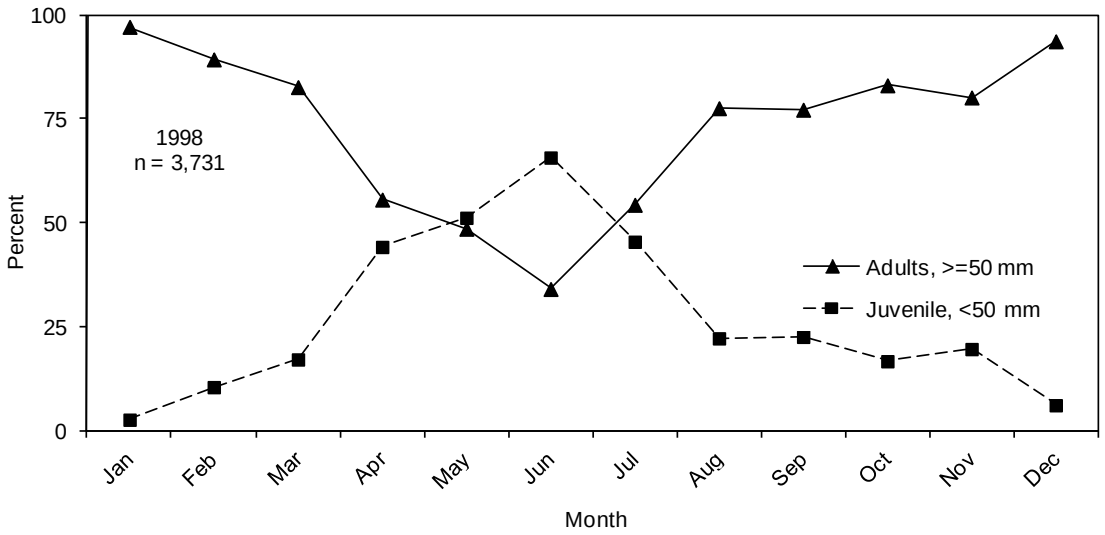


Figure 6.6 Percentage of juvenile (<50 mm shell height) and adult (≥ 50 mm) bay scallops by month in 1998. NCDMF biological sampling.

The adult stage is characterized by the radial furrows and ridges on the shell, although the shell ribs appear at a much earlier size (3 mm) (Figure 6.5). 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 et al. 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 (Castagna 1975; Fay et al. 1983).

6.1.5 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 et al. 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 et al. 1983).

Growth rates of bay scallops depend on water temperature, current velocity, food abundance, and sometimes scallop density (Fay et al. 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 (Figure 6.6) (Spitsbergen 1977; Spitsbergen 1979). Shell growth slows from September through the spring with very limited growth from September through November (Figure 6.7) (Kirby-Smith 1970; Spitsbergen 1979).

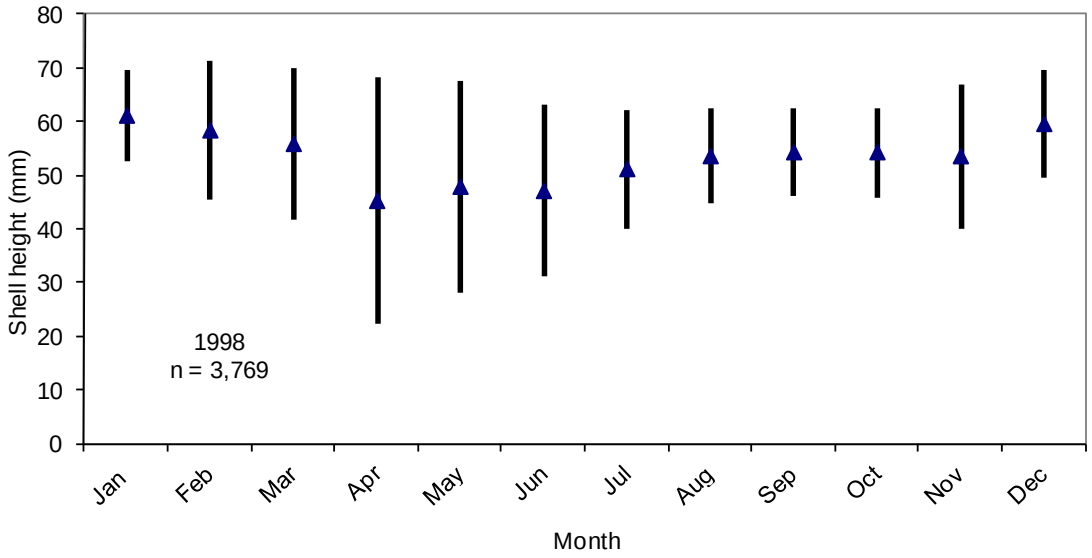


Figure 6.7 Average monthly bay scallop shell height (mm) in 1998 with one standard deviation from the mean. NCDMF biological sampling.

6.1.6 DISEASE AND PREDATION

The occurrence of unusual algal blooms known as “brown tides” has 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 ssubstantial. 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 is available.

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).

Some scientists and fishermen believe that the number of cownose rays is rising (Myer et al. 2007). The situation can be compared to problems experienced in the Chesapeake Bay with ray predation on oyster beds. Accurate data collection on cownose ray abundance through time is limited and claims that cownose ray populations have exploded are not justified because the natural expansion of their population is limited due to late maturity and low fecundity of the species. Periodic local shellfish damage is likely a function of cownose ray movement rather than abundance (J. Musick, Virginia Institute of Marine Science, personal communication 2006).

Research has determined that cownose rays feed in areas where bay scallops occur in high densities, greater than 70 scallops per square meter (Peterson et al. 2001; Powers and Gaskill 2005). Mortality occurs between August 15 and September 15 which corresponds with the southerly migration of cownose rays (Peterson et al. 2001; Powers and Gaskill 2005; Goodman et al. 2010). Beginning in August 2002, the NCDMF 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 the 2003 and 2004 summer openings.

An issue paper specific to cownose ray impacts to bay scallops was developed for the 2007 FMP (NCDMF 2007). The selected management strategy by the MFC was to complete pilot research into various approaches to control cownose ray predation on bay scallops. Additional research recommendations included collecting 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, and investigate market development for cownose rays.

In 2006, Virginia Sea Grant hosted a workshop bringing together academia, managers, and industry to identify cownose ray research issues and extension needs (Virginia Sea Grant Program and Virginia Institute of Marine Science 2006). The workshop identified the problems facing many commercial shellfish fishermen and the need for responsible management of the cownose ray resource if there was a fishery. The overall conclusions of the workshop were that shellfish-ray interactions are an important regional issue, that little information exists on cownose ray population dynamics, and that a cownose ray fishery has potential if educational and marketing efforts are strengthened.

Recent efforts by the state of Virginia to promote cownose ray marketing through a subsidy program paid to industry has generated landings for cownose ray, but rays were retained as bycatch to targeted species and effort was not consistent (Fisher 2010). There was some success at marketing fresh fillets to retail and wholesale markets, but value added markets disappeared (Amory 2012). It will take some time before a sustainable product can be developed from cownose rays (Amory 2012). Studies by Virginia Sea Grant are underway to investigate cownose ray as cut bait in the blue crab trap and trot-line fisheries, American lobster and crayfish trap fisheries, and the mid-Atlantic shark longline fishery.

6.2 PRESENT STOCK STATUS

6.2.1 INTRODUCTION

Bay scallop stocks along the Atlantic seaboard have been at low levels since the mid 1980s and have remained low (Figure 6.8). One of the main causes was the numerous occurrences of the brown tide (*Aureococcus anophagefferans*) that decimated scallops in Peconic Bay in Long Island and Narragansett Bay in Rhode Island in 1985 (MacKenzie 2008). Scallops are fragile and sensitive to even slight environmental changes. Since 1985, climate change and temperature rise, phytoplankton composition, predation, nitrogen pollution, decrease in eelgrass abundance, and increases in the human population along the coastal watersheds have most likely had impacts on the bay scallop (MacKenzie 2008).

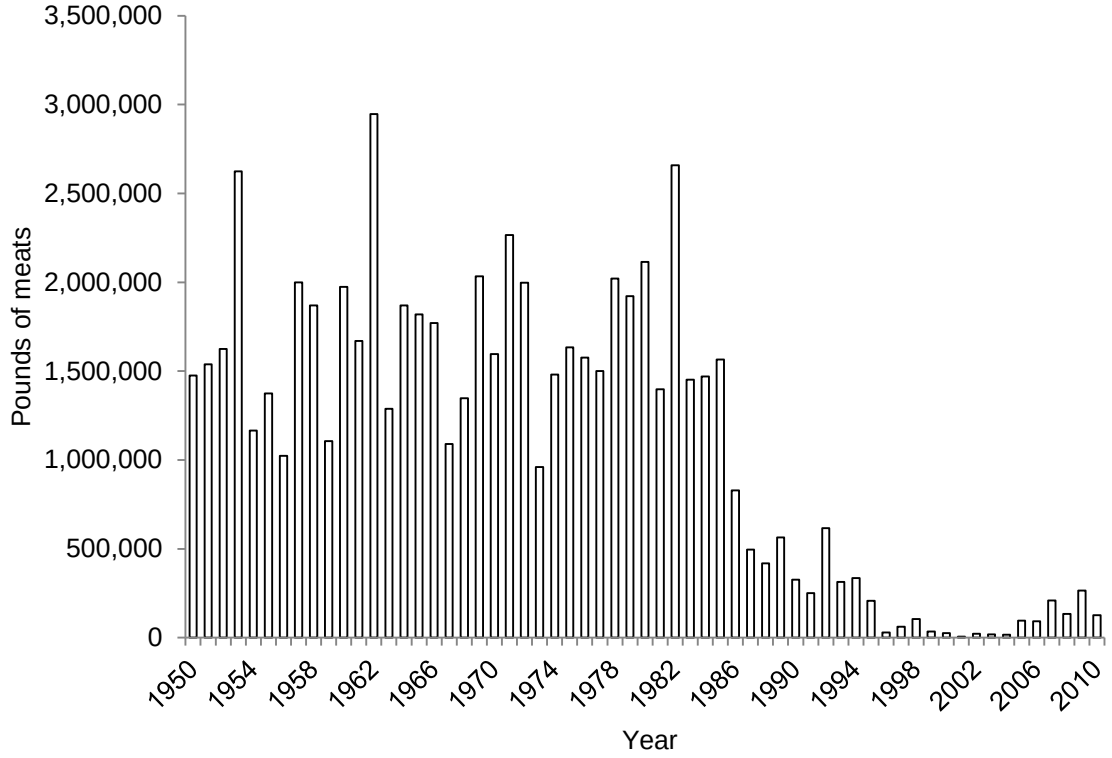


Figure 6.8 Landings of bay scallops along the Atlantic Seaboard from 1950 to 2010 National Marine Fisheries Service (NMFS) database.

The bay scallop population in North Carolina was decimated by a red tide event (*Karenia 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). Bay scallop populations in both Core Sound and Bogue Sound have become virtually non-existent in recent years because of heavy predation by cownose rays in the fall during the early 2000s with commercial landings below 150 pounds in 2004 and no landings in 2005 (Figure 6.9) (Powers and Gaskill 2005).

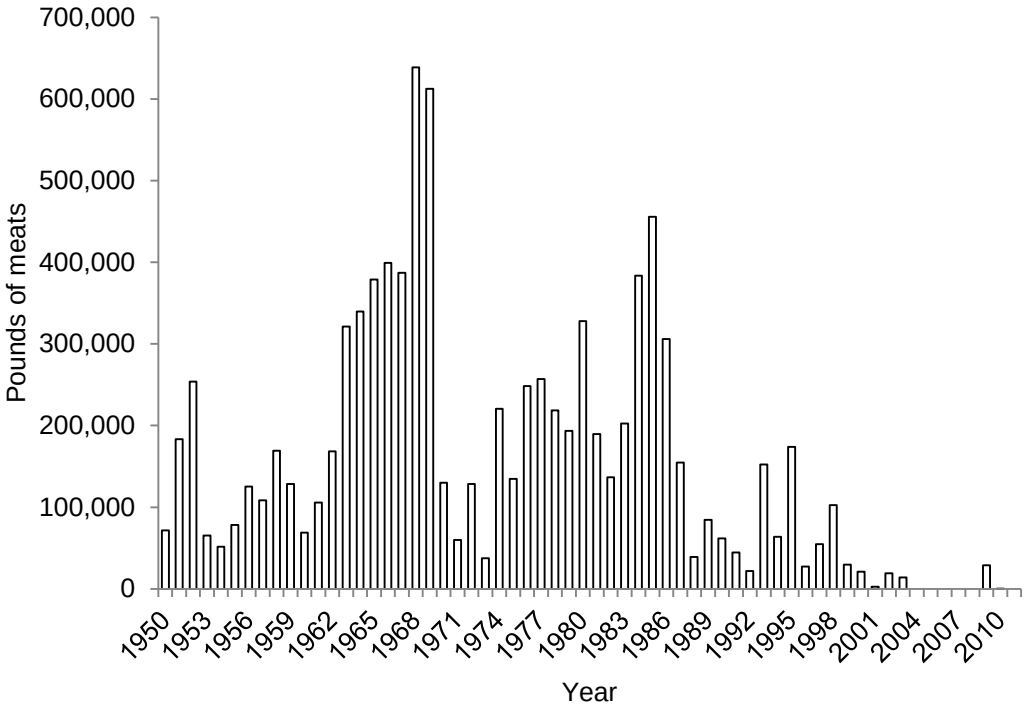


Figure 6.9 Landings of bay scallops in North Carolina from 1950 to 2011 (NCDMF Trip Ticket Program).

North Carolina's bay scallop stocks are listed as a species of concern in the annual Stock Status Report because of the population declines. Species are designated by NCDMF 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.

A prohibited take strategy was implemented from 2006 to 2008, because widespread low levels of scallop abundance indicated scallop populations should be protected until sampling showed some recovery. It was not the reduction in abundance but the lack of recovery in the last two decades prior to the red tide event in 1987-1988 that is of concern to managers (Figure 6.9). Although prolific spawners like scallops can repopulate quickly, scientists now believe their numbers can get so low that recovery can be prolonged if they are not allowed undisturbed opportunities to multiply (Arnold et al. 1998).

6.2.2 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 NCDMF 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 Bogue, Back, and Core sounds during October and from Pamlico Sound in January captures population information after ray predation and before the fishing season. This information is used to estimate abundance before the fishing season begins (NCDMF 2010).

Analyses of these data have demonstrated trends between NCDMF independent data and landings data from the following year. The long term landings data (1972-2005) most likely reflected population abundance because harvest was allowed to continue until scallop densities reached levels below those that make the fishing economically viable (Peterson and Summerson 1992). However, during 2006 and after the implementation of the 2007 Bay Scallop FMP, a harvest prohibition take went into effect in order to rebuild the stock and until a standardized catch per unit effort could be met. Therefore using landings data as an indicator is no longer an effective tool to indicate population size.

North Carolina Division of Marine Fisheries staff sample bay scallops quarterly in Bogue, Back, and Core sounds using a scallop dredge at fixed areas. Since 2008, staff also sample eastern Pamlico Sound using a quadrat of one square meter in size four times a year. Scallop dredge sampling quarterly at fixed areas in the New River and Topsail Sound began in October 2009. Expanding the sampling coverage or number of stations in all areas will improve estimates of bay scallop abundance. As bay scallops expand and retract from year to year, broader coverage of these areas will help identify more precisely what is happening to the population before entering the harvest season.

Data on scallop abundance from fishery independent sampling are evaluated annually as directed by the 2007 Bay Scallop FMP and Amendment 1 of the Bay Scallop FMP when standardized scallop population level indicators were first established as progressive triggers for opening the harvest season. These triggers are based on NCDMF sampling that occurred between the pre-red tide months of October and December in 1984 and 1985 for Back, Bogue, and Core sounds and in post-red tide January 2009 in Pamlico Sound (Table 6.1). These progressive triggers allow for flexibility to open the fisheries as the bay scallop population recovers and determines harvest limits based on 50%, 75%, and 125% of the natural log of the Catch Per Unit Effort (lnCPUE) target (Table 6.1).

Table 6.1 Standardized catch per unit effort (lnCPUE) of bay scallops sampled in Back, Bogue, Core and Pamlico Sounds.

	Back Sound	Bogue Sound	Core Sound	Pamlico Sound
Target $lnCPUE_{2009\ (Jan)}$				-0.18
Target $lnCPUE_{1984\text{-}1985\ (Oct)}$	2.02	2.33	1.72	
Progressive trigger 50%	1.01	1.17	0.86	-0.27
Progressive trigger 75%	1.52	1.75	1.29	-0.23
Progressive trigger 125%	2.53	2.91	2.15	-0.14

One 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. Although we consider the bay scallop population as one management unit in this FMP, we separate the management of the scallop population by waterbody based on the abundances within that waterbody.

There may be several discrete stocks of bay scallops in North Carolina waters. Mitochondrial DNA data demonstrated low ($\leq$4 migrants/generation) larval exchange between Topsail, Bogue, Back, and Pamlico sounds (Marko and Barr 2007). This means there is a potential for recruitment limitation into the different sounds from other sounds. In other words, if larval supply is limited between sounds, it could take some time to re-colonize a sound that has suffered population declines (Marko and Barr 2007). This could in itself reduce connectivity even more by decreasing the number of larvae produced within a sound and increasing the distances between stocks in other sounds. 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 (Marko and Barr 2007). However, it is possible that Pamlico Sound is a "sink" for larval transport and therefore, may explain why we see some years of high abundance, possibly from increased larval flow into the Sound (Marko and Barr 2007).

6.2.3 RESEARCH RECOMMENDATIONS

Increased sampling in all regions should be implemented along with better methods to quantify the population, including the means to give more precise measures of spatial and temporal variability at both within and between Sound scales. Other data that are valuable to collect in order to make better management decisions based on scallop abundance include larval recruitment and spat settlement. Genetic information to identify separate stocks that exist in North Carolina would also benefit the management of bay scallops.

7.0 STATUS OF THE FISHERIES

7.1 LANDINGS ALONG THE ATLANTIC EAST COAST

Bay scallops have been harvested commercially since colonial times and rank third among the three commercially exploited scallops along the Atlantic east coast with regards to magnitude of catch following sea scallops (*Placopecten magellanicus*) and calico scallops (*Argopecten*

gibbus) (Fay 1983; NOAA 2005). Annual fluctuations in commercial landings are common along the Atlantic east coast with an abrupt decline beginning in the late1980s (Figure 7.1). Massachusetts has dominated the Atlantic coast bay scallop landings from 1950 to the mid-1990s with North Carolina ranked third after New York (Table 7.1). Subsequent recruitment failure of bay scallops in these states made North Carolina the dominant state from the 1990s through early 2000s (Table 7.1)(Wanziak et al. 2004; Brousseau 2005). Landings in Massachusetts started to show improvement in 2005 (Table 7.1). In response to decreasing landings, strict regulations have been in effect in most states along the Atlantic coast for over a decade (Appendix 13.4).

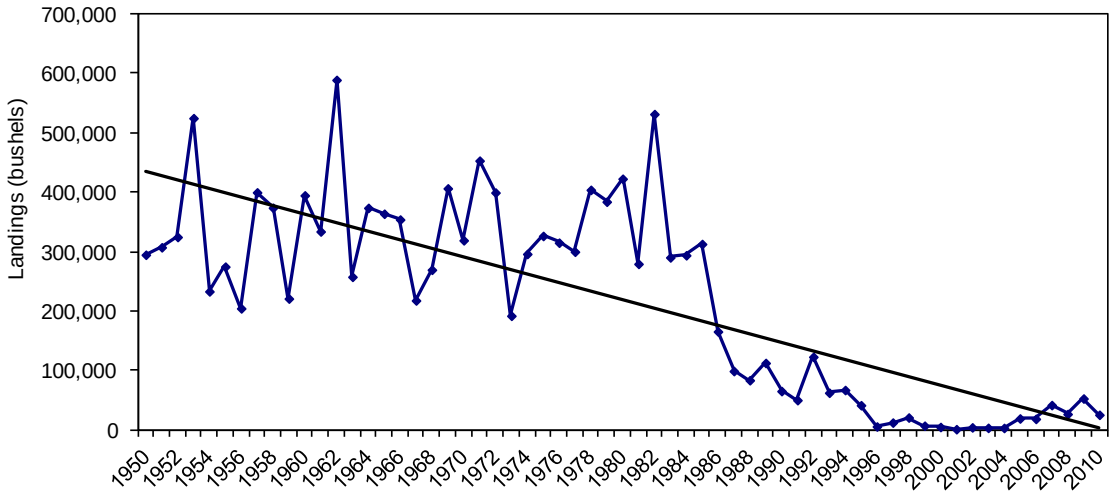


Figure 7.1 Commercial bay scallop landings (bushels) along the Atlantic east coast, 1950-2010. NMFS commercial fisheries landings database, http://www.st.nmfs.noaa.gov.

Table 7.1 Atlantic east coast bay scallop commercial landings (bushels) by state, 1970-2003. NMFS commercial fisheries landings database, http://www.st.nmfs.noaa.gov.

Year	Massachusetts	New Jersey	New York	North Carolina	Other*
1950	197,140		5,400	14,320	78,060
1951	222,840		20,220	36,680	27,740
1952	210,260		36,460	50,760	27,340
1953	357,720		32,400	13,060	121,740
1954	152,240		25,440	10,340	45,220
1955	174,620		45,220	15,660	39,380
1956	67,060	62,820	29,940	25,040	19,780
1957	204,480	14,320	117,900	21,680	41,560
1958	170,740	18,700	118,800	33,880	31,900
1959	84,200	880	76,280	25,660	34,120
1960	185,120		168,600	13,740	27,420
1961	114,560	14,160	158,220	21,140	26,040
1962	252,220	72,940	197,580	33,700	32,840
1963	66,640	54,780	60,480	64,220	11,640
1964	87,880	75,260	137,420	67,940	5,320
1965	89,060	19,100	177,200	75,800	2,800
1966	176,000	34,920	63,480	79,820	
1967	91,020	17,100	32,400	77,460	
1968	98,260	3,360	40,280	127,740	
1969	234,440		49,740	122,500	
1970	220,240		72,980	26,040	
1971	410,000		28,800	12,000	2,540
1972	355,300		18,680	25,660	
1973	138,820	12,120	33,740	7,480	
1974	113,400	3,240	135,560	44,080	
1975	210,800		88,820	26,960	
1976	177,920		87,600	49,700	
1977	201,780		39,800	51,400	7,060
1978	214,340		56,060	43,710	90,100
1979	248,780		69,160	38,687	27,620
1980	270,580		86,160	65,556	600
1981	192,660		48,840	37,888	200
1982	402,160		100,060	27,327	2,260
1983	207,720		33,440	40,496	8,830
1984	156,420		55,700	76,725	5,220
1985	187,140		34,760	91,130	
1986	101,860		2,580	61,235	
1987	68,160		60	30,914	
1988	75,861		60	7,785	
1989	95,520		320	16,895	

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

Table 7.1 (continued) Atlantic east coast bay scallop commercial landings (bushels) by state, 1970-2003. NMFS commercial fisheries landings database, http://www.st.nmfs.noaa.gov.

Year	Massachusetts	New Jersey	New York	North Carolina	Other*
1990	50,878		2,134	12,404	
1991	38,169		3,094	8,909	
1992	112,964		4,904	4,344	885
1993	27,205		3,025	30,501	1,857
1994			54,292	12,792	120
1995	5		5,186	34,762	1,666
1996	268		11	5,479	16
1997			1,448	10,922	
1998			365	20,530	
1999			1,155	5,931	
2000			736	4,207	
2001			759	504	
2002			460	3,845	10
2003	258		361	2,839	60
2004	2,664	76	447		163
2005	18,052		1,248		
2006	15,341		3,263		
2007	41,715		163		
2008	26,561		241		
2009	42,069		3,735	5,801	1,297
2010	25,435			67	

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

7.2 HISTORICAL FISHERY

The bay scallop has been an important food source in the coastal area of central North Carolina based on evidence early Native Amercians consuming them and depositing the empty shells on kitchen middens. When settlers came into coastal North Carolina, they too began to eat bay scallops (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 shipping scallops from Beaufort and Morehead City to New Bern by rail. He bought scallops, paid to have them opened, and shipped them by the bushel to New York, Philadelphia, and other northern markets with very few shipped to other parts of NC. 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 with 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, Ocracoke, and northward, as well as in New River and southward. Fishermen waded on shoals and harvested the scallops by hand using a six-tined hand rake called a "potato or a peanut digger" equipped 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 is 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 seagrass 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 located. 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. Laws passed by the Fisheries Commission concerning bay scallops between 1915 and 1918 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 1922-1924, an additional two weeks in December was added to the closed season. Commercial harvest was generally opened in January and closed in April while local harvest 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 using an elevated temperature to shuck calico scallops (Patent number 4255834, http://patft.uspto.gov/netacgi/nph-Parser?Sect2=PTO1&Sect2=HITOFF&p=1&u=%2Fnetahtml%2FPTO%2Fsearch-bool.html&r=1&f=G&l=50&d=PALL&RefSrch=yes&Query=PN%2F4330904). Five shucking machines were set up in North Carolina; one along the Beaufort/Morehead City causeway, one in Salter Path, one in Broad Creek, one on Highway 58 north of Cape Carteret, and one in Sneads Ferry (C. Davis, NCDMF, personal communication). 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 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 NCDMF 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 landings have been recorded (MacKenzie 2008). Landings ranged from a peak of approximately 1.4 million pounds of meats in 1928 when North Carolina led the nation in scallop production, to a low of zero landings in 2005 even though there was an open harvest season (Figure 7.2). Landings are closely linked to weather and other environmental factors.

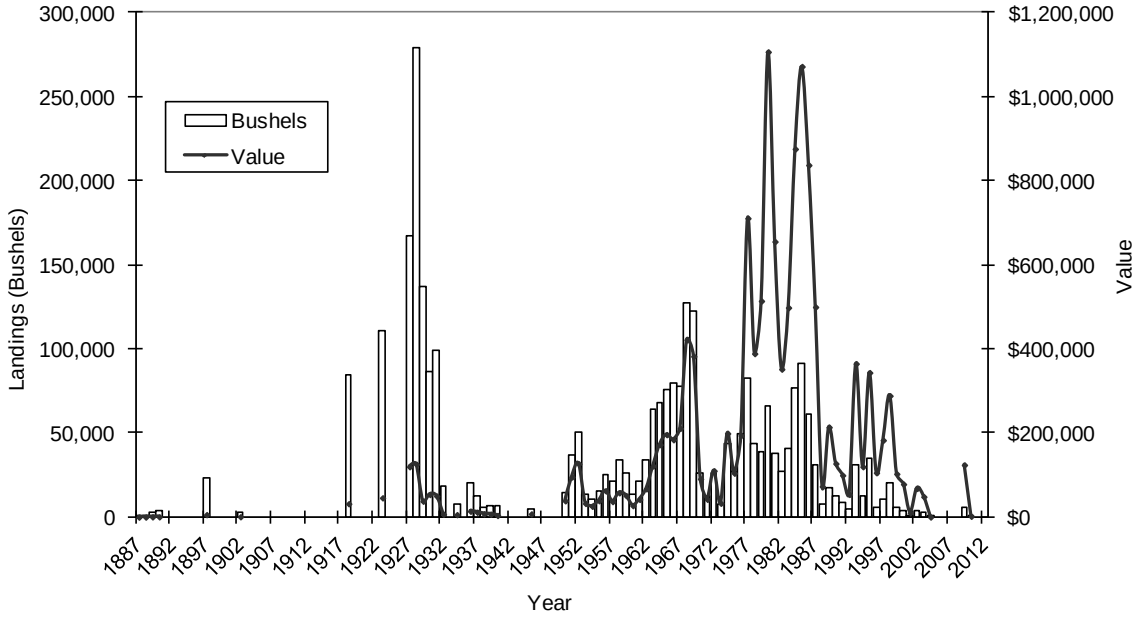


Figure 7.2 Bay scallop historical landings (bushels) and value, 1897-2012. NCDMF Trip Ticket Program.

Bay scallops are very susceptible to hurricanes because of freshwater runoff, direct physical damage, and habitat loss. Hard freezes and high temperatures kill scallops in shallow, tidal waters when they are exposed for long periods of time. The loss of SAV is detrimental to juveniles since they are dependent on SAV blades for 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 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 regions has not fully occurred. Landings in recent years have been extremely low due to the failure of scallop stocks to recover after the red tide event, fishing pressure, and 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 strongly felt 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 fishing for finfish and shrimp trawling were over, however that income can no longer be relied upon. While fluctuations in the abundance of bay scallops have been 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.

7.3 COLLECTION OF COMMERCIAL STATISTICS

Annual North Carolina landings data were collected by the Division of Commercial Fisheries (U.S. Fish and Wildlife Service (USFWS), Department of the Interior) from 1880 to 1974 (Chestnut and Davis 1975). The National Marine Fisheries Service 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 NCDMF and NMFS began a cooperative commercial fishery data collection program in 1978, maintaining the same methodology established in 1972. However, NCDMF 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 NCDMF/NMFS cooperative statistics program (Lupton and Phalen 1996). With the support of the commercial fishing industry, NCDMF 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.

7.4 COMMERCIAL FISHERY PRIOR TO THE 2007 FISHERY MANAGEMENT ..... PLAN

7.4.1 ANNUAL LANDINGS

The North Carolina commercial bay scallop 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 each year (Figure 7.3). The 1970s showed some decline in commercial landings from the previous decade with an average of 35,680 bushels harvested per year, however, harvest improved in the 1980s increasing 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.

In the early 2000s annual landings were minimal ranging from 4,207 bushels in 2000 to less than 100 bushels in 2004. A harvest season was opened in 2005 with no commercial landings documented. A prohibited take period for bay scallops occurred from 2006 to 2008. A short harvest season opened in 2009 for only Core and Pamlico sounds and in Pamlico Sound in 2010.

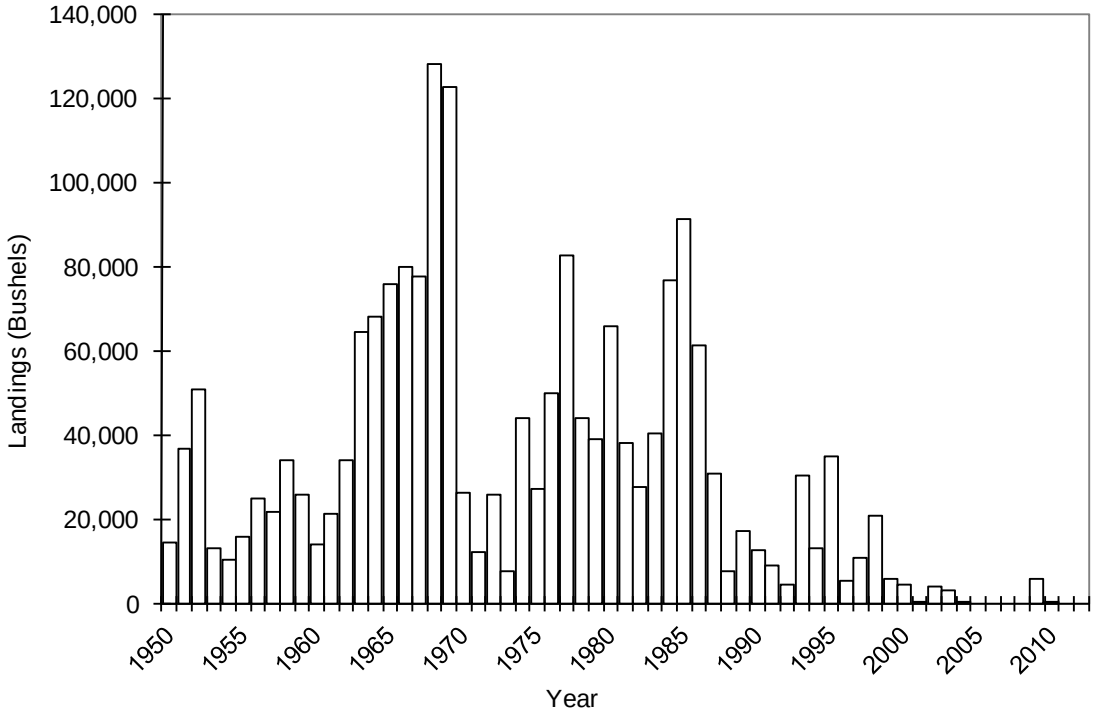


Figure 7.3 North Carolina commercial bay scallop landings (bushels), 1950-2012. NCDMF Trip Ticket Program.

7.4.2 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, NCDMF, personal communication 2005). Shorter season openings also occurred including four days in December of 1994 to 1998 for Christmas money 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 cownose ray migration and resulting predation.

The 2007 FMP shortened the season to no sooner than the last Monday in January and eliminated harvest in December (NCDMF 2007). Amendment 1, adopted in November 2010 by the MFC, further restricted the harvest season to the last Monday in January through April 1 and included specific trip limits based on progressive triggers (NCDMF 2010). This subsection will only show commercial information prior to 2005 since the management strategy in the FMP has changed how the fishery is prosecuted. A separate subsection will further discuss the commercial fishery after the 2007 FMP was implemented.

Prior to 2005, the main harvest season began in January when peak landings (average 8,477 bushels per year) typically occur and remained open to the last Friday in May (Figure 7.4).

Annually, an average of 541 trips were taken from 1994 to 2005 (Figure 7.4). Landings decline from January through April although meat weight increases (Figure 7.5).

A relationship between meat weights and gonad development guides fisheries managers in setting the bay scallop season. Managers try to allow for the completion of at least one 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 7.5). After some bay scallops spawn in October, meat weights begin to increase with maximum meat weights occurring between February and May (Figure 7.5) (Spitsbergen 1979; Kellogg and Spitsbergen 1983).

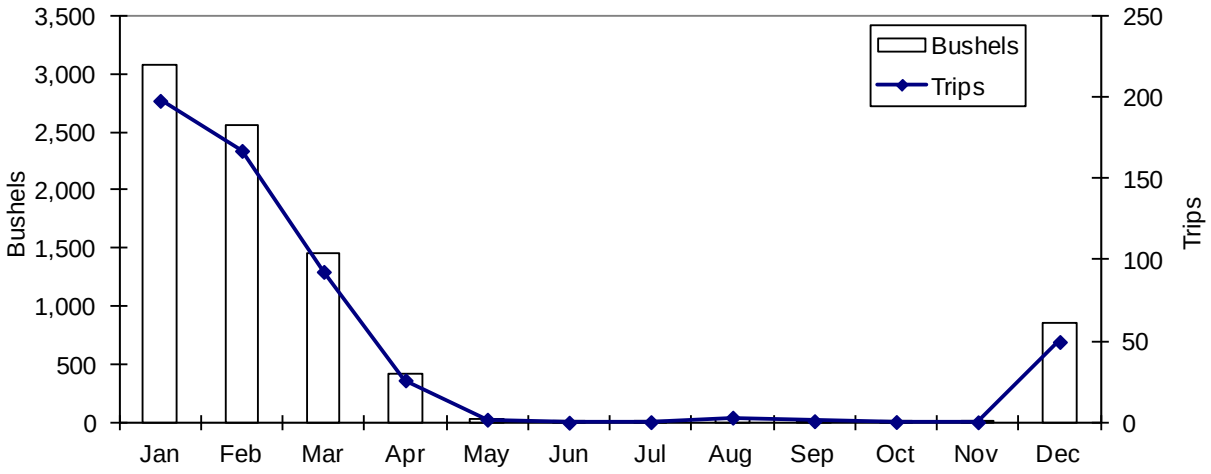


Figure 7.4 Average monthly commercial landings (bushels) and trips in the bay scallop fishery, 1994-2005. NCDMF Trip Ticket Program.

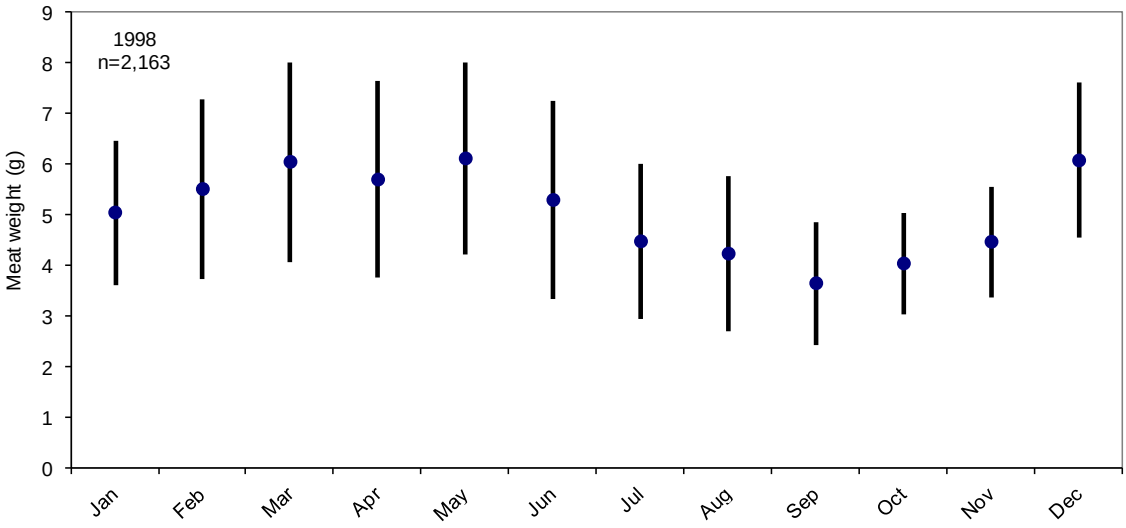


Figure 7.5 Average monthly bay scallop meat weight (g) in 1998 with one standard deviation from the mean. Using bay scallops with shell height ≥ 50 mm only to ensure complete maturity. NCDMF biological sampling.

7.4.3 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 7.6). 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 Intracoastal Waterway (ICW) of Onslow County.

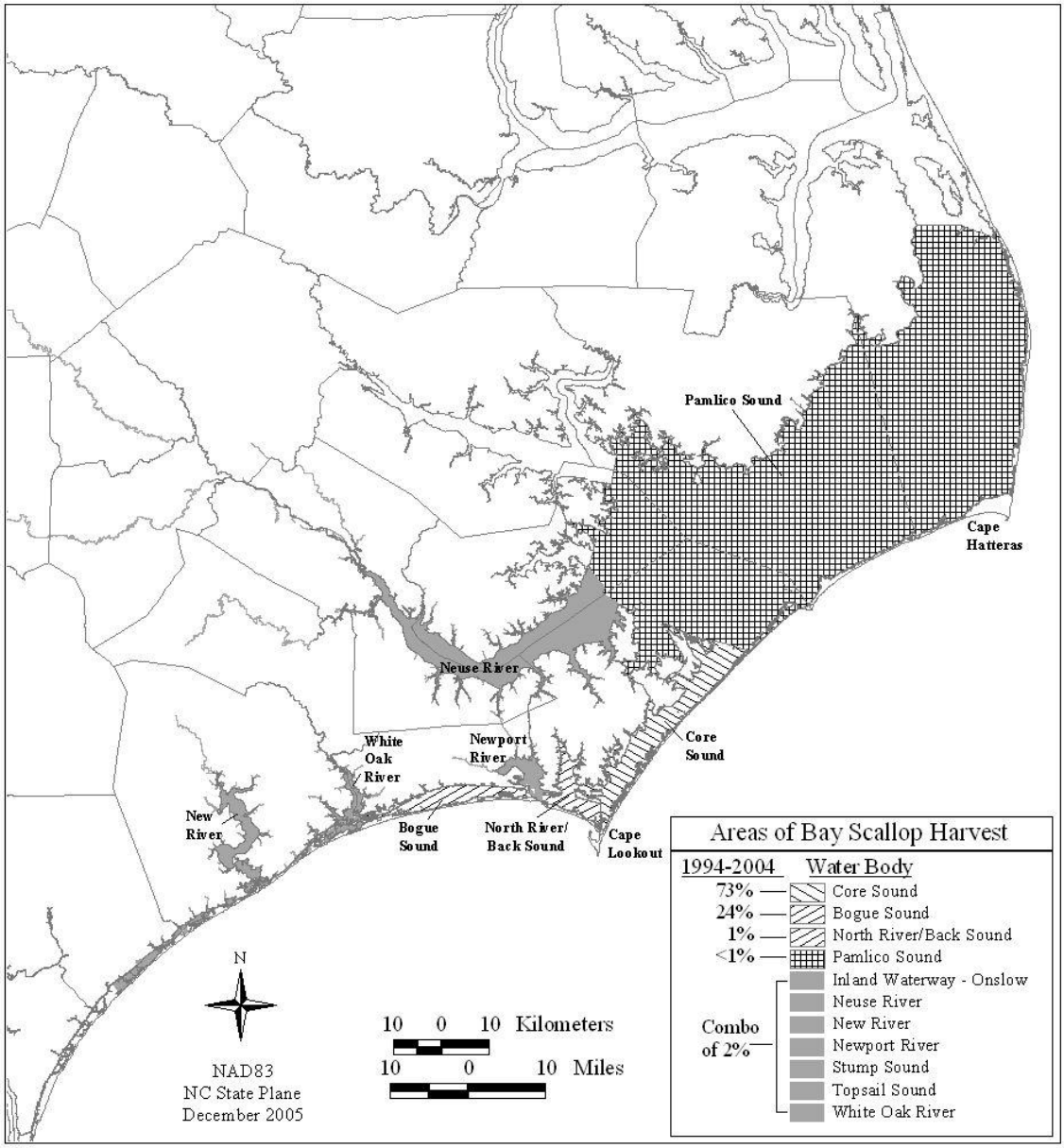


Figure 7.6 Bay scallop harvest areas of North Carolina, 1994-2004. NCDMF Trip Ticket Program and NCDMF GIS database.

Bogue Sound was the dominant waterbody for bay scallop landings from 1972 to 1981 and accounted for 53% of the total landings (Figure 7.7). 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 7.8). Core Sound continued to be the dominant waterbody since the initiation of the NCDMF Trip Ticket program in 1994 and accounted for 74% of the overall landings from 1994 to 2004. The last year with significant landings was in 1995, when 32,798 bushels were harvested from Core Sound (Figure 7.8). 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.

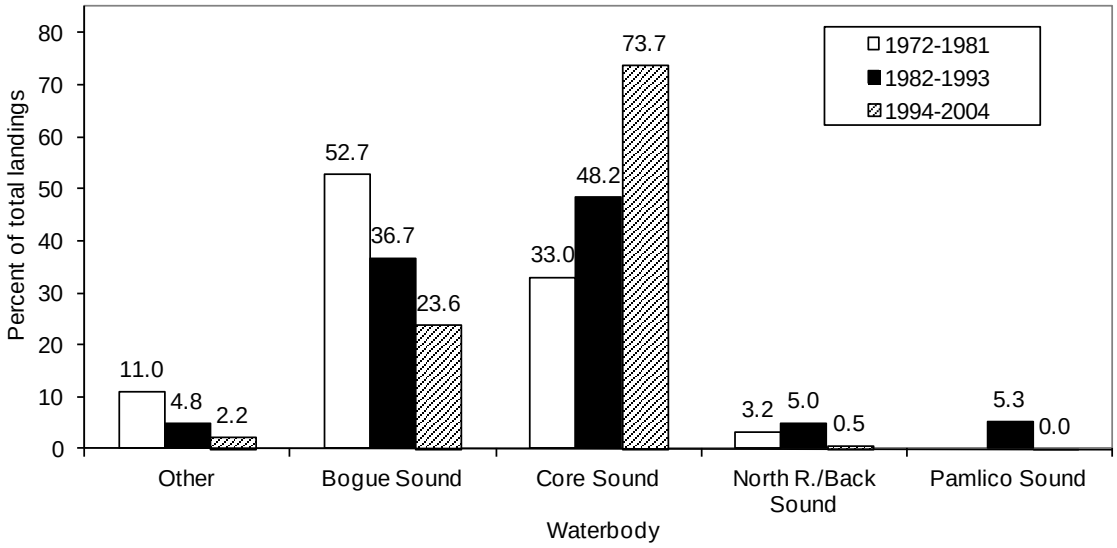


Figure 7.7 Average bay scallop landings (as a percentage) by waterbody for three distinct time periods: 1972-1981, 1982-1993, and 1994-2004. Other waterbodies include: Inland waterways, New River, White Oak River, Neuse River, Newport River, Stump Sound, and Topsail Sound. NCDMF Trip Ticket Program.

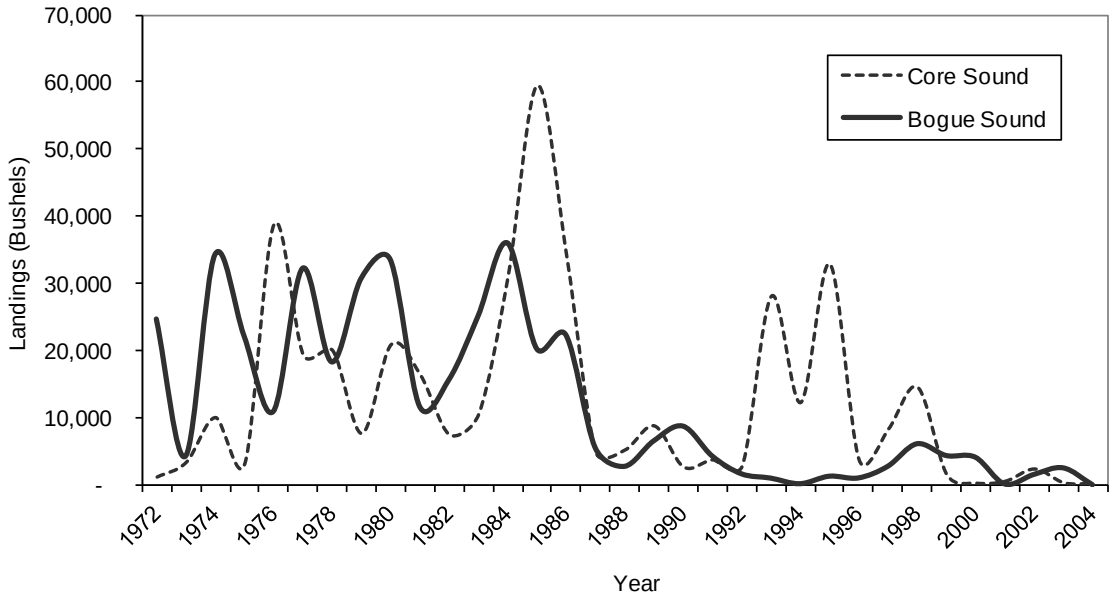


Figure 7.8 Bay scallop landings (bushels) from the top two areas in North Carolina, 1972-2004. NCDMF Trip Ticket Program.

7.4.4 CHARACTERIZATION OF BAY SCALLOP TRIPS

There were 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 7.9). Adverse weather conditions (i.e., hurricanes, cold winters) can impact the annual landings. Tropical storm Dennis (1999), Hurricane Floyd (1999), and Hurricane Isabel (2003) likely decreased bay scallop harvest in following years. Ninety-eight percent of the trips between 1994 to 2004 harvested less than 25 bushels of bay scallops while forty-six percent of the trips harvested between 15 to 20 (Figure 7.10).

Occasionally, bay scallop fishermen have been known to sell their catch from more than one trip to a licensed dealer at one time. This would likely account 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, NCDMF, personal communication 2005).

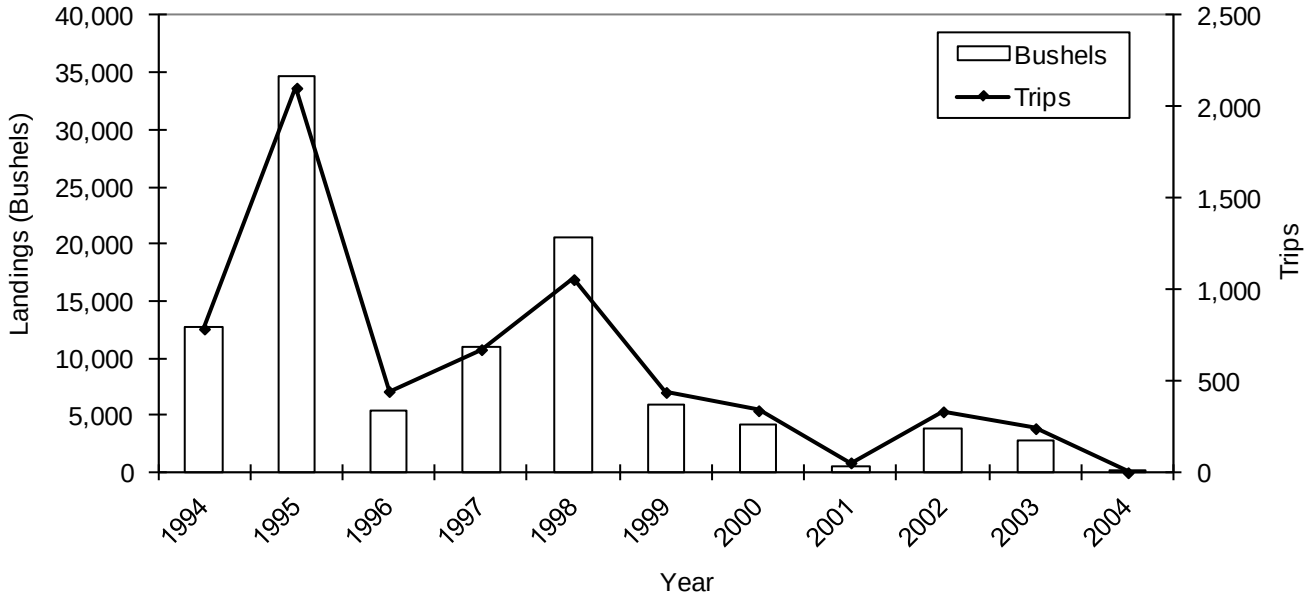


Figure 7.9 Number of trips with bay scallop commercial harvest in North Carolina, 1994-2004. NCDMF Trip Ticket Program.

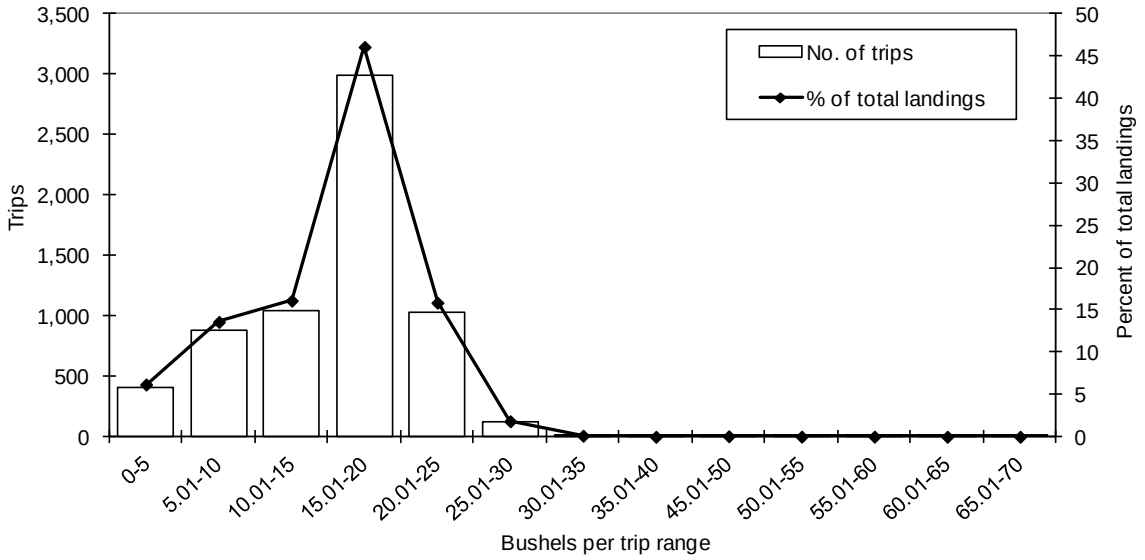


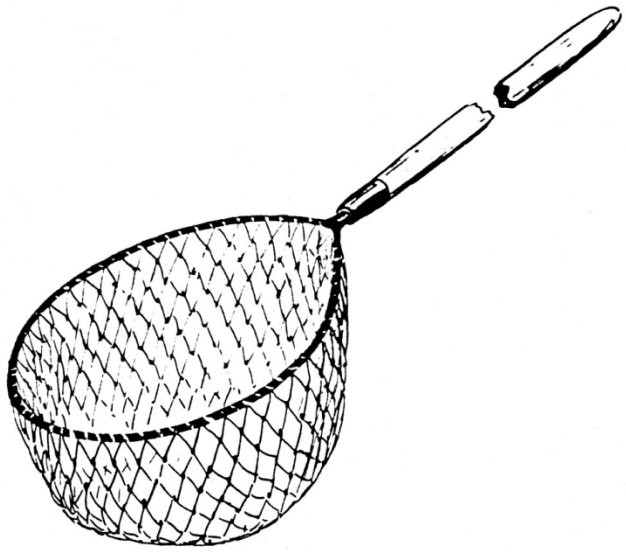
Figure 7.10 Total number of trips for each 5-bushel commercial quantity landed in North Carolina, 1994-2004. NCDMF Trip Ticket Program.

7.4.5 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 7.11 and 7.12). Harvesting bay scallops by hand accounted for 7% of the landings for the same time period (Figure 7.12). Regular hand rakes have evolved from garden type ones to lightweight aluminum models (Figure 7.11A). The scallop scoop is a common hand gear that consists of a nylon mesh bag attached to long handle and used by fishermen standing in the bow of a boat or wading in the water. One scoop can hold 20-30 scallops at a time (Cunningham et al. 1992) (Figure 7.11B). A 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 7.11C). 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

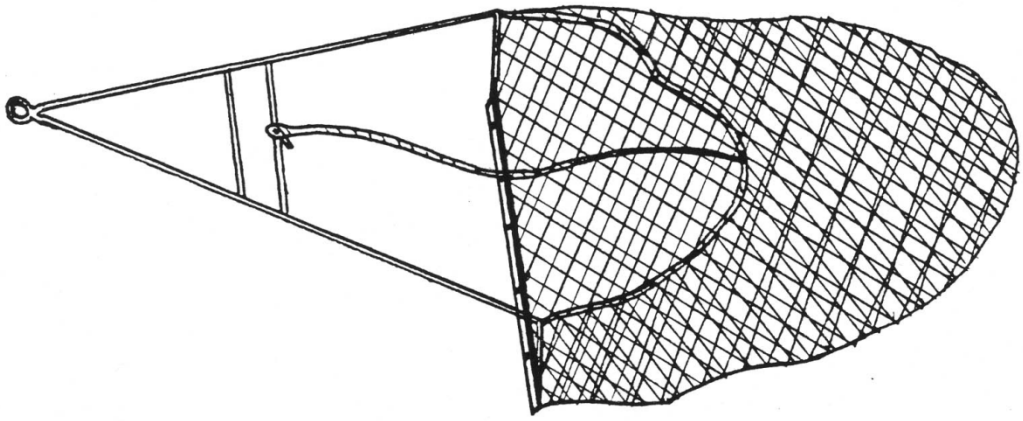


Figure 7.11 Primary types of gear used in the bay scallop fishery of North Carolina. A. Hand rake; B. Scallop scoop; and C. Bay scallop dredge (Cunningham et al. 1992).

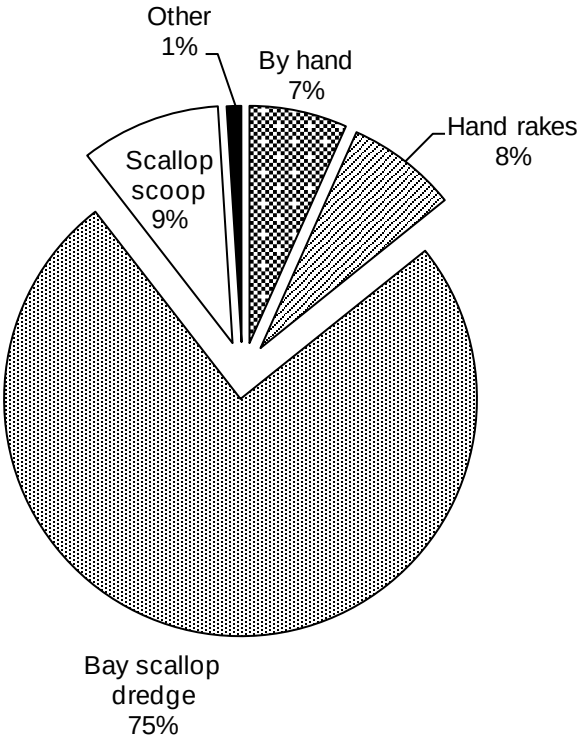


Figure 7.12 Proportion of landings by gear types in the bay scallop fishery of North Carolina, 1994-2004. NCDMF Trip Ticket program.

Catch per unit effort estimates were separated by gear into hand harvest and 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. 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 7.13). 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. CPUE estimates in 2004 were confidential for both hand and mechanical harvest, therefore, are not presented here.

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 7.14). Overall annual dredge effort was higher in Bogue Sound than in Core Sound (Table 7.2). Fishermen did not land any dredged bay scallops in 2000 or 2003 in Core Sound. 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.

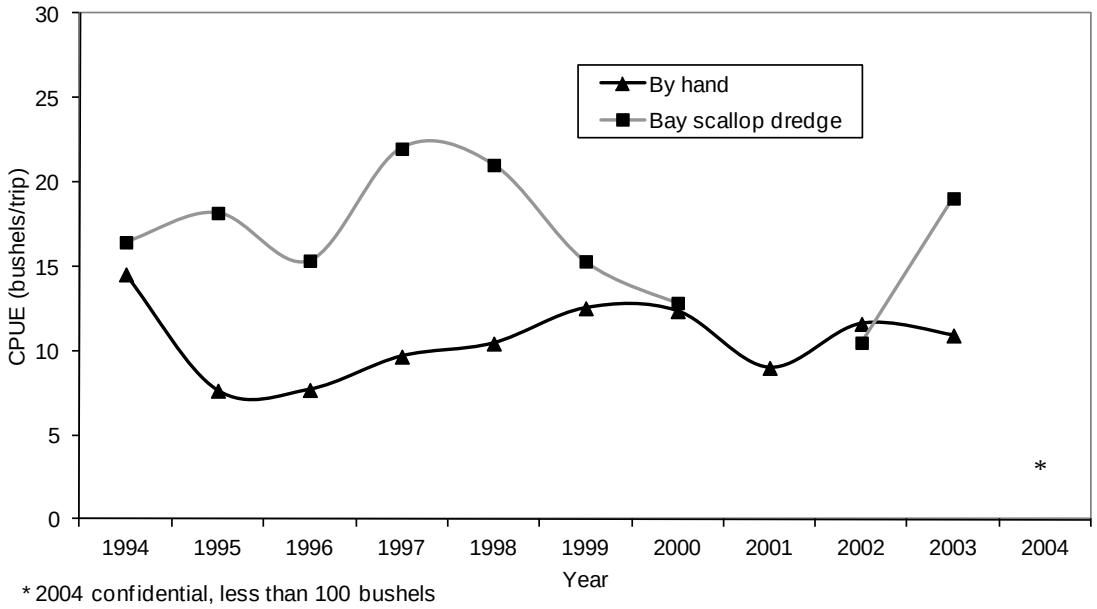


Figure 7.13 Annual catch per unit effort (CPUE) (bushels/trip) for bay scallop dredges only (mechanical) and hand harvest of bay scallops in North Carolina, 1994-2004. NCDMF Trip Ticket Program.

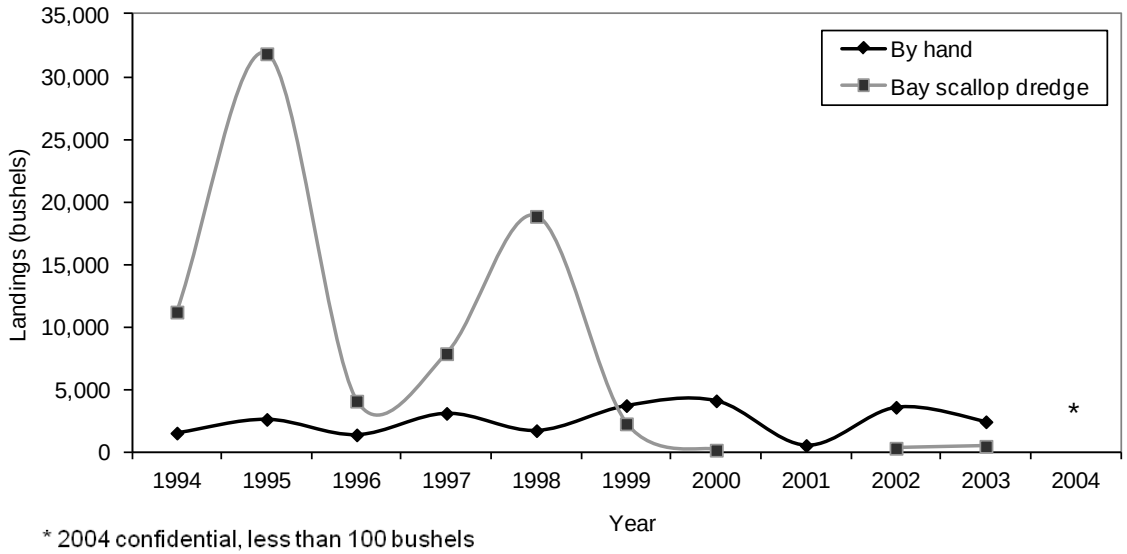


Figure 7.14 Annual bay scallop landings (bushels) separated into hand and bay scallop dredges only (mechanical) harvest methods in North Carolina, 1994-2004. NCDMF Trip Ticket Program.

Table 7.2 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. NCDMF 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.

7.5 COMMERCIAL FISHERY AFTER THE 2007 FISHERY MANAGEMENT PLAN

Prohibited take regulations were in effect from 2006 to 2008 as part of the Bay Scallop FMP until a fishery independent sampling indicator was used to evaluate stock abundance and ultimately determine if the fisheries could be reopened once abundance had increased. Currently, it is not the reduction in abundance but the lack of recovery in the last two decades to annual commercial harvest levels prior to the red tide event in 1987-1988 that is of concern to managers (Figure 7.15).

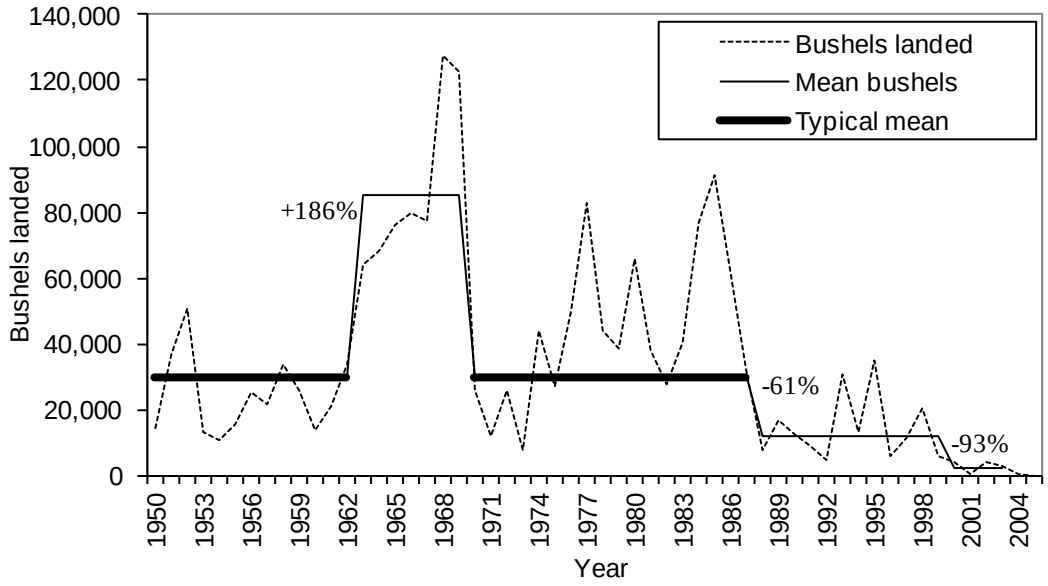


Figure 7.15 Overall statewide landings of bay scallops from 1950 to 2005 showing significant deviations from the “typical” mean of 29,732 bushels.

Data on scallop abundance from fishery independent sampling are evaluated annually as directed by the FMP. Fishery independent sampling in Core, Bogue, and Back sounds began to show an increase in abundance beginning in 2008. The public also began to notice increased numbers of scallops in Core, Bogue, and eastern Pamlico sounds and contacted the NCDMF about opening the scallop season in 2009. A standardized scallop population level indicator was selected as a target for reopening the harvest season by the MFC at its January 2009 meeting and a commercial and recreational harvest season occurred in Pamlico and Core Sounds from January 26 through April 1, 2009 (Proclamation SC-1-2009). Harvest was limited to hand harvest only (by hand, hand rakes, tongs, dip nets, and scoops), three days a week (Monday, Wednesday, and Friday), and five U.S. standard bushels per person per day not to exceed ten U.S. standard bushels per fishing operation a day, with transfer of scallops from a catching vessel to another vessel prohibited. A total of 5,801 bushels were harvested in 2009, the majority from scoops and rakes, and 69% of the harvest was from Core Sound.

Due to numerous complaints to the NCDMF about the management of bay scallops, the MFC at its meeting in March 2010 approved to go forward with an amendment to the Bay Scallop Fishery Management Plan. An amendment is required when changes to any recommendations or management strategies contained in a FMP are deemed necessary by the Marine Fisheries Commission (MFC 2010). Bay scallop abundance is highly variable in all areas each year and the impacts to the recreational and commercial fishermen are felt strongly in the local regions when harvest remains closed. Progressive triggers were developed to determine gradual harvest effort that allows for limited bay scallop harvest while maintaining the FMP goal of rebuilding the stock to pre-red tide abundance levels.

Amendment 1 produced progressive harvest triggers based on varying scallop abundance levels in the previously set fishery independent sampling targets for Back, Bogue, and Core sounds. It also provided new indices for re-opening harvest in other areas of the state (NCDMF 2010). The 1984-1985 time series was selected as the target abundance level for Bogue, Core, and Back sounds, the main harvest areas, because it reflected abundance levels prior to the red tide event in 1987-1988, when the typical average annual harvest was about 30,000 bushels of scallops (Figure 7.15 and Figure 7.16). The target opening level for eastern Pamlico Sound was set by default by opening the area in 2009 based on only one sampling estimate in January 2009 using a quadrat of one square meter in size at set locations since 2008 (Figure 7.17). Adaptive management targets and progressive triggers were also desired for all areas south of Bogue Sound but limited sampling could not determine target abundance indicators for this region. The MFC selected the Bogue Sound progressive triggers for re-opening areas south of Bogue Sound until triggers could be developed for this region.

The harvest limits for each trigger in Amendment 1 are shown in Table 7.3. The open season is allowed only from the last Monday in January through April 1st. The MFC allowed hand harvest methods at all triggers with trip limits starting at 10 bushels per person per day not to exceed two harvest limits per fishing operation on Monday and Wednesday, with an additional day for harvest as abundance reaches the higher triggers. The maximum individual allowed harvest limit is set at 15 bushels after reaching the 100% and 125% triggers. Scallop dredges are only allowed when the trigger is met at 125% of the target level from March 1 through April 1 at 15 bushels per day only on Tuesday and Thursday. The intention of delaying harvest to dredges was to reduce prop scarring and dragging dredges through grassbeds (submerged aquatic vegetation) in the shallow water areas because scallops will likely have already been removed by hand harvesters.

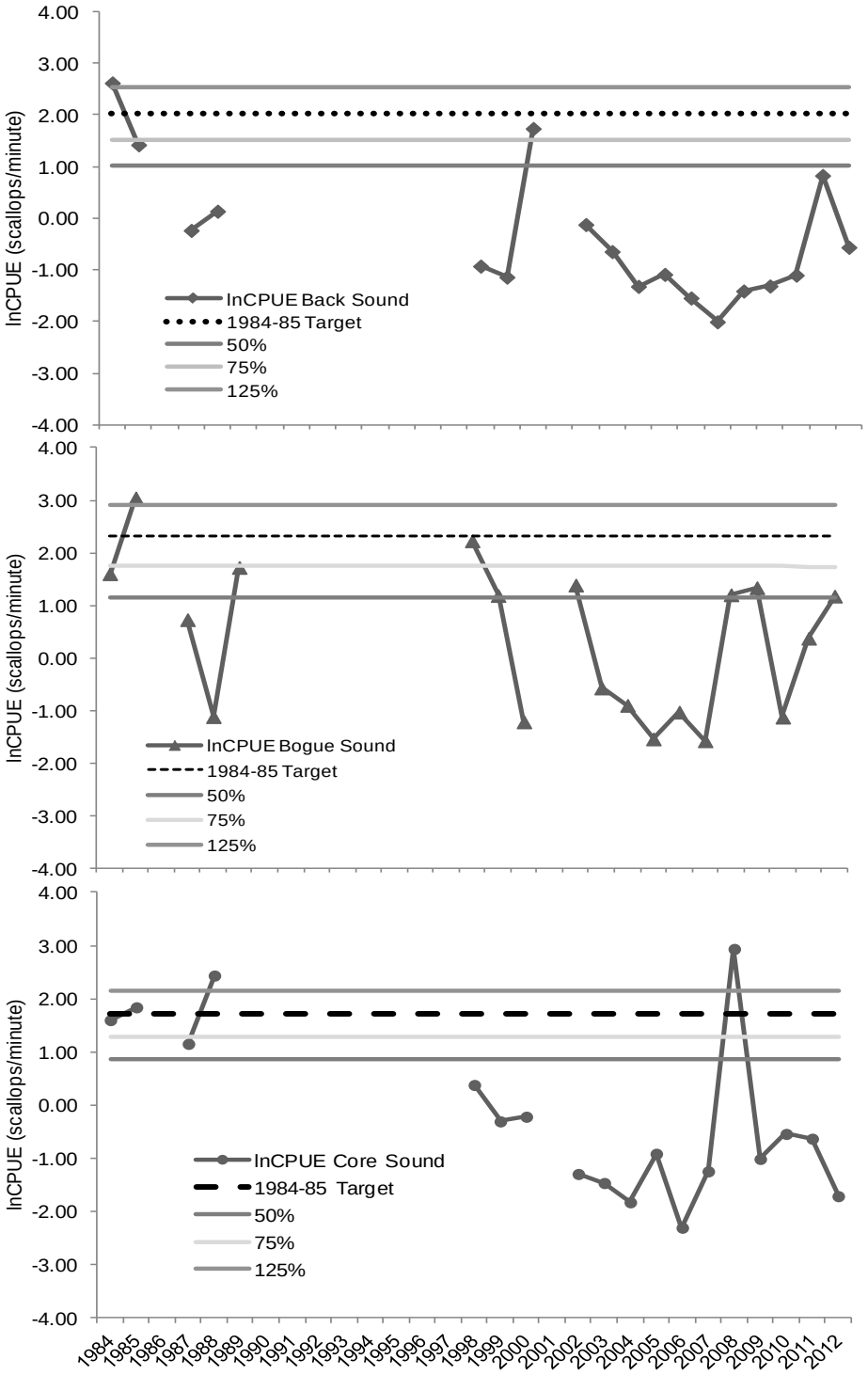


Figure 7.16 The mean number of scallops (lnCPUE)(scallops/minute) for Back, Bogue, and Core sounds during the October-December sampling time period and average lnCPUE (target) for the 1984-1985 period showing progressive triggers at 50%, 75%, and 125% of the target. Year indicates the sampling year which is used to determine the harvest season in the next calendar year.

Table 7.3 Marine Fisheries Commission selected adaptive management measures for opening the bay scallop commercial fishery in Amendment 1. The harvest levels are based on progressive triggers derived from the $lnCPUE_{1984\text{-}1985\ (Oct\text{-}Dec)}$ target indicators for Core, Bogue and Back sounds and the $lnCPUE_{Jan\ 2009}$ target indicator for Pamlico Sound.

Progressive triggers and target	Trip limit	Days open in the week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater and less than 75% of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon and Wed	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
75% or greater and less than 125% of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon, Tues, Wed, and Thurs	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
125% or greater of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon, Tues, Wed, and Thurs	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
	15 bushels per person per day not to exceed 30 bushels per fishing operation	Mon and Wed	Bay scallop dredges as described by rule 15A NCAC 03K. 0503	Delay opening until first full week in March after hand harvest removes scallops from shallow waters to April 1st

All areas except Pamlico Sound showed levels well below the 50% trigger for re-opening the 2010 bay scallop harvest season (Figure 7.16). Pamlico Sound was opened from February 1 through April 1, 2010 (Proclamation SC-1-2010) under the 2007 Bay Scallop FMP harvest restrictions (Figure 7.17). Commercial landings of bay scallops were so low (less than 100 bushels) in 2010 that the exact amount cannot be reported because of confidentiality. Landings are considered confidential if less than 3 dealers, participants, and/or vessels participated in the fishery.

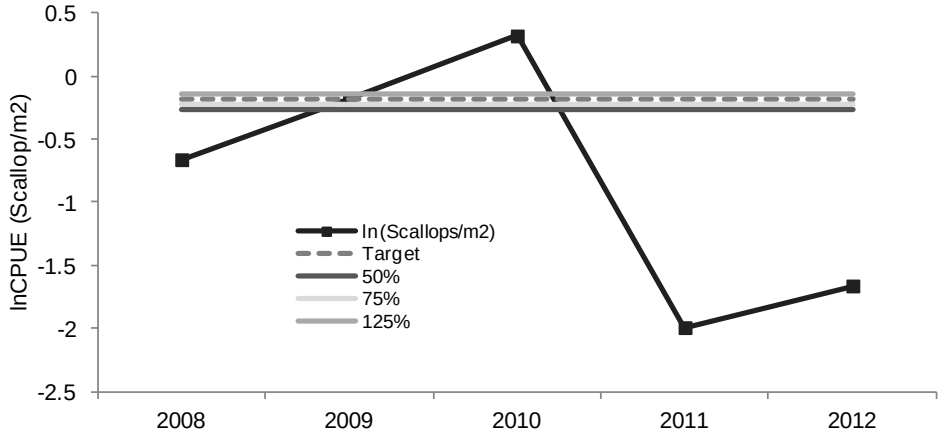


Figure 7.17 The mean number of scallops (lnCPUE)(scallops/m^2) for Pamlico Sound during the January sampling time period and average lnCPUE (target) for the 2009 target showing progressive triggers at 50%, 75%, and 125% of the target. Year indicates the sampling year which is used to determine the harvest season for the same calendar year.

7.6 RECREATIONAL FISHERY

Recreational harvest seasons open by proclamation at the same time as the commercial fishery. Amendment 1 of the Bay Scallop FMP specifies that the daily harvest limit is one bushel per person per day not to exceed one bushel per recreational fishing operation and harvest can only occur from Thursday through Sunday each week (NCDMF 2010).

In 1985, NOAA and the USFWS completed a survey to quantify recreational shellfish fishing activities in the United States (NOAA 1991). For this survey, shellfish were defined as all mollusks (i.e., scallops, mussels, oysters, and clams) and crustaceans (i.e., lobsters, crabs, and shrimp). The survey indicated that in 1985, 129,972 fishermen expended 1,009,000 days fishing for shellfish in NC; however trends in recreational catch and effort could not be assessed due to data limitations. In 1991, the telephone portion of the Marine Recreational Fishery Statistics Survey (MRFSS) included a question on the number of recreational fishing trips taken that targeted shellfish. Results from the survey indicated there were more than one million trips taken to harvest shellfish in North Carolina during the survey time period; however, no data on actual shellfish harvest estimates were given. In 1997, the Fisheries Reform Act created the Recreational Commercial Gear License (RCGL) to allow recreational fisherman to use limited amounts of commercial gear to harvest seafood for personal consumption but shellfish gears were not authorized under this license. Therefore, recreational harvest data could not be collected through the use of this license. Any state resident can purchase a commercial shellfish license, at a lower cost than a RCGL, and use any commercial fishing gear to harvest shellfish in commercial quantities for recreational purposes. However, recreational harvest from a commercial shellfish license does not get recorded because it is not sold to a seafood dealer. In addition, the FRA requires NCDMF 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 harvest data makes it extremely difficult to address potential management issues such as harvest limits, size limits, and gear restrictions on shellfish in the recreational fishery.

The need for recreational harvest data eventually prompted the introduction of House Bill 1427 before the general assembly in 2004 to establish a recreational shellfish license. This license would apply to the harvest of shellfish only and would have been instituted on a trial basis for three years but the bill was never passed. Later in 2004, House Bill 831 approved a saltwater fishing license that mandated those individuals recreationally fishing for both finfish and shellfish must obtain a license. However, the state legislature revisited the issue in 2005 and replaced the saltwater fishing license with the Coastal Recreational Fishing License (CRFL). The CRFL, which was implemented on January 1, 2007, was only required when targeting finfish, thereby eliminating the creation of a sampling universe to be used to estimate shellfish harvest. As a result, NCDMF developed a small optional survey to obtain additional information on shellfish harvest from CRFL license holders at the point of license sale. The optional survey would ask whether the CRFL holder actively harvests crabs, oysters, clams, or scallops; and would identify a pool of individuals to survey at a later date with more specific questions regarding their harvest of shellfish. Unfortunately, this survey would neglect any individuals who fish exclusively for shellfish and would therefore not purchase a CRFL.

In November 2010, NCDMF started a shellfish survey that collects monthly data on the harvest of crabs, oysters, clams, and scallops from the CRFL license pool. The survey sample is made up of about 650 randomly selected CRFL holders that held a valid license for at least one day during the survey period and answered "yes" to the harvest of at least one of the following species; crabs, oysters, clams, or scallops. The selected CRFL holders are sent a letter

explaining the survey along with a web address and accompanying PIN to complete the survey online. Those that do not use the web-based method to respond are sent a paper version of the survey 10-14 days later. This survey obtains information on the number of trips taken during the survey period, average length of the trip, average party size, number of species kept and discarded, gear used, and location information like water access, waterbody, and county of harvest. Data from this survey can be used to estimate catch and effort in the recreational shellfish fishery but for only those people who purchased a CRFL license.

Some recreational fishermen may purchase a commercial shellfish license over a CRFL 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 seafood 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 could provide a pool of people to survey to determine if the license is indeed being used for recreational purposes only. This is also true for fishermen who buy a Standard Commercial Fishing License (SCFL) with a shellfish endorsement but do not have any reported landings of shellfish. Even though this approach limits the sampling universe to only recreational fishermen who bought a commercial license, it would still provide some information on the recreational harvest of shellfish that can occur without being constrained to recreational harvest limits.

With the new shellfish harvest survey in place, the potential for some estimate of recreational harvest is at hand, however, recently, the commercial and recreational fisheries for bay scallop have not been open since April of 2010. As a result, there are still no estimates of recreational bay scallop harvest available at this time.

8.0 PROTECTED SPECIES INTERACTIONS IN THE COMMERCIAL BAY SCALLOP FISHERY

The major gear used to commercially harvest bay scallops in NC is the scallop dredge and prior to the 2007 Bay Scallop FMP accounted for over 70% of the total bay scallop landings per year. Currently, NMFS does not specifically classify the bay scallop dredge fishery but has listed the sea scallop dredge fishery as a Category III fishery. Category III fisheries have either a remote likelihood of interaction with protected species or no known interactions. Based on the 2012 List of Fisheries compiled by the NMFS, the U.S. Mid-Atlantic sea scallop dredge fishery has had no documented interactions with protected resources (http://www.nmfs.noaa.gov/pr/pdfs/fr/fr76-73912.pdf).

The current management strategy limits the use of bay scallop dredges in estuarine waters of North Carolina from the first full week in March through April 1st on Tuesdays and Thursdays, only after the index of abundance reaches at least 125% of the progressive trigger (NCDMF 2010). The very restricted time period when dredges are in use would likely have no impact on protected species such as sea turtles. Typically, sea turtles are uncommon in the internal coastal waters of NC during the early part of the year.

9.0 PRIVATE CULTURE, AQUACULTURE, AND STOCK ENHANCEMENT

9.1 PRIVATE CULTURE

Private aquaculture in North Carolina coastal water occurs in leased public trust waters rather than on private property (NC Blue Ribbon Advisory Council on Oysters 1995). An increased interest in bay scallop culture in North Carolina has been observed in recent years. With bay scallop populations being low, fishermen are seeking alternative methods to produce bay scallops. Commercial culture of bay scallops is administered through the shellfish lease program. Seed needed for bay scallop culture is currently not available in state however may be provided with the introduction of a state funded Shellfish Research Hatchery (SRH) in 2010. The hatchery is operated by UNCW under the intent for research with extension into industry. The SRH currently has the ability to produce 1.3 million bay scallop seed annually.

9.1.1 LEASE PROGRAM

Current shellfish lease rules are stated in North Carolina MFC Rules 15A NCAC 03O .0201-.0211. "Shellfish" is defined as oyster, clams, scallops, mussels or any other species of mollusks that the MFC determines suitable for cultivation, harvesting, and marketing from public grounds and private beds (North Carolina General Statute 113-201.1). The NCDMF administers a shellfish lease program whereby state residents may apply to lease estuarine bottom or water columns for commercial production. An application for a bottom or water column lease must be submitted along with a management plan, a map of the site, and a $200.00 application fee for bottom leases and a $100.00 application fee for water column amendments. Once the application is received, the NCDMF investigates the site and NCDMF biologists, marine patrol and shellfish sanitation officials review the resulting report prepared by NCDMF staff. Hearings are held to solicit public input regarding the issuance of a proposed lease. The secretary of the DENR or his proxy then evaluates the proposed lease. After approval by the secretary, the applicant must provide a survey plat before execution of the lease contract. The contract includes production and reporting requirements and yearly lease fees. The lease contract is renewable on a 5-year cycle for both bottom leases and water column amendments.

One of the primary problems is once a lease is granted it is up to the leaseholder to make it productive. There are a number of leaseholders that fail to meet production and effort requirements because of high start up costs and insufficient production methodologies. Leases that fail to meet production requirements are not renewed at the end of the lease cycle.

Public opposition to leasing has become a contentious issue in some areas, especially Core Sound. Obtaining new leases may be difficult depending on the region of the coast. The public often opposes leasing on the grounds that it is a violation of public trust and creates potential conflict between commercial fishermen and leaseholders. There are two areas in North Carolina where shellfish leasing is indefinitely banned. The coastal waters of Brunswick County have not been subject to shellfish leases since 1967 and no information could be located on the events that preceded this action. Another area where leasing is banned covers more than half of the eastern side of Core Sound and a portion of Pamlico Sound bordering Carteret County and was established in 1996. Western Core Sound is also restricted to only leasing bottoms that were currently under lease when the provisions of Session Laws 2003-64 were implemented on June 30, 2003 (NCDMF 2008a).

No new leases can be permitted in areas containing SAV. With bay scallops being associated with SAV for growth and survivability, independent planting of SAV on a granted lease could be an option for bay scallop leases. However this option will need to be investigated further for compliance with U.S. Army Corp of Engineers (USACE) rules. Currently all shellfish leases in North Carolina are permitted under USACE Nationwide Permit (NWP) 48 for shellfish aquaculture through NCDMF. NCDMF must ensure compliance with NWP 48 as well as other related NWPs to be able to permit shellfish leases in North Carolina. Under NWP 48 adverse impacts to submerged aquatic vegetation are not authorized by any NWP within any of the twenty coastal counties defined by North Carolina's Coastal Area Management Act of 1974. The presence/absence of SAV is confirmed by sampling during the shellfish lease investigation.

Shellfish culturists often encounter difficulties obtaining a shellfish lease and find the requirements for maintaining and managing the lease site burdensome. The shellfish lease program has suffered because of a general lack of productivity and the perception that some lease areas are simply being held to exclude the public from personal shellfish gardens. Opposition to shellfish leases for oyster culture has come from commercial fishermen who fear that increased leasing of the bottom will overtake their fishing grounds as well as the tourist industry and residential groups that feel shellfish leases are unsightly and restrict access to water resources.

9.1.1.1 HISTORICAL PRIVATE CULTURE FISHERY

Oyster and clams have been the predominant species of private culture in North Carolina. Although North Carolina law did not formally prescribe the methods for obtaining private shellfish bottoms until 1858, laws existed giving private oyster growers special privileges in harvesting and selling their oysters as early as 1855. Evidently, early cultivation sites were based on "squatters" rights.

The 1858 law provided for licenses to oyster and clam bottoms to be issued by the Clerk of Superior Court of the respective county at no charge. The grant had to be marked and used on a continuing basis for the production of shellfish. Initially, grants could be no larger than two acres. In 1873 this restriction was raised to allow ten acre sites. Only one grant could be held per person. Riparian owner's rights could not be affected, and no natural shellfish bed could be enclosed. Some clerks required surveys for these shellfish licenses (Winslow 1889).

Winslow (1889) reported that there were 250 such licenses in the state. He described the plots as "gardens," a term which is still in use today to describe shellfish leases. The production from these gardens was normally limited to amounts adequate to supply the licensee's table (Winslow 1889). Although subsequent laws for oyster cultivation were passed, this system remained in effect in some counties until 1907 (Jernigan 1983).

On 15-16 October 1884, papers were presented at the Fishermen's Convention in Raleigh, which created a great deal of interest in oyster culture. Lieutenant Francis Winslow, U.S. Navy, and Professor W. K. Brooks, John Hopkins University, both presented arguments for encouraging a privately controlled oyster industry in North Carolina. They cited the depletion of the public oyster beds in Chesapeake Bay and the increasing oyster production from private beds in Connecticut and foreign countries as examples of what could be expected here (Winslow 1885; Brooks 1885).

Pursuant to the interest generated at the Fishermen's Convention, a survey began on 12 April 1886 to determine the extent and condition of North Carolina's oyster- producing habitat. The

survey was conducted under the direction of Lieutenant Francis Winslow. Winslow found 8,327.9 acres of oyster producing bottom in Dare, Hyde, Pamlico, Carteret and portions of Onslow counties. He also identified some 583,000 acres of bottom suitable for oyster cultivation (Winslow 1889). In his report, Winslow proposed an entirely new system for allowing private cultivation of oysters on public bottomlands. The General Assembly adopted these recommendations under the authority of the 1887 Session Laws, Chapter 90, for Onslow County and Chapter 119 for Pamlico Sound (Jernigan 1983).

Under these laws, the natural beds were to be established by a board of three Shellfish Commissioners to be held in the public trust in much the same manner that the Baylor Grounds were set aside in Virginia. Shellfish franchises were to be approved by the Secretary of State who issued the grant. Application fees were $2.05, and franchises were purchased at a cost of 25 cents per acre. Surveys of each grant were conducted for the applicant by a state surveyor at set rates. The grounds were recorded for tax purposes (Winslow 1889).

These grants were required to be improved within five years. Within two miles of the shore of Pamlico Sound, grants could be for no more than ten acres, and only one grant per creek was allowed. However, one person could be granted up to 640 acres in any five year period. Non-residents were allowed to enter grants more than two miles from shore in Pamlico Sound. This new law caused a great deal of interest and by 1889 approximately 50,000 acres had been issued in franchises.

Statutory authority to lease bottomlands for shellfish cultivation can be traced back to a statute adopted in 1909. Interest was generated from the cultivation experiments of the North Carolina Geological and Economic Survey as fishermen harvested oysters from the planted areas and probably influenced the adoption of the legislation (Pratt 1911). The early legislation contained concepts that are still in use today. All leaseholders had to be residents of North Carolina. A survey was required and an investigation of existing oyster stocks was conducted by qualified personnel for each application. There were rental fees and strict marking requirements. The application fee was a $10 deposit applied to survey costs if the lease was approved.

Other aspects of the law were somewhat different from today. Shellfish lease acreage was limited to ten acres in the bays and smaller sounds (Chestnut 1951). An individual lease area could contain up to fifty acres within two miles of the shore of Pamlico Sound and 200 acres farther from shore. Shellfish leases were issued for an initial 20-year term with the option for unlimited 10-year renewals. The performance requirement for leaseholders was strictly set at planting an average of 50 bushels of shells or seed per acre after the first two years and an average of 125 bushels per acre after four years. For up to four months after the granting of the lease, the public could protest on the grounds that the area contained a natural shellfish bed. In any given year from 1901 to 1949 there were about 264 leased areas totaling 3,232 acres (Chestnut 1951).

During the early 1960s the shellfish lease statute was changed to reduce the initial lease period to ten years. The rental fee was raised to $5.00 per acre per year for all leases. A differential system had previously been in place, basing rent on the area and the length of existence of the lease. Due to the extended length of time necessary to legally put these changes in place, all leases did not operate under these changes until 1997.

In 1965 the MFC was given the authority to adopt rules defining commercial production of shellfish based upon the productive potential of areas and considering climatic or biological

conditions, availability of seed oysters and clams, and availability of shells or other cultch materials. From 1966 through 1975, the MFC adopted a production requirement of "at least five bushels of oysters or clams per lease acre per year, averaged over any two consecutive years after January 1 following the second anniversary of an initial lease and throughout the term of a renewal lease" (North Carolina Fisheries Regulations for Coastal Waters 1975. H-12 Cultivation of Oysters).

In 1976 this rule was changed to read "Failure to produce and market at least 25 bushels of oysters or clams per lease acre per year, averaged over the most recent three-year period after January 1 following the second anniversary of an initial lease and throughout the term of a renewal lease, shall constitute failure to utilize the leasehold on a continuing basis for the commercial production of shellfish" (North Carolina Regulations for Coastal Waters 1977, 15A NCAC 03C.0311). The produce and market wording was intended to emphasize the commercial purpose.

The legislation authorizing the MFC to adopt production requirements also made provisions for periods of low oyster productivity. The statute further provided that if a leaseholder made a diligent effort his or her lease could not be terminated; "Acts of God" were also reason to excuse lack of production.

Following a legislative study in 1981, the shellfish lease application fee was raised from $25.00 to $100.00 and a lease renewal fee of $50.00 was established. During the period 1982 to 1986, an average of 10 bushels of shellfish per acre of leased bottom was produced in North Carolina. This figure includes both oysters and clams and falls well below the requirement of 25 bushels per acre. The production requirement was not being met by 71% of the active shellfish leaseholders during 1982 to 1986. Furthermore, by policy, the NCDMF was accepting the planting of 25 bushels per acre of seed or shells as a diligent effort to meet production. A total of 100 of the 285 leases could not meet production requirements during that period. Action to terminate these shellfish leases was blocked by legislative action for one year. In the interim, leaseholders were given an opportunity to attend instructional seminars and receive a two-year extension to meet production.

In 1989 legislation was enacted to allow the use of the water column above the shellfish lease. The number of water column leases was low because the high rental fee of $500 per acre per year for renewed water column amendment probably deterred many potential leaseholders from holding these areas longer than 4 years. In 2005, the General Statutes decreased the cost of the water column leases to $100 per acre a year, the rent is prorated if a water column amendment is issued for less than a 12-month period. The rental is in addition to the fees required for new and renewal of shellfish leases (G.S. 113-202.1(d)).

The MFC recommendations from the 2001 Hard Clam and Oyster FMP included increases in application fees ($200), renewal of application fees ($100), rental fees ($10 per acre per year), and changing the term of the lease contract expiration date to June 30 to coincide with the commercial licensing system (G.S. 113-202). Some shellfish franchises (private culture areas obtained for a one-time fee under the 1889 laws) issued prior to the shellfish leasing program still exist. Those that are recognized as valid claims to bottomlands were required beginning January 1, 1991, to meet the requirements for surveys, management plans, and commercial shellfish production set for shellfish leases. There are 256 recognized claimants of franchises or lands beneath navigable waters in North Carolina and no more can be issued. The DENR portal now provides maps and locations of the recognized claims at: http://portal.ncdenr.org/web/mf/submerged-lands-maps. Production data from these franchises

began showing up in the 1991 statistics but cannot be differentiated from the shellfish lease landings. Only a small portion of the valid franchises may be issued a shellfish lease (Margaret Nicely, NC Department of Justice, personal communication Jan. 30, 2013).

In 2003, the production requirements were changed to accommodate the MFC management recommendation in the 2001 Oyster and Hard Clam FMP to require planting of seed or cultch material. The new production requirements are: (1) Produce and market 10 bushels of shellfish per acre per year and; (2) Plant 25 bushels of seed shellfish per acre per year or 50 bushels of cultch per acre per year, or a combination of cultch and seed shellfish where the percentage of required cultch planted and the percentage of required seed shellfish planted totals at least 100 percent (15A NCAC 03O .0201(b)(1)(2)).

In the 2008 Oyster and Hard Clam FMP amendments several changes both in rule and statute occurred to improve production (NCDMF 2008a; NCDMF 2008b).

9.1.1.2 PRESENT PRIVATE CULTURE FISHERY

Today the majority of shellfish leases are held by commercial fishermen to cultivate hard clams and oysters to supplement their income from public harvest areas by holding shellfish to improve the meat condition and/or sell during better market conditions. Private bottom acreage has fluctuated very little over time while number of leases has shown a gradual increase indicating leases are getting slightly smaller. There has been no commercial bay scallop culture on shellfish leases in North Carolina. One pilot study to culture bay scallops in Core Sound found very high mortality before grow out to a marketable size, but also the surviving bay scallops would more likely expire naturally before a harvest season could be opened because of their short lifespan (Hooper 2011).

The 2008 amendments to the Oyster FMP and Hard Clam FMP endorsed several modifications to the shellfish lease program to increase the accountability of the leaseholders and improve public acceptance of the program (NCDMF 2008a; NCDMF 2008b). The modifications required both rule and statute change. The NC General Assembly accepted the changes to the statutes in 2009 and the rules were modified in 2008. The changes included:

- Change the rule specifying a three year running production average to a five year running production average and change the statutory provision for a ten year lease contract to a five year contract.
- Limit acreage per shellfish lease applications to 5 acres.
- A leaseholder holding at least 5 acres of shellfish bottom is required to meet shellfish lease production requirements before being approved for any additional lease acreage.
- Require latitude/longitude coordinates on lease corner locations as part of the requirement of a registered land survey.
- Develop regional lease acreage caps based on established use of water bodies.
- Rewrite the statutory provision limiting the amount of shellfish lease acreage that can be held by an individual to include acreage held by corporations where the individual is a member, or any combination of corporate family holdings.
- Modify the statute to add a training requirement to persons acquiring leases through lawful transfer to become more familiar with shellfish cultivation techniques and requirements.
- Require applicants or transferees not currently holding a shellfish cultivation lease and leaseholders not meeting production requirements to review training and educational materials on the leaseholder program and obligations of the participants; Requires the

satisfactory completion of an examination with a passing score based on information provided in the training materials.

- Exempt the sale of oysters and clams by a hatchery or aquaculture operation if the sale is to the holder of an Aquaculture Operation Permit holder, Under Dock Oyster Culture Permit holder, or shellfish cultivation leaseholder for further grow out.

9.1.2 RESEARCH RECOMMENDATIONS

- Examine the effects of scallop culture and oyster cultch on seagrass density.

9.2 AQUACULTURE

Aquaculture in North Carolina is currently defined under Article 63, Aquaculture Development Act as the propagation and rearing of aquatic species in controlled or selected environments, including but not limited to, ocean ranching (G.S. 106-758). Aquaculture is considered a form of agriculture and the Department of Agriculture and Consumer Services is designated as the lead state agency in matters pertaining to aquaculture (G.S. 106-759). The Department of Agriculture and Consumer Services has the authority to regulate the production and sale of commercially raised freshwater fish and freshwater crustacean species. Rules have been developed by the Board of the Department of Agriculture and Consumer Services to register facilities for the production and sale of freshwater cultured species, and set standards under which the commercially reared species may be transported, possessed, bought, and sold. The governing body of the Department of Agriculture and Consumer Services is limited to commercially reared fish and does not include authority over the wild fishery resource which is managed under the authority of the Wildlife Resource Commission (G.S. 106-761(a)). The General Assembly gives the Marine Fisheries Commission the authority to make rules and take all steps necessary to improve cultivation, harvesting, marketing of shellfish in North Carolina both from public and private beds (G.S. 113-201). The General Assembly also gives the MFC jurisdiction over the conservation of marine and estuarine resources including the regulation of aquaculture facilities as defined in G.S. 106-758 which cultivate or rear marine and estuarine resources (G.S. 113-132).

9.2.1 NORTH CAROLINA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES

The Department of Agriculture and Consumer Services has the power and duties to provide aquaculturists with information and assistance in obtaining permits related to aquaculture activities, promote investment in aquaculture facilities in order to expand production and processing capabilities, and to work with the appropriate state and federal agencies to review, develop, and implement policies and procedures to facilitate aquaculture development. The North Carolina Department of Agriculture & Consumer Services issues the aquaculture licenses. The license is for any person who owns or operates an aquaculture facility for the purpose of possession, production, transportation, sale or commercial catchout. Twenty-two species are approved for propagation and production, with no shellfish species listed: (http://www.ncagr.gov/markets/aquaculture/documents/ExplanationoftheAquacultureLicense.pdf) Possession of any species other than those on the list is not allowed except with special written permission from the Wildlife Resources Commission. Three of the 22 species have specific restrictions that also must be approved through the Wildlife Resource Commission.

9.2.2 NORTH CAROLINA DIVISION OF MARINE FISHERIES

Despite the addition of water column use on approved lease sites, increased NC Sea Grant involvement, and funds provided by the Fisheries Resource Grant Program, interest in utilizing hatchery-reared seed and modern aquaculture techniques to culture shellfish is minimal. To be considered aquaculture by NCDMF, the product has to come from a hatchery reared individual. Aquaculture operations cannot harvest from the wild stock and then grow out. Some aquaculture species are exempted from size limits and seasons. In the past specific cultivation conditions were listed on the aquaculture operation permit; however, currently conditions cannot be put in place without a specific rule.

With the inconsistent availability of wild harvest, high market value, and quick, high growth rate, bay scallops could be a viable cultured species in the state. A major impediment to increasing aquaculture production of bay scallops is locating markets willing to pay the higher prices necessary to offset increased labor, operation, and materials costs. Another obstacle is that the few shellfish hatcheries in North Carolina are not able to produce sufficient number of bay scallop seed to meet the demands of shellfish growers. Therefore, growers typically utilize out-of-state sources for shellfish seed. Since the introduction of the cooperative shellfish hatchery between UNCW and DENR, bay scallops have been spawned successfully and should benefit leaseholders with a supply of in-state seed.

The importation of shellfish seed into North Carolina was not regulated prior to 1986. The Atlantic States Marine Fisheries Commission (ASMFC) addressed the potential danger of spreading shellfish pest, predators, and disease in their October 1986 meeting. The states of Maine, New Hampshire, Massachusetts, Rhode Island, Virginia, North Carolina, South Carolina, Georgia, and Florida endorsed a cooperative agreement on shellfish transfers. The agreement assigned responsibility in the control of imports with the importing state and the importing state retains the ultimate authority to accept or reject any shipment of shellfish. The exporter retains the ultimate responsibility of proving the health status of shipments.

The ASMFC Interstate Shellfish Transport Committee drafted a plan implementing a cooperative agreement (ASMFC 1989). Although the agreement was endorsed by the member states, the implementation of the plan has not been consistent across the states. The NCDMF policy is to follow the guidelines set forth in the ASMFC Cooperative Agreement. NCDMF requires certification that a shellfish seed shipment is free of shellfish pests, predators, pathogens, or parasites, with documentation that the shellfish are disease free or that the exporting facility uses sterile hatchery procedures that would not contaminate the shipment (sterile closed system or treatment of incoming water). A documented history that organisms from the exporting facility have had no incidence of contamination is also required. The responsibility for obtaining the certification lies with the applicant. This policy is consistent with policies in Maine, Rhode Island, Virginia, and South Carolina, although not as restrictive. North Carolina's policy also lacks detailed procedures leaving state managers to make some decisions on a case-by-case basis.

A selected management strategy in both the Oyster and Hard Clam FMPs in 2001 recommended formulation and amplification of the policy on the importation of marine and estuarine organisms. Based on information gained from the Eastern United States Interstate Shellfish Seed Transport Workshop held in Charleston, South Carolina in February 2002, the NCDMF reviewed and updated the disease assessment protocols as part of the criteria for issuance of Permits to Introduce or Transfer Marine and Estuarine Organisms into the Coastal Waters of the State of North Carolina. The only significant modification deemed necessary was

to increase the number of organisms for analysis from 30 individuals to 60 individuals from each batch.

The shipping window of thirty days from removal of the sample individuals from the batch until receipt of the shipment was the shortest timeframe practical to have the assessment completed, report submitted, permit issued and delivery received. The concern with the shipping window is due to the possibility of events that could cause infections or infestations of the remaining individuals in the batch during the assessment and processing timeframe. The permitting procedures require testing by a qualified laboratory but are not specific in the testing. By not specifying the testing requirements it allows the flexibility to use historically acceptable procedures and developing technologies. The flexible range in testing also enables specific tests for specific species – some tests are specific for diseases and species and would not be of value for organisms unaffected by the specific disease. Over the past five years only two importations have been denied – one for the presence of a diseased organism and the other for falsifying the testing certification document. Although somewhat cumbersome, the testing criteria for the issuance of the permit does provide some measure of oversight of species legally entering our waters. Additional reinforcement to comply with the permit requirement for shellfish lease holders is that they are required to provide documentation of the source of their shellfish seed to receive credit towards their mandatory production limits; seed originating outside the state without an accompanying permit are illegal and are not credited toward the lease production.

The need for a state aquaculture policy has been recently discussed within NCDMF to address the challenges of the present aquaculture industry. Issues affecting near shore marine aquaculture include the growing human population associated with development pressures of the coastal communities and confusing or overlapping laws. Aquaculture challenges include lack of clear regulations and questions about exclusive access to public bottoms. Proactive policies can prevent, or at least minimize some of the following potential environmental impacts: spread of disease among populations, genetic contamination and competition between farmed and native stocks, effects from aquaculture operations on water quality, wetlands, and other natural habitats, waste, marine mammals and birds, which can be attracted to the food source and become a nuisance or pest in higher populated areas, and the risk of introducing non-native species (intentionally or unintentionally) (U.S. Commission on Ocean Policy 2004). It is often more difficult to back-track once unclear, conflicting policies or risky facilities are in place and impacts to the environment have already occurred. Proper planning will likely stimulate and guide the evolution of the aquaculture sector by providing incentives and safeguards, attracting investment and boosting development.

9.2.3 NORTH CAROLINA OYSTER HATCHERY PROGRAM

In response to introduced legislation (Senate Bill 550) and budget appropriations, the North Carolina Aquariums Division created the North Carolina Oyster Hatchery Program and appointed an interagency committee. The committee included representatives from state agencies (the Aquariums, NCDMF, and North Carolina Sea Grant), colleges and universities (UNC-Chapel Hill, UNC Coastal Studies Institute, UNCW, Carteret Community College) and the NC Coastal Federation (NCCF). The committee met throughout 2005-2006 to develop recommendations regarding a state-supported hatchery system and associated programs that would inform and contribute to oyster restoration and aquaculture. A system including 3 hatcheries and 2 remote setting sites was proposed to address the varied challenges facing oysters. Beyond this infrastructure, the North Carolina Oyster Hatchery Program recommendations included programs for education, training, and research that would

complement and enhance production goals. While the focus was to be the culture of the eastern oyster (*Crassostrea virginica)*, it was agreed that the facilities could be used to support research and development of culture strategies for other commercially important and troubled shellfish species (i.e. bay scallops and hard clams).

In 2008, only a portion of the recommendations made by the North Carolina Oyster Hatchery Program were moved forward, with the General Assembly authorizing the construction of a research hatchery at UNCW's Center for Marine Science. Construction was initiated in late August 2009 under the supervision of NCDMF. A NCDMF advisory committee (the Hatchery Advisory Committee (HAC)) was appointed in 2008 (including UNCW, NCDMF, NCCF and industry stakeholders) to make recommendations on research objectives, hatchery design and general operations. Upon completion in February 2011, the Shellfish Research Hatchery (SRH) was turned over to UNCW to operate. While the absence of consistent programmatic funds has constrained development of a long-term research agenda, the SRH staff has followed the HAC recommendations (as articulated in the SRH 2011-2016 strategic plan) to the extent that available resources allowed. An oyster breeding program was initiated in the spring of 2012 with additional support from North Carolina Sea Grant's Blue Crab and Shellfish Research Program and the New Hanover County Farm Bureau, and the efficacy of flow-through culture systems for the production of bay scallop seed (supported by UNCW) has been investigated during the 2011 and 2012 fall production season. Pilot-scale field grow-out trails of both scallops and oysters are ongoing.

The mission of the SRH is to conduct and facilitate research that will both inform and contribute to North Carolina's efforts to restore declining populations of ecologically and commercially important shellfish, and to build a sustainable shellfish aquaculture industry (UNCW 2009). While the SRH currently is not producing bay scallop seed for industry, seed is being produced in amounts for research. Objectives within the SRH Strategic Plan 2011-2016 is to identify hatchery-based research priorities for non-oyster species and to work with appropriate advisory committees to identify research needs that could be addressed using the facilities and abilities. Therefore, the framework has been set for the SRH to aid in future development of bay scallop enhancement programs with potential capabilities to support industry development.

9.3 STOCK ENHANCEMENT

The 2007 Bay Scallop FMP recommended management strategies of spawner transplant of wild harvest stocks and cultured release. However, funding for NCMDF bay scallop enhancement is limited and there is no enhancement program for bay scallops in North Carolina. Historically, some enhancement work has been done in North Carolina, but these activities only occurred at an experimental level and were short-term. However, with low population levels coastwide, many states such as Florida have considered stock enhancement and sanctuaries as management strategies to revive depleted stocks.

Restocking and stock enhancement through release of cultured and wild harvest seed are two methods of adding more bay scallops back into a population. 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.

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. Larval releases have been proposed as an economically effective method for the supplementation of shellfish stocks (Wilbur and Schmidt 2009). University of North Carolina Wilmington initiated a study to directly assess the efficacy of larval releases in Bogue Sound. While the results were less than definitive with the respect to the magnitude of contribution the larval releases had on the scallop population, there is some suggestion that the method has merit (Wilbur and Schmidt 2009). 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-stage 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 suggests 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 seagrass 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.

More recent restoration options to benefit the bay scallop stocks include protection of adult scallops from cownose ray predation with stockades, using collectors for gathering spat and as a nursery for juvenile scallops to grow out, and the possible use of shore-side ponds as sources for scallop seed (Fegley et al. 2009). Cownose ray predation can be site-specific enough that stockades made of PVC can be created to enclose scallops in a refuge from cownose rays migrating through the sounds (Peterson et al. 2001; Myers et al. 2007; Fegley et al. 2009). The timing of the annual migration can be unpredictable from year-to-year but these refuges could provide enough spawning scallops to repopulate many areas within the same hydrographic

basin (Fegley et al. 2009). Unfortunately, human poaching of the scallops within the stockades was evident during the study because they are designed to be highly visible above-water to water users. This restoration method will likely need to be limited to areas where human interactions are reduced. Spat collector bags consisting of 'onion' bags filled with mesh netting inside for scallop attachment were used to collect seed in various locations (Fegley et al. 2009). The spat bag collectors accumulated thousands of bay scallop recruits. Seed abundance and growth was variable by location, and bag losses either from burial or movement due to wind or tides decreased the yield of scallops in some locations. Spat collector bags could be used to supplement the local stock by introducing the scallops inside the bags to a nearby seagrass beds, although appropriate site locations will need to be determined through trial and error.

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. The current SRH could be a viable source of bay scallop seed. Research through the SRH could initiate culture techniques for rehabilitating and farming bay scallops in North Carolina. Currently the hatchery is rearing bay scallop seed and could supply seed for enhancement projects research and public education.

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. Additional research will be needed to incorporate viable enhancement methods and options in the estuaries of North Carolina.

10.0 SOCIOECONOMIC ASPECTS OF THE BAY SCALLOP FISHERY

10.1 COMMERCIAL FISHERY

10.1.1 EX-VESSEL VALUE AND PRICE

Bay scallops have been an economically important shellfish species in North Carolina since the earliest landings records were kept. However, the value of bay scallops has always lagged behind that of oysters (*Crassostrea virginica*) and hard clams (*Mercenaria mercenaria*) (Chestnut and Davis 1975). Figure 10.1 shows the nominal and inflation adjusted ex-vessel value of landings adjusted to the value of a dollar in 1972. The year 1972 was chosen for inflation adjustment purposes as this was the first year that NCDMF began to have data that covered all managed species. Inflation adjusted values are calculated to provide a dollar value that is comparable across all years. There are no comparable deflated figures prior to 1918 since the US government did not begin calculating the Consumer Price Index as a measure of inflation prior to that year.

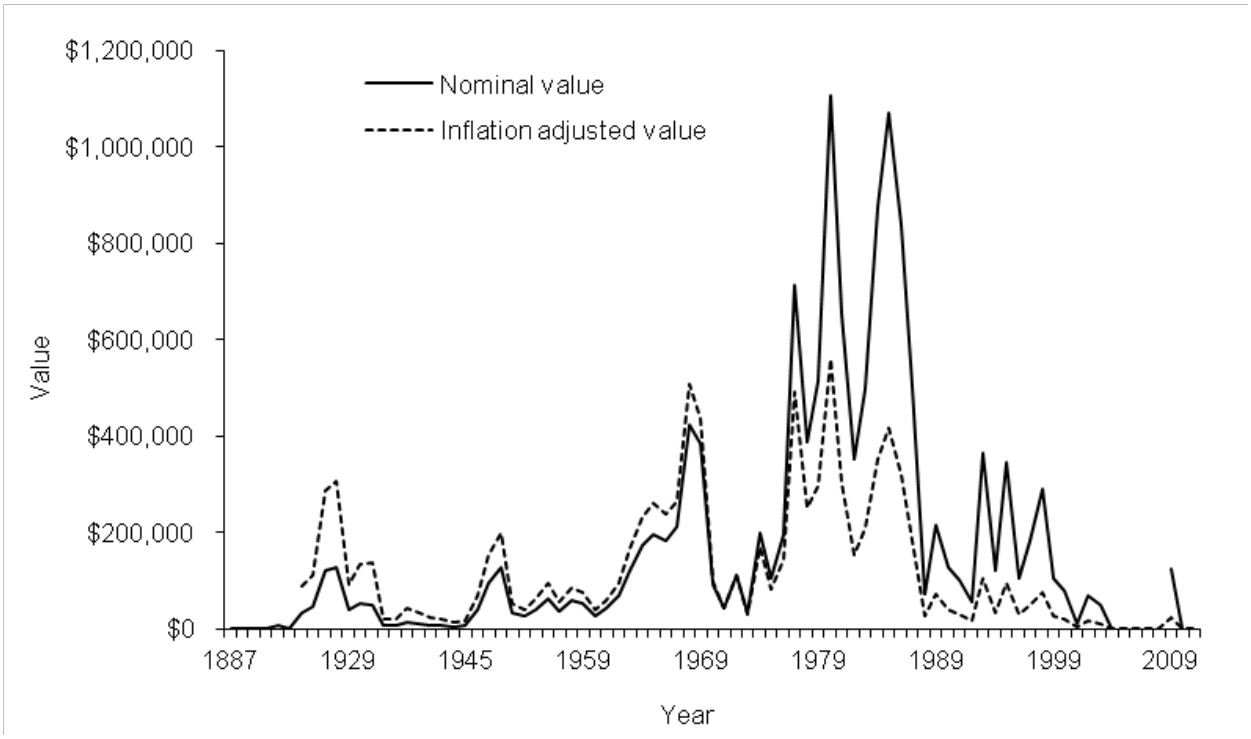


Figure 10.1 Commercial ex-vessel value of bay scallop landings, North Carolina, 1887-2011. Chestnut and Davis 1975, NCDMF Trip Ticket Program.

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 1988-1992 were years when the landings values appear to be quite a bit lower than the years preceding or after. With the exception of 2009, the most recent years have seen a collapse in landings value to the lowest on record (Table 10.1).

Table 10.1 Nominal and inflation adjusted ex-vessel value and price per pound of bay scallop landings, North Carolina, 1887-2011. Chestnut and Davis, 1975. NCDMF Trip Ticket Program.

Year	Nominal value	Inflation adjusted value	Nominal price/lb	Inflation adjusted 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
2005	$0	$0	$0	$0
2006	$0	$0	$0	$0
2007	$0	$0	$0	$0
2008	$0	$0	$0	$0
2009	$124,256	$24,217	$4.28	$0.83
2010	<$1,500	<$300	$6.25	$1.20
2011	$0	$0	$0	$0

Historically, the annual ex-vessel value of bay scallops has been routinely higher than $100,000. In exceptionally productive years (1968, 1969, 1977, 1980 and 1985), the nominal ex-vessel value of landings has been greater than $400,000. Nominal landings value peaked in 1980 at $1,107,072. During the years from 2005 through 2008 and 2011, no landings were recorded due to a closure of the fishery.

The inflation adjusted ex-vessel values show a similar trend of fluctuation. The landings consistently were near or above $100,000 in value through the mid 1980's. Inflation adjusted values dropped precipitously through the 1990's and into the 2000's. In recent years, when the bay scallop fishery was open, 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 NCDMF 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 overall. However, when available the price per pound of bay scallops has remained relatively high on a nominal basis (Figure 10.2).

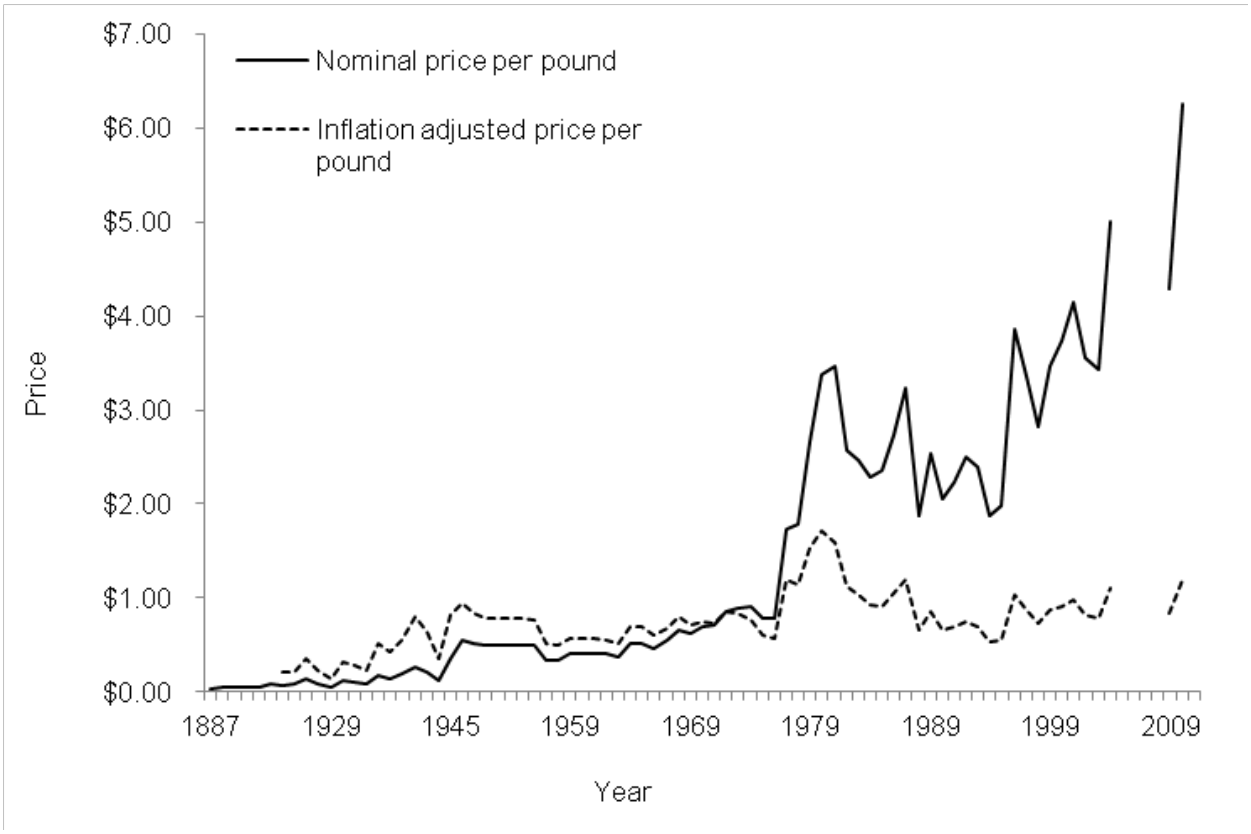


Figure 10.2 Commercial ex-vessel price per pound for bay scallops, North Carolina, 1887-2011. Chestnut and Davis 1975. DMF Trip Ticket Program.

With the exception of the 1980's, the price per pound of bay scallops has exhibited a steady increase. The lowest nominal price per pound for bay scallops was $.03 in 1887 with the highest being $6.25 per pound in 2010. When inflation is taken into account, 1929 had the lowest price per pound at $.14. The highest inflation adjusted price per pound for bay scallops was seen in 1980 at $1.71 per pound.

10.1.2 GEAR

The advent of the North Carolina trip ticket program in 1994 allowed the NCDMF 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 consist of using scallop dredges.

Table 10.2 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 primary method of harvest changed to rakes. Since 2000, the majority of bay scallop trips used hand-harvesting methods. There were no mechanically harvested bay scallops in 2001 as a NCDMF proclamation prohibited their use. In 2004, there were only two trips reported that landed bay scallops and no landings occurred in 2005. Beginning in 2006, harvest was prohibited and continued through 2008. During 2009, Core Sound and eastern Pamlico Sound was open to hand harvest only. In 2010, only Pamlico Sound was opened to hand harvest only.

The average nominal ex-vessel value per trip ranged from a low of $143 in 1994 for bay scallops harvested by hand to a high of $369 in 1997 for bay scallops harvested using mechanical methods. In most years, mechanical 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 was allowed except in 2000.

Table 10.2 Trips, ex-vessel value, and average price per pound for harvesting by hand and mechanical methods for bay scallops, North Carolina, 1994-2010. NCDMF Trip Ticket Program.

	Hand harvest				Mechanical harvest			
Year	Trips	Value	Average value per trip	Price per pound	Trips	Value	Average value per trip	Price per pound
1994	103	$14,713	$143	$1.97	685	$105,341	$154	$1.87
1995	339	$36,695	$108	$2.83	1766	$307,226	$174	$1.92
1996	176	$26,091	$148	$3.86	270	$79,628	$295	$3.86
1997	318	$51,506	$162	$3.35	357	$131,689	$369	$3.36
1998	162	$24,459	$151	$2.89	896	$264,484	$295	$2.81
1999	295	$64,003	$217	$3.46	146	$38,995	$267	$3.49
2000	330	$76,059	$230	$3.73	11	$2,499	$227	$3.89
2001	56	$10,423	$186	$4.14	0	$0	$0	$0
2002	308	$62,356	$202	$3.50	27	$6,009	$223	$4.25
2003	220	$40,238	$183	$3.35	23	$8,399	$365	$3.84
2004	*	*	*	*	0	$0	$0	$0
2005	0	$0	$0	$0	0	$0	$0	$0
2006	0	$0	$0	$0	0	$0	$0	$0
2007	0	$0	$0	$0	0	$0	$0	$0
2008	0	$0	$0	$0	0	$0	$0	$0
2009	1,094	$124,256	$114	$4.28	0	$0	$0	$0
2010	5	$1,250	$250	$6.25	0	$0	$0	$0

*confidential

10.1.3 WATERBODIES

In the early years of the trip ticket program, Core Sound saw the greatest portion of the bay scallop catch each year. Figure 10.3 shows the annual ex-vessel value of bay scallops from Core Sound, Bogue Sound and all other state waterbodies combined. Between 1994 and 1999 the annual value of bay scallops harvested from Core Sound greatly fluctuated. 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. Starting 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. In 2004 and 2005 little to no landings were recorded due to poor abundance although the harvest season was open and a period of prohibited take occurred from 2006 through 2008. During 2009 and 2010, landings came from Core and Pamlico sounds and totaled $125,000 ex-vessel value.

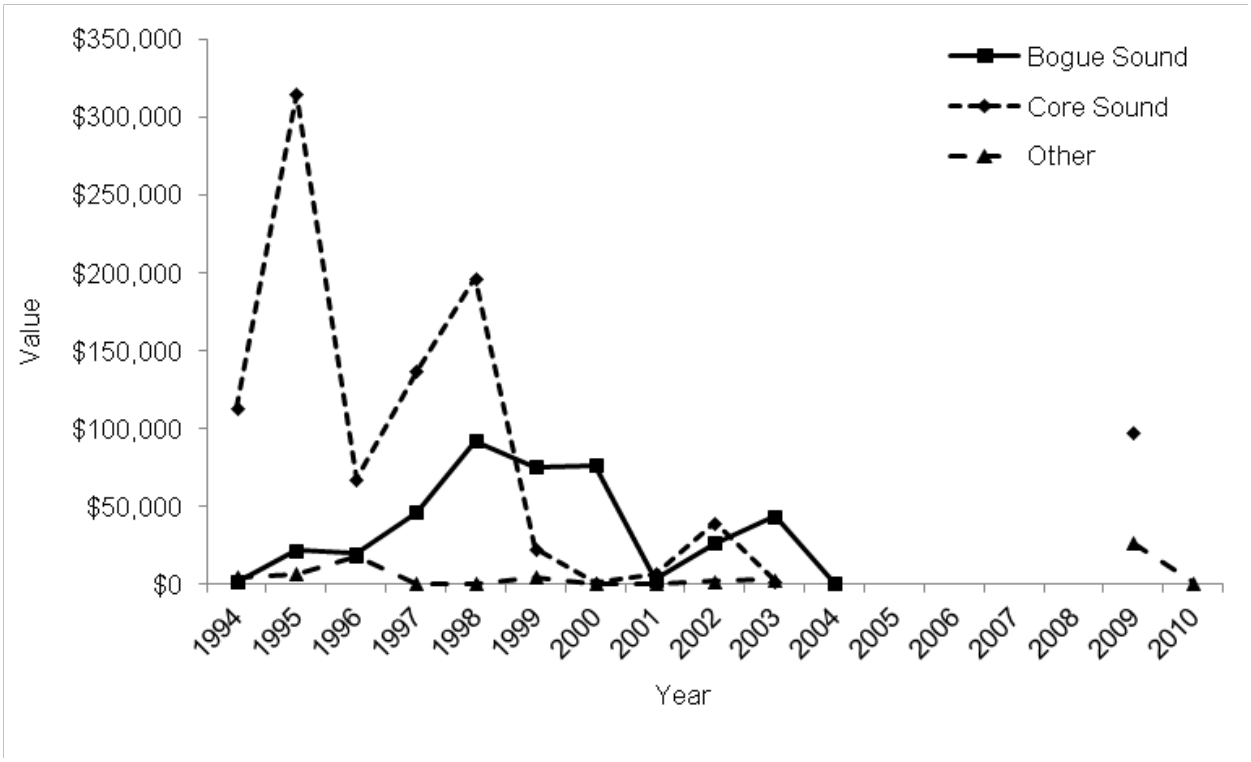


Figure 10.3 Annual ex-vessel value (inflated) for bay scallops from selected waterbodies, North Carolina, 1994-2010. NCDMF Trip Ticket Program.

10.1.4 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. The bay scallop fishery occurs in the winter when few other species are available

and requires relatively low capital expense for equipment, making it appealing when the season is open and the resource is abundant. Since the trip ticket program began in 1994, participants ranged from a high of 284 in 1995 when bay scallops were plentiful to less than 5 participants in 2004 and 2010 (Table 10.3).

Table 10.3 Number of participants and annual ex-vessel landings value for bay scallops, North Carolina, 1994-2010. NCDMF Trip Ticket Program.**

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2009	2010
< $100	23	35	13	10	18	9	11	9	12	15	0	36	0
$100.01 - $500	108	97	28	28	38	24	21	9	26	29	1	87	2
$500.01 - $1,000	29	52	14	20	20	17	16	4	17	12	0	47	1
$1,000.01 - $5,000	29	87	33	24	38	27	22	4	18	11	0	38	0
> $5,000	2	13	1	14	20	4	2	0	1	1	0	0	0
Total participants	191	284	89	96	134	81	72	26	74	68	1	208	3

**no season during 2005-2008

Table 10.4 shows the number of dealers statewide who reported landings of bay scallops on trip tickets between 1994 and 2010. The number of dealers closely mirrors landings. In years where fewer bay scallops were harvested, there is a 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 one in 2004 and two in 2010.

Table 10.4 Number of dealers and annual ex-vessel landings value for bay scallops, North Carolina, 1994-2010. NCDMF Trip Ticket Program.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2009	2010
<= $500	4	7	2	2	6	4	9	7	8	11	1	6	0
$500.01 - $1,000	3	2	3	3	0	5	1	0	2	1	0	8	2
$1,000.01 - $2,500	3	3	7	0	2	4	3	2	4	3	0	11	0
$2,500.01 - $5,000	3	5	2	4	3	3	2	2	7	3	0	6	0
$5,000.01 - $10,000	5	7	2	4	5	0	2	0	1	1	0	1	0
>=$10,000	4	6	2	3	6	5	3	0	1	1	0	3	0
Total dealers	22	30	18	16	22	21	20	11	23	20	1	35	2

**no season during 2005-2008

The majority of dealers purchasing bay scallops from North Carolina fishermen are located in Carteret County, as the bulk of all North Carolina bay scallops traditionally are harvested from Core and Bogue sounds. Other counties that recorded landings include Dare, Craven, Onslow, Pender, and New Hanover.

10.1.5 PROCESSING

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

currently when the season is open, shucking operations often take place at home where family members work to process bay scallops at the end of a fishing trip.

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 date back to 1968 and end 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 reasoning for this was that the adductor muscle 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 are rarely harmful. Oysters, clams, or mussels harvested from closed shellfishing areas may not be safe to eat even if cooked, since the animals can concentrate biotoxins, chemicals or bacterial toxins that are heat stable and not cooked out of the product. Additionally, the U.S. Food and Drug Administration (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 10.5 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. The certification year of 1968-69 had the highest number of operations certified with 77. The 1991-1992 certification year saw only 15 operations certified, the least of any year in the time series. Some factors that may 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 10.5 Bay scallop shucker/packer (S/P) and shucker (S) operations certified in North Carolina, 1968-1994. NCDMF Shellfish Sanitation Section.

Year	Shucker/Packer (S/P)	Shucker (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 10.6 shows the number of certified plants by county based on two year groupings. The majority of bay scallops are harvested in Core and Bogue Sounds and consequently the vast majority of bay scallops were processed in Carteret County. This is consistent with historical records (Gutsell 1928).

Table 10.6 Locations of certified bay scallop processor operations, North Carolina, 1968-1994. NCDMF 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

10.1.6 ECONOMIC IMPACTS OF COMMERCIAL FISHING

The commercial fishing industry in North Carolina produces ripple effects as money is spent and re-spent in the state's economy. Each dollar earned within the industry generates a more vigorous economy by stimulating additional activity that fosters jobs, income and output. The impacts are estimated by NCDMF using IMPLAN economic modeling software.

The most recent year of substantial landings of bay scallops in North Carolina is 2009. The ex-vessel value of these landings was $124,256. This led to an estimated economic impact to the state economy of approximately $204,000 (Table 10.7). This estimate is limited and must be viewed as conservative, as it does not included wholesale (seafood dealers), retail and food service sectors due to lack of data.

Table 10.7 Economic impact of commercial bay scallop landings in North Carolina. 2009. NCDMF Socioeconomics Program.

Economic inputs	$124,256
Additional economic activity	$79,691
Total economic impact	$203,947

10.2 RECREATIONAL FISHERY ECONOMICS

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

10.3 SOCIAL IMPORTANCE OF THE FISHERY

10.3.1 COMMERCIAL FISHERY

There are insufficient data available to indicate the current social importance and demographics of the commercial bay scallop fishery. NCDMF surveys commercial fishermen throughout the coast to assess the social importance of commercial fisheries. Due to the series of fishery closures, the sample size of fishermen that indicated fishing for bay scallops in recent socioeconomic surveys is too low to draw statistically accurate conclusions.

10.3.2 RECREATIONAL FISHERY

There are insufficient data available to indicate the current social importance and demographics of the recreational bay scallop fishery. NCDMF currently conducts a recreational shellfish/crab survey; however, this survey began during the winter of 2010. No recreational bay scallop data have yet been collected due to the fishery being closed since the survey's inception.

The survey of recreational bay scallop participants will be conducted by mail with a sampling frame consisting of CRFL holders as well as by onsite intercept at coastal recreational access points. There is no requirement to hold a CRFL in order to take shellfish recreationally. As a result, this sampling frame for the survey conducted via mail does not account for anglers that harvest shellfish but do not possess a fishing license. This is also true of the current RCGL. The lack of contact information may make it very difficult to obtain estimates of the economic and social impact of recreational effort in the bay scallop fishery. To remedy this issue, NCDMF

will be conducting an intercept survey in addition to the mail survey during the 2013 recreational bay scallop season. A better estimate of how much data are available will become more apparent as the recreational bay scallop fishery is opened and the surveys are conducted.

10.3.3 DEMOGRAPHIC CHARACTERISTICS

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

10.3.4 RESEARCH RECOMMENDATIONS

Should the bay scallop fishery be opened, socioeconomic surveys of commercial participants in the bay scallop fishery need to be performed to determine specific business characteristics, the economics of working in the fishery, which issues are important to the participants, attitudes towards management of the fishery and general demographic information. NCDMF has conducted many surveys of this type in the past; however, very few of the surveys have been carried out with participants of the bay scallop fishery in recent years.

NCDMF currently does not license or certify bay scallop processors. A method could 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 involved in the processing. It is not known how many people were shucking scallops in any year since 1994. NCDMF 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 needed data.

While NCDMF will be collecting data from recreational bay scallop fishery participants on catch and demographics, the expenditures and economic value of the participant activities will remain unknown. While this data is currently un-available, the economic impact and value of the bay scallop fishery could be determined by sampling the fishery participants in years that the bay scallop fishery is open and recreational harvest is allowed.

11.0 ENVIRONMENTAL FACTORS

11.1 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. Data from the NCDMF Bottom Mapping Program (Figure 11.1) shows the areas where bay scallops have been located during sampling since 1988. This data shows that 82% of the scallops found during bottom sampling were located in subtidal areas with vegetated hard bottom without shell.

For additional information on the environmental factors discussed in this section, please refer to the North Carolina Coastal Habitat Protection Plan (CHPP) (Deaton et al. 2010).

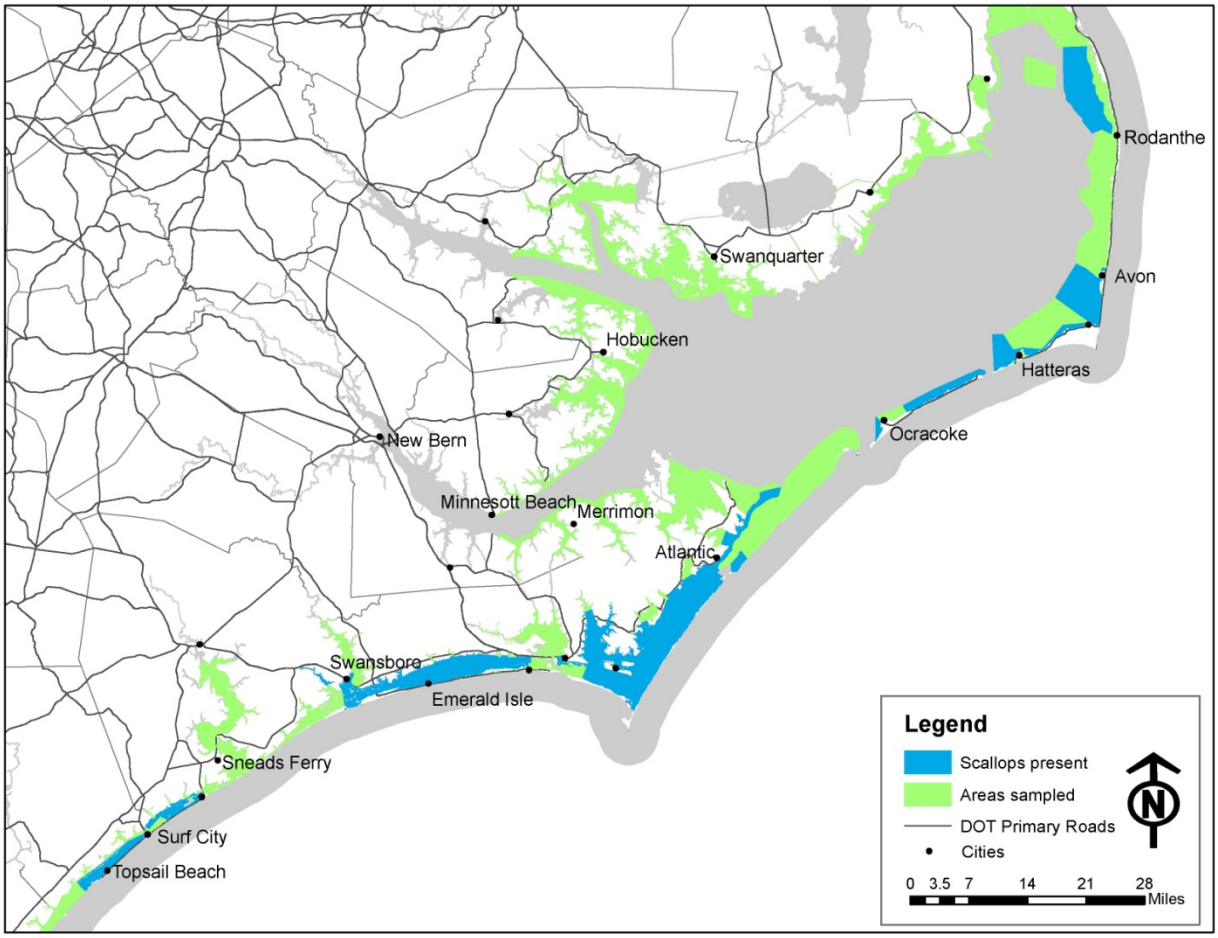


Figure 11.1 Presence of bay scallops found by NCDMF Bottom Mapping Program data, 1988-2012.

11.1.1 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” (Deaton et al. 2010). 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 Fish Habitat Area [MFC rule 15A NCAC 03I .0101 (4)(i)]. Only high salinity seagrass beds 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, NCDMF 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 (NCDMF 1990). In addition to finfish, over 70 benthic invertebrate species have been reported from eelgrass beds along the east coast (Thayer et al. 1984). Submerged aquatic vegetation 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.

Submerged aquatic vegetation stabilizes and traps sediment, reduces wave energy, and cycles nutrients within a local ecosystem (Thayer et al. 1984). The three-dimensional structure provides a surface for small plants and animals to attach to and provides a safe refuge and foraging area for a large number of juvenile fish and invertebrates (SAFMC 1998). Beds of SAV also produce large quantities of organic matter, which support a complex food base for numerous fish and other organisms (Thayer et al. 1984). The structure of SAV grass blades creates an excellent nursery area and enhances a safe corridor between habitats, reducing predation (Micheli and Peterson 1999). High densities of seagrass shoots and increased plant surface area inhibit predator efficiency and provide shelter (Prescott 1990).

Based on location of adult scallops in seagrass beds, eelgrass and shoal grass are considered the selected 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 the 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 1970). 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 to 19 days prior to attaching to a substrate with a byssal thread (Fay et al.1983). Where SAV patches are interspersed over a large area, the probability of scallop larvae finding an appropriate settlement site is greater.

Submerged aquatic vegetation habitat supports other types of aquatic plants in addition to submerged grasses. Macroalgae (benthic, drift, and floating forms) often co-occur with SAV and provide similar ecological services, but the plant taxa have distinctly different growth forms and contrasting life requirements (SAFMC 1998). Macroalgae grow faster than SAV and do not require unconsolidated substrate for anchoring extensive root systems. Because of this growth pattern, macroalgae do not provide as much sediment stabilization as submerged rooted vascular plants. Generally, macroalgal leaves are less rigid than those of submerged rooted vascular plants, thus reducing their function as substrate for attachment and as a source of friction for sediment deposition. Macroalgal genera include salt/brackish (*Ulva, Codium, Gracilaria, Enteromorpha*) and freshwater (*Chara* and *Nitella*) species.

Recently, *Codium* algae have been shown to serve as important habitats for bay scallops by providing structure for attachment as well as refuge (Carroll et al. 2010). No difference was found in scallop survival between substrates for a given size and date. Cordero et al. (2012) showed that scallops can survive in different habitat types but survival of small scallops in seagrass and algae habitats was significantly greater than in oyster and rubble habitats.

The primary factors controlling distribution of SAV are water depth, sediment composition, currents/wave energy, and the penetration of photosynthetically active radiation (PAR) through the water column (Goldsborough and Kemp 1988; Duarte 1991; Kenworthy and Haunert 1991; Dennison et al. 1993; Stevenson et al. 1993; Gallegos 1994; Moore et al. 1996; Virnstein and Morris 1996; Moore et al. 1997; Koch 2001; French and Moore 2003; Havens 2003; Kemp et al. 2004; Cho and Poirrier 2005; Duarte et al. 2005; Biber et al. 2008). At a minimum, high salinity SAV leaves require 15% to 25% of incident light (Dennison and Alberte 1986; Kenworthy and Haunert 1991; Bulthius 1994; Fonseca et al. 1998). Low salinity species have generally lower light requirements (9% to 13%) than high salinity grasses (Funderburk et al. 1991; Fonseca et al. 1998; Environmental Protection Agency (EPA) 2000; Kemp et al. 2004). Light penetration, or

water clarity, is affected by epibiotic growth and natural substances in the water column, such as dissolved organic matter (e.g., humics), suspended particulate matter (e.g., sediment and minerals), detritus, phytoplankton, and algae (Kemp et al. 2004; Biber et al. 2008).

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; Carroll et al. 2012). However, the asset of increased growth rate is offset by increased predation in patchier, less dense grass beds (Irlandi et al. 1995; Carroll et al. 2012). Predators include sea gulls, wading birds, whelks, cownose rays, starfish, pinfish, toadfish, and several crab species (Pattilo et al. 1997).

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. It is possible that proximity of adult scallops to hydrologically accessible SAV could enhance the bay scallop population and SAV in areas with low current velocities could be more isolated resulting in lower bay scallop recruitment.

11.1.1.1 STATUS

Submerged aquatic vegetation habitat occurs along the entire east coast of the United States, with the exception of South Carolina and Georgia, where high freshwater input, high turbidity, and large tidal amplitude (vertical tide range) inhibit their occurrence. Along the Atlantic coast, North Carolina supports more SAV than any other state, except for Florida (Funderburk et al. 1991; Sargent et al. 1995). NOAA aerial imagery taken from 1985 to 1990, resulted in a total area of visible SAV of approximately 134,000 acres (Ferguson and Wood 1994). Other mapping efforts of smaller areas in North Carolina include Carroway and Priddy (1983) in Core and Bogue sounds and the North Carolina Division of Water Quality (DWQ) (1998) in the Neuse River system. In addition to mapped SAV, Davis and Brinson (1989) surveyed and described the distribution of SAV in Currituck Sound and the Western Albemarle-Pamlico estuarine system. More recent mapping efforts suggest SAV habitat covers over 196,000 acres in coastal North Carolina and include transect data from NCDMF and DWQ Rapid Response Teams and maps based on aerial photography from Elizabeth City State University, North Carolina State University, and Albemarle Pamlico National Estuary Program (Deaton et al. 2010). Data from all of these sources have been combined to create a mosaic of all known SAV habitat in North Carolina (Figure 11.2).

Although there have been reports of large-scale losses of SAV in North Carolina's low salinity tributaries on the mainland side of Pamlico Sound, the high salinity grass beds behind the barrier islands that are inhabited by bay scallops appear to remain relatively stable based on a comparison of mapping efforts through time. While a quantified change analysis is not available, based on the most recent data there appears to be an increase of SAV in some of the low salinity systems and southern range of SAV, which may be related to improved water clarity associated with the coastwide drought in 2007 to 2008. Preliminary review of core areas of high salinity SAV, such as behind the Outer Banks in Pamlico Sound and Core Sound do not indicate

large change. However, there may have been a shift to increased patchiness of previously dense beds in Bogue Sound.

Although localized annual monitoring of SAV presence and species composition is underway, a coastwide analysis of annual change in distribution and abundance is preferred. A cooperative agency/academic research project (funded by Coastal Recreational Fishing License dollars) is underway investigating methods to measure change in SAV coverage. With better information available on light and other habitat requirements of SAV, it may be possible to manage water quality for protection of SAV.

Changes in the amount or condition of high salinity seagrass beds will have a direct impact on bay scallop populations. Protection and enhancement of this habitat should be high priorities for management of bay scallop populations. Submerged aquatic vegetation restoration has been researched in the Chesapeake Bay with varying degrees of success (see special section in Restoration Ecology-Shafer (ed.) 2010; Orth et al. 2006; Tettelbach et al. 2011). Carroll et al. (2008) found increased eelgrass productivity and leaf nitrogen in areas with added clams while Wall et al. (2011) found that bivalve filtration can mediate the effects of nutrient loading on eelgrass. Further research should be completed in North Carolina to identify successful SAV enhancement techniques.

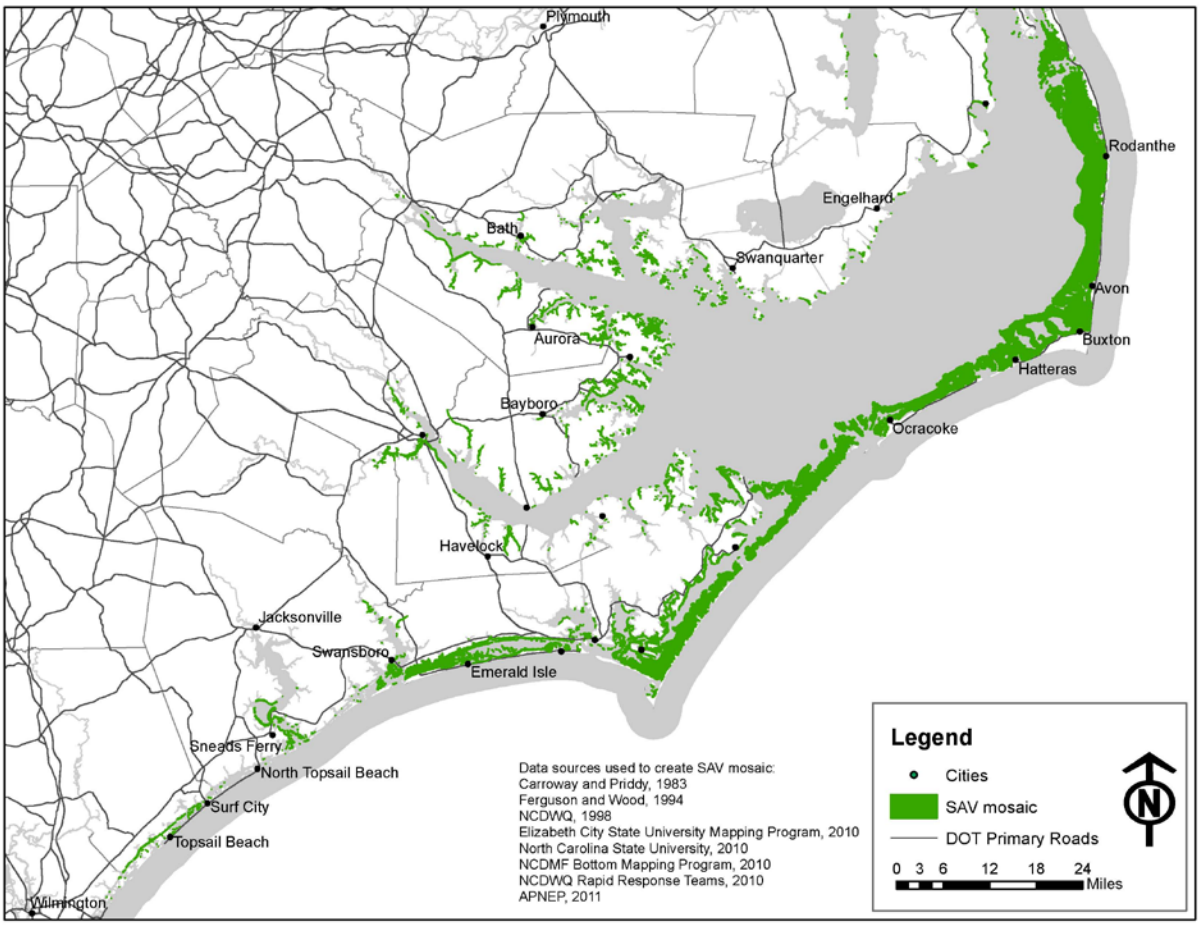


Figure 11.2 Submerged aquatic vegetation mapped between 1981 to 2012 within the range of the bay scallop in North Carolina.

11.1.1.2 THREATS

Water Quality

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 (Twilley et al. 1985; Orth et al. 1986; Goldsborough and Kemp 1988; Kenworthy and Haunert 1991; Funderburk et al. 1991; Dennison et al. 1993; Stevenson et al. 1993; Durako 1994; Orth et al. 2006; Steward and Green 2007). Because the plants are rooted in anaerobic sediments, they need to produce a large amount of oxygen to aerate the roots, and therefore have the highest light requirements of all aquatic plants (including phytoplankton, macroalgae, floating leaf plants, etc.). Elevated nitrogen concentrations have also been shown to be toxic to eelgrass (Burkholder et al. 1992). Catastrophic losses of seagrass beds have been correlated with these water quality problems in other states in the past (Twilley et al. 1985; Orth et al. 1986; Durako 1994).

Nutrient enrichment and/or increased sediment loads impact light available to SAV leaves by:

- Reducing water clarity with suspended sediment or phytoplankton associated with algal blooms that absorb light rays prior to reaching SAV blades,

- Increasing epiphytic coverage, sedimentation, or covering by drift algae on the SAV blades (Virnstein and Morris 1996), and
- Diminishing dissolved oxygen concentrations as photosynthesis from SAV beds decrease, coupled with increasing concentrations of hydrogen sulfide resulting in toxicity (Dennison et al. 1993; Fonseca et al. 1998).

In addition to epiphytic growth, eutrophication of shallow estuaries can lead to the proliferation of extensive thick unattached mats of ephemeral macroalgae over and around SAV, often filamentous or sheet-like bloom forming green and brown algae (*Ulva, Cladophora, Chaetomorpha, Gracilaria, Ectocarpus*) (McGlathery 2001). Some of these macroalgal species are also epiphytes (Neckles et al. 1993). Studies have found that macroalgae biomass was directly related to increased nutrient levels (Neckles et al. 1993; Valiela et al. 1997) and that SAV loss (density and productivity) increased with increasing macroalgae abundance and height (Hauxwell et al. 2000). Where eelgrass loss occurred due to macroalgal cover, nitrogen loading rates were 30 kg/ha/yr in the urbanized watershed compared to 5 kg/ha/yr in the forested watershed. Once heavy macroalgal blooms die off, they decompose rapidly, increasing nutrient levels in the water column, which stimulates phytoplankton production and further light reductions. Low grazing pressure has also been shown to lead to increased epiphytic biomass on SAV, and may have a greater effect than nutrient enrichment (Neckles et al. 1993). Monitoring of the epiphytic and macrophytic algal community has been used as an indicator of SAV condition and anthropogenic impacts in some areas (Dunn et al. 2008). More research is needed on the effects of nuisance algae on bay scallops.

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.

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*. Modifications may be needed to regulations and 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. Research should be continued 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.

Water-Dependent Development

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. 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). Results from a NCDMF study (Connell and Murphey 2004) indicate that current dock designs over SAV beds in North Carolina result in a reduction in SAV coverage and density.

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. The potential for boating-related damage will increase as additional docks and marinas are constructed along the coast.

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. 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. CRC dock rules were modified in 2009 providing some additional protection for SAV by requiring applications for docking facilities over SAV in less than 2 feet of water (Mean Low Water) to be reviewed by the state resource agencies.

Bottom-Disturbing Fishing Gear

Bottom disturbing fishing gears have the potential to destroy or damage SAV (NCDMF 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 (MSC) 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 mobile 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.0102)]. Use of smaller hand rakes is allowed.

Mobile gear can be divided into gears that disturb the structure above the sediment and those designed to dig into the sediment. Long haul seines or bottom trawls can shear or cut 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.

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). Submerged aquatic vegetation 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).

Mechanical clam harvest (i.e. clam kicking, hydraulic clam dredging) can also severely impact seagrass beds since substrate is displaced (Guthrie and Lewis 1982). Peterson et al. (1987) found that propeller backwash utilized in 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, mechanical harvest is now restricted to non-vegetated sandy bottom, in waters ranging from 3 feet to 10 feet deep, in Core and Bogue sounds, and Newport, North, New, and White Oak rivers. The fishery is managed intensively, with strong enforcement to prevent mechanical harvest 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 mechanical clam harvest 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.

Researchers 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 time 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). Most damage observed by NCDMF 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, NCDMF, personal communication 2013). To minimize SAV impacts, NCDMF 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, NCDMF, personal communication 2013). Impacts of scallop harvest methods on SAVs are discussed further in section 12.1 Impacts of Treading on Submerged Aquatic Vegetation While Harvesting Bay Scallops issue paper.

Fishery restrictions already exist for most of the gears used in North Carolina that are potentially damaging to SAV. The boundaries of No Trawl Areas in Core Sound were modified in the Shrimp FMP (NCDMF 2006) to avoid most grass beds. As a result of an issue paper in the 2007 Bay Scallop FMP, grass beds in the west end of Bogue Sound near Archers Creek that were open to trawling are now closed by proclamation.

11.1.2 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" (Deaton et al. 2010). 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.

NCDMF'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 (NCDMF unpublished data). The three-dimensional hard structure functions similar to SAV by 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). Oyster habitat may be particularly important to scallops where SAV is absent.

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 (NCDMF 2008a). 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 scallops and other 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).

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 (NCDMF 2008a). 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 (NCDMF 2008a). 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 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 (NCDMF 2008a). Most shell bottom losses have been to subtidal beds in Pamlico Sound, where NCDMF 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 and MSX) (NCDMF 2008a).

Causes of shell bottom losses include harvest, dredging for navigation channels or marina basins, and 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.

11.1.3 WATER COLUMN

The life history section of the plan (Section 6.1) 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 11.1). 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 11.1 Water quality requirements of bay scallop egg and larvae (Pattilo et al. 1997).

Parameter	Optimum	Max/min threshold
Temperature (^{o}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) and can affect predation. Powers and Kittinger (2002) found that blue crab predation on juvenile hard clams and bay scallops decreased with increasing water velocity, while whelk predation on bay scallops increased under the same treatment. Dilution of water-borne chemical cues was likely the reason for reduced blue crab predation (Powers and Kittinger 2002).

The condition of the water column and activities that threaten it are discussed further in Section 11.2, Water Quality.

11.1.4 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 organisms 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 11.2) for more information on chemical contamination of bottom sediments.

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, long haul seines, swipe nets, or mechanical methods for clams or oysters in Primary Nursery Areas (PNA) [15A NCAC 03N .0104], and prohibition of trawls, pots, or mechanical shellfish gear in crab spawning sanctuaries [15A NCAC 03L .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, which are used more extensively (DeAlteris et al. 1999; Collie et al. 2000). Some researchers conclude that 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). Further, 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 minimal negative impacts (Van Dolah et al. 1991; Currie and Parry 1996; Cahoon et al. 2002).

11.1.5 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).

Land use changes associated with population growth have been and continue to be the primary anthropogenic cause of wetland habitat loss (Dahl 2000). 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 need to be enhanced. Additional initiatives should also be implemented to protect and enhance wetland habitat.

11.2 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. Use Support ratings for the White Oak River basin are summarized by categories, with aquatic life and shellfish harvest being the most biologically pertinent categories. In the shellfish harvesting use support category, monitored waters rated as impaired increased from 24% in 2001 to 32% in 2006 (DWQ 2001 and 2007). This information is determined by shellfish closures due to elevated levels of fecal coliform. Aquatic life use support category had 6% of saltwater acres impaired, but 75% of saltwater acres had no data (DWQ 2006). According to the NCCF White Oak Restoration Project Report, developed land in the lower White Oak River increased by 82% from 1990 to 2009 and 42% of that river's oyster and clam beds are permanently closed to shellfishing due to high bacteria levels (NCCF 2009).

The percent of impervious surfaces in a watershed is strongly correlated with fecal coliform abundance (Mallin et al. 2000). 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).

11.2.1 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 dissolved oxygen 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.

11.2.2 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.

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 from 1994 to 1997 to evaluate the 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 (EPA 2012). Information was collected from 2002 through 2006 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.

Endocrine Disrupting Chemicals

Toxins of more recent concern are endocrine disrupting chemicals (EDCs), which are hormonally active chemicals that alter growth, development, reproductive or metabolic processes, adversely affecting the organism, its progeny, and/or stock viability (Weis and Weis 1989; Wilbur and Pentony 1999; DeFur and Foersom 2000). Endocrine disrupting chemicals may include some, but not necessarily all industrial chemicals, pesticides, metals, flame retardants, plasticizers, disinfectants, prescription medications such as antibiotics and hormones, and some pharmaceuticals and personal care products. While the public may realize that pesticides and heavy metals from industrial and car emissions may be dangerous, it is less known that seemingly benign products such as caffeine, ibuprofen, antibacterial soap, and byproducts from plastic bottles and upholstery materials are entering coastal waters and may be adversely affecting the growth and reproduction of aquatic organisms. Some examples of the effects that have been documented as a result of exposure to these contaminants include: decreases in reproduction, altered sexual development, environmental antibiotic resistance to one or more antibiotics, and changes in population structure or localized extinction of some species. These chemicals are human generated and are very persistent in the environment. They may be active at very low levels (P. McClellan-Green/NCSU, personal communication, 2009). The majority of these chemicals are not removed with most types of tertiary wastewater treatment and enter waters through effluent discharges (Giorgino et al. 2007). They can also enter surface waters through urban and agriculture runoff.

While varying effects of EDCs on fish and crustaceans have been shown, including reproductive abnormalities, altered sex ratios, intersex individuals, and inhibited growth, discussion here will be limited to effects on mollusks (Table 11.2). Decreased reproduction, increased vitellogenesis, and sperm abnormalities have been documented in oysters, clams, and scallops exposed to human hormones or hormone-like substances (Gagne et al. 2002; Matozzo and Marin 2005; Wang and Croll 2006; Canesi et al. 2008). Exposure to insecticides via agricultural runoff also decreased reproduction and filtration, and caused gonad atrophy and abnormal larval development in oysters, snails, clams and scallops (Wessel et al. 2007; Anguiano-Vega et al. 2007). Exposure to organics and metals had the same consequences (Curiewx-Belfond 2001; Chu et al. 2003; Smaoui-Damak et al. 2006; Choy et al. 2007; Wintermyer and Copper 2007). In other studies on the effects from mixed contaminants associated with marina harbor pollutants and sewage effluent observed altered sex ratios, impaired immune function, delayed growth and development, and decreased reproduction in mussels (Gagne et al. 2002; Gagne et al. 2007).

Table 11.2 Endocrine disrupting chemicals by class, sources, concentrations and effects on mollusks.

Class	Source	Conc.'s	Effects	Compounds	References
Human hormones and hormone-like substances (incl. pharmaceuticals)	Birth control, anti-depressants	As low as 0.05 ppb	Decreased reproduction, increased vitellogenisis, sperm abnormalities	17b-Estradiol 17a-Ethynylestradiol 4-Nonylphenol Testosterone Fluoxetine (Prozac)	Gagne et al. 2002; Matozzo and Marin 2008; Wang and Croll 2006; Canesi et al. 2008
Insecticides, nematocides and fungicides (non-hormonal)	agricultural runoff	As low as 0.5 ppb	Reduced filtration, gonad atrophy, decreased reproduction, abnormal larval development	Lindane Endosulfan PCB, Araclor	Wessel et al. 2007; Anguiano-Vega et al. 2007
Organics and metals		As low as 0.1 ppb	Delay sexual maturity, decreased reproduction and growth, abnormal development, gonad atrophy	Benzopryene, Organotins, Tributyltin, Cadmium, PCB mixture	Curiewx-Belfond 2001; Chu et al. 2003; Smaoui-Damak et al. 2006; Choy et al. 2007, Wintermyer and Cooper 2007
Mixed contaminants	marina harbor contaminants, sewage effluent		Decreased gonadal activity, altered sex ratio, decreased serotonin, increased vitelloginein-like protein	Metals, organics, organitins, sewage effluent	Gagne et al. 2002; Gagne et al. 2007

The prevalence and effects of endocrine disrupting chemicals in North Carolina is largely unknown. In North Carolina, the United States Geological Survey (USGS) conducted a limited amount of monitoring for endocrine disrupting chemicals in freshwater reaches of the Tar, Neuse, and Cape Fear river basins (Giorgino et al. 2007; M. United USGS, personal communication, 2009). Prescription drugs (antibiotics and other medications), non-prescription drugs, flame retardants, plasticizers, fragrances, pesticides, detergent metabolites, antimicrobial agents, and other suspected endocrine disruptors were detected. In the areas sampled in North Carolina, pharmaceuticals, followed by flame retardants and plasticizers were the most frequently detected wastewater compounds. While some of the sites were downstream of wastewater discharges, others were in areas receiving runoff from agriculture and urban development as well.

Typical municipal wastewater treatment processes are not capable of removing hormones, antibiotics, and other EDCs, making sewage effluent a major source. The current recommended federal policy for disposal of unused drugs is to flush medicines down the toilet or mix with cat litter and take to a landfill. To prevent these drugs from entering surface waters via wastewater treatment plant discharges, efforts have been made in recent years to hold drug take back events, where medicines can be collected and properly disposed. Permanent drop-off locations are needed to increase public participation in drug take back events and keep these chemicals out of surface waters.

One technique used locally to enhance scallop hand-harvest is to add dish detergent to the water to smooth the water surface and aid in visually locating scallops. Detergents contain anionic surfactants which may act as EDCs, and may contain antimicrobial components, which are known EDCs. The Material Safety Data Sheet for DAWN™ reads that "All surfactants are readily biodegradable." The DWQ Aquatic Toxicology Unit explains that this indicates that the substance is not considered harmful to aquatic organisms or known to cause long-term adverse effects in the environment at relevant environmental concentrations. They explain that most toxic of surfactants were also the most rapidly biodegraded into considerably less toxic products and do not accumulate in the environment. Alaska Department of Environmental Conservation

recommends the use of DAWN™ at a 0.1% by volume concentration as a surfactant in oil spills because it is not toxic to soil microbes and is commonly used for cleaning oiled wildlife due to its effectiveness and low toxicity. To avoid potential impacts from detergents, the Division of Water Quality should determine whether detergents are pollutants and regulate their use in coastal fishing waters.

11.3 HABITAT AND WATER QUALITY PROTECTION

11.3.1 MARINE FISHERIES COMMISSION AUTHORITY

Presently, the MFC has authority for the following actions with regard to marine and estuarine resources: manage, restore, develop, cultivate, conserve, protect, and regulate. Marine and estuarine resources are "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 the MFC's primary responsibilities are management of fisheries (season, size, and bag limits, licensing, etc.), the MFC has the 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 use of artificial reefs. Authority for the MFC is found at G.S. 143B-289.51 and 52.

In an effort to protect SAV and other habitats from bottom-disturbing fishing gears, the MFC prohibits the use of rakes and dredges of a specific weight and type in internal coastal waters (MFC 2009; 15A NCAC 03J .0303, 03K .0102, and 03K .0503), dredges/mechanical methods to take shellfish and crabs in certain areas (15A NCAC 03K .0204, 03R .0108, 03L .0203, and 03R .0109), and trawl nets in certain areas [15A NCAC 03J .0104 (b) (4) and 03R .0106]. Harvest methods for hard clams have been established in beds of submerged aquatic vegetation (15A NCAC 03K .0304), and the Fisheries Director has been granted proclamation authority to specify means and methods for mechanical harvest of shellfish by season and area (15A NCAC 03K .0302 and 03K .0501).

The MFC has also provided habitat and fishery resource protection by prohibiting the use of various commercial gears in Primary Nursery Areas (PNAs) [15A NCAC 03N .0104 and 03R .0103], and prohibiting the use of trawl nets in Secondary Nursery Areas (15A NCAC 03N .0105 (a) and 03R .0104). The MFC also has rules specific to the protection of oyster habitat and oyster management areas. Oyster dredges may weigh no more than 100 pounds, with only one oyster dredge per vessel (15A NCAC 03J .0303). Oyster beds planted and posted by the state are protected from bottom disturbing gear (15A NCAC 03K .0203). Certain areas of internal coastal waters are closed to mechanical harvest of oysters (15A NCAC 03K .0204 and 03R .0108).

Crab spawning sanctuaries (15A NCAC 03L .0205) located at Oregon Inlet, Hatteras Inlet, Ocracoke Inlet, Drum Inlet and Bardens Inlet (15A NCAC 03R .0110) may have extensive seagrass beds. Use of trawls, pots, and mechanical methods for oysters or clams in these areas from March to August is prohibited.

11.3.2 AUTHORITY FROM OTHER AGENCIES

The North Carolina Department of Environment and Natural Resources has several divisions responsible for providing technical and financial assistance, planning, permitting, certification, monitoring, and regulatory activities, which impact the coastal water quality or habitat. Wetland and stream development activity throughout North Carolina is permitted through the US Army Corps of Engineers (USACE) and DWQ (DWQ; 401-certification program). The North Carolina Division of Coastal Management (DCM) is responsible for development permits along the estuarine shoreline in 20 coastal counties.

The DWQ has established a water quality classification and standards program for "best usage" to promote protection of unique and special pristine waters with outstanding resource values. The High Quality Waters (HQW), Outstanding Resource Waters (ORW), Nutrient Sensitive Waters (NSW), and Water Supply (WS) classifications have outlined management strategies to control point and nonpoint source pollution.

Various federal and state environmental and resource agencies, including NCDMF, evaluate projects proposed for permitting and provide comments and recommendations to the DCM, DWQ, and USACE on potential habitat and resource impacts. Habitat protection relies on enforcement, the efforts of commenting agencies to evaluate impacts, and the incorporation of recommendations into permitting decisions. Habitats are also protected through the acquisition and management of natural areas such as parks, refuges, reserves, or protected lands by public agencies and/or private groups.

11.3.3 COASTAL HABITAT PROTECTION PLANS

The Fisheries Reform Act of 1997 mandated the DENR to prepare a Coastal Habitat Protection Plan (G. S. 143B-279.8). The legislative goal for the CHPP is long-term enhancement of the coastal fisheries associated with coastal habitats and provides a framework for management actions to protect and restore habitats critical to North Carolina's coastal fishery resources. There are three commissions that have regulatory jurisdiction over the coastal resources, water, and marine fishery resources including: MFC, Coastal Resources Commission (CRC), and the EMC. The first CHPP was completed in December 2004 and implementation plans for each division and the department was approved in July 2005. The first update to the plan was completed in 2010. 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 helps to ensure consistent actions among these three commissions as well as their supporting DENR agencies.

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 in the CHPP 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" (Deaton et al. 2010). 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 "Strategic Habitat Areas" (SHAs). SHAs 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. The process of identifying and designating SHAs began in 2005. The SHA identification process for Region 1-Albemarle Sound and Northeast Coastal Ocean was completed in early 2009 and Region 2-Pamlico Sound and Central Coastal Ocean was completed in 2012. SHA identification for Region3-White Oak River Basin and South-Central Coastal Ocean began in 2012.

The CHPP focuses on the fish habitat and threats to the habitat. This FMP describes habitat conditions or needs for the various life stages of the bay scallop. The FRA gives precedent to the CHPP and stipulates habitat and water quality considerations in the FMP be consistent with CHPP. Any recommendations will be considered and acted upon through the CHPP implementation process.

11.3.4 STATUS OF 2007 HABITAT RECOMMENDATIONS

Since the 2007 bay scallop fishery management plan, habitat and water quality conditions appear to be the same or in some cases, somewhat better. The area of submerged aquatic vegetation coverage appears to be expanding in estuaries south of New River and in the lower salinity estuaries of the Neuse and Tar-Pamlico. The latter increase could be related to nutrient reduction efforts in those river basins, but may also be a result of several years of drought. Wetland acreage continues to decline from permitted losses and natural erosion associated with storms and rising sea level. Efforts have increased to restore more subtidal oyster beds in Pamlico Sound through NCDMF's oyster sanctuary program and partnerships with non-profit organizations. Water quality degradation, in terms of aquatic life use support impairment, is greatest in freshwater streams in the Neuse and Cape Fear River basins and in estuarine creeks in the Neuse River basin.

In reviewing the past bay scallop habitat and water quality management recommendations, many have been implemented or are substantially underway. Many of these were also components of the CHPP implementation plan. They include:

Habitat

1. Coast-wide imagery of SAV was taken in 2007/2008 and the NCDMF SAV mosaic was updated using the 2011 Albemarle-Pamlico National Estuary Partnership SAV mapping that displayed the results of this effort (Figure 10.2).
2. Identification and designation of strategic SAV areas is underway through the SHA process.
3. Dredging of PNA, SAV and shellfish habitat is avoided through NCDMF's permit review process.
4. CRC has revised dock rules to require review by resource agencies for General Permit dock applications located over SAV, shell bottom, or PNAs, and where water depth is less than 2 feet at Mean Low Water, to avoid boating related impacts.
5. Additional bottom disturbing gear restrictions have been implemented through the bay scallop, shrimp, and oyster fishery management plans to avoid damage to SAV and oysters.
6. Additional funding has supported expansion of oyster sanctuaries, development of a shell recycling program to supplement cultch planting, and acceleration of shell bottom

mapping.

Water Quality

1. NCDMF staff continues to work with the permitting and commenting agencies to enhance protection of water quality. The MFC utilizes its permit commenting authority outlined in G.S. 143B-289.52 as needed.
2. Neuse and Tar-Pamlico NSW nutrient reduction measures have successfully reduced nutrient loading by more than their 30% reduction goals for point source dischargers and agriculture.
3. DWQ revised coastal stormwater rules that limit impervious surface and run-off in coastal areas.
4. Loss of additional riparian wetlands has been minimized through the permitting process, land acquisition, and land use planning.

11.4 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 managing bay scallop stocks. Below are the 2010 CHPP management recommendations and research needs that could be beneficial to protecting and improving habitat and water quality utilized by bay scallops.

Habitat

1. Identify and designate SHAs that will enhance protection of the bay scallop.
2. Remap and monitor SAV coverage in North Carolina to assess distribution and change over time.
3. Restore coastal wetlands to compensate for previous losses and enhance water quality conditions for the bay scallop.
4. Work with CRC to revise shoreline stabilization rules to adequately protect riparian wetlands and shallow water habitat and significantly reduce the rate of shoreline hardening.
5. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV and other fish habitats.
6. Evaluate dock criteria siting and construction to determine if existing requirements are adequate for SAV survival and growth, and modify if necessary.
7. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.
8. Shallow areas where trawling is currently allowed should be re-examined to determine if additional restrictions are necessary.
9. Accelerate and complete mapping of all shell bottom in coastal North Carolina.

Water Quality

1. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.
2. Reduce impervious surfaces and increase on-site infiltration of stormwater through voluntary or regulatory measures.
3. Provide more incentives for low-impact development.
4. 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.

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. Provide proper disposal of unwanted drugs, reduce insecticide and heavy metal run-off, and develop technologies to treat wastewater for antibiotics and hormones.
7. Discourage use of detergents in coastal waters, especially detergents with antimicrobial components.

11.5 RESEARCH NEEDS

1. Determine the spatial and biological characteristics of SAV beds that maximize their ecological value to the bay scallop for enhancement or conservation purposes.
2. Develop techniques to enhance SAV habitat to promote scallop survival.
3. Conduct research to evaluate the role of shell hash and shell bottom in bay scallop recruitment and survival, particularly where SAV is absent.
4. Determine the concentrations of EDCs in known bay scallop habitats and impacts on bay scallops.
5. Assess the impacts of nutrient loading and algae on SAV and the life history of bay scallops.
6. Determine levels of TSS, turbidity, chlorophyll a, and other parameters necessary to achieve the desired water clarity and investigate the feasibility of a water quality standard for light attenuation required for SAV growth.

12.0 PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

12.1 IMPACTS OF TREADING ON SUBMERGED AQUATIC VEGETATION WHILE HARVESTING BAY SCALLOPS[1]

February 21, 2014

I. ISSUE

There are concerns regarding the impacts of walking or treading on submerged aquatic vegetation (SAV) while harvesting bay scallops and that it may be more detrimental to SAVs than scallop dredging.

II. ORIGINATION

This issue was brought forward by commercial fishermen to NCDMF staff and the director in 2010.

III. BACKGROUND

During the development of Amendment 1 of the Bay Scallop FMP, one of the concerns brought forward by commercial fishermen is the suggestion that hand harvest is more harmful to SAVs and to small scallops than dredges. The logic is that fishermen need to walk or tread around for many hours over SAVs to get their limit while dredging takes a shorter amount of time to harvest the limit. They also commented that rakes dig into the SAV more than the dredge and that the bottom should be worked regularly to stay alive. They also contended that prop scarring by boats pulling these dredges does not occur. It should be noted that rakes can be no wider than 12 inches or weigh no more than six pounds in established beds of SAV to reduce uprooting of seagrasses (15A NCAC 03K .0102).

[1] Presented to: PDT 1/3/13 and 5/28/13; AC 2/4/13, 8/12/13,and 1/21/14; MRT 8/19/13 and 1/27/14.

During this same time, University of North Carolina's Institute of Marine Sciences staff stated that although SAVs dislodged because of dredging activity did not appear to be a significant problem it was critical that a study be conducted to compare the effects of hand harvest to dredging. The MFC Habitat and Water Quality Advisory Committee also made a recommendation to begin research on impacts of scalloping activities on bay scallop habitat.

One additional concern that has been voiced over time while hand harvesting bay scallops is fishermen's exposure to cold water conditions while wading during winter and their health and safety while fishing with scoops or rakes.

The scallop dredge may be used to harvest bay scallops from SAV beds and consists of a wire or nylon bag attached to a metal frame. The scallop dredge has a toothless bar at the mouth and must not weigh more than 50 lb. This dredge is designed to ride along the surface of the bottom and scoop up bay scallops (West et al. 1994; Deaton et al. 2010).

In a study to assess the impacts of clam raking and mechanical harvest of clams in SAV 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 mechanical clam harvest (a practice of dislodging clams from the bottom using a boat's propeller wash and catching them in a heavily chained trawl, pulled behind a boat) and clam raking had significant negative effects on the bay scallop fishery from 1961 to 1976. However, they found 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) described 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 less compact sediment with higher silt/clay content. They concluded that intense scallop dredging has the potential for immediate and long-term reduction of eelgrass beds, especially in soft bottom. They infer that because the early portion of scallop season occurs while most early stage juveniles from the previous fall spawning are attached to seagrass blades that are removed or displaced by dredging, fewer adults are available to the fishery the following year.

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 during the winter of 2001-2002. 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 downstream of the collection site. They found that hand harvest yielded six times the harvest per unit of time compared to the dredge. In addition, 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 while dredging caused significant displacement to seagrass. However, there were no significant differences in biomass between the dredged plots and the undisturbed plots, one month later. Unexpectedly, results showed 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 in large scale areas, 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 and has been identified nationally as a major source of SAV loss. It is believed that damage associated with propeller scarring surpasses damage from shellfish dredges (Thayer et al. 1984). Propeller or "prop" scarring occurs when outboard vessels travel through very shallow water so that the boat prop cuts leaves, roots, and stems as well as creates a narrow trench through the sediment (Deaton et al. 2010). Propeller scarring has severely damaged seagrass beds in Florida and is an increasing problem in Chesapeake Bay. In both areas, increasing occurrence of propeller scarring is 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 propeller scarring is not currently a significant problem in North Carolina. However, as human populations along the coast increase, it is also expected that the number of boats will increase (Deaton et al. 2010).

Present management of the bay scallop fishery has always assumed that hand harvest is a more sustainable prosecution of the fishery in North Carolina for both the SAV habitat and the bay scallop population. However, there may be indirect impacts of using a scoop or rake while physically treading intensively over SAVs. Physical damage to seagrass such as shoot loss and burial as well as crushing and burial of juvenile scallops needs to be considered in the management of bay scallops.

IV. AUTHORITY

North Carolina General Statutes

113-134	Rules
113-182	Regulations of fishing and fisheries
113-201	Legislative findings and declaration of policy; authority of Marine Fisheries Commission
143B-289.52	Marine Fisheries Commission – powers and duties

N.C. Marine Fisheries Commission Rules 2013 (15A NCAC)

03K .0102	Prohibited Rakes
03K .0501(b)(3)	Bay Scallops-Seasons and Harvest Limits
03K .0503	Prohibited Bay Scallop Dredge

V. DISCUSSION

A research recommendation made in Amendment 1 of the Bay Scallop FMP was to conduct research on the impacts of scalloping activities on bay scallop habitat. In 2010, the NCDMF put

together a small proof of concept study to evaluate treading on seagrass. This proof of concept is to provide information to verify the potential need of further study of treading on SAV only and therefore the results of this study are limited. NCDMF staff set up this small study within the area of The Straits near Harkers Island, North Carolina. This study area is a historically sampled site by the National Marine Fisheries Service Beaufort Lab and has been characterized in earlier studies to have high silt/clay sediment content. Four, one-meter square quadrats were established within this site. Each plot was assigned as a one-time event, a different level of foot tread time to simulate treading activity in seagrass beds at varying time periods (0 minutes [control], 5 minutes, 10 minutes, and 15 minutes). Before treading occurred, a 10-cm diameter core sample of the bottom was taken outside but adjacent to each quadrat, so that each quadrat was unaltered before treading was initiated. From each core, total shoot number and 10 arbitrarily selected shoots were measured for length (mm) at the height of the tallest blade. Core sampling was repeated within each quadrat, two weeks later on February 23 and again on March 9, 2011 and shoot number and length were recorded.

A two-way ANOVA was used to examine shoot height of the seagrass blades with SAS PROC GLM. Tread time (0, 5, 10, and 15 minutes) and date (Feb. 9, Feb. 23, and March 9) were the two treatment variables. Total shoot count from the bottom core samples were examined for trends over time between the different tread times.

No trends were apparent given the variability of the data. Sample sizes ranged from four to 10 for each treatment combination (Table 12.1). Means are given in Table 12.2 and summarized graphically in Figure 12.1.

Table 12.1 Shoot height sample size for each date and tread level combination.

Date/Tread time	0 min	5 min	10 min	15 min
9-Feb-11	10	10	10	10
23-Feb-11	10	4	10	10
9-Mar-11	10	10	4	8

Table 12.2 Mean shoot height (mm) for each date and tread level combination.

Date/Tread time	0 min	5 min	10 min	15 min
9-Feb-11	82.8	44.8	52.5	58.8
23-Feb-11	71.1	76.5	52.0	69.6
9-Mar-11	72.5	77.8	62.3	74.4

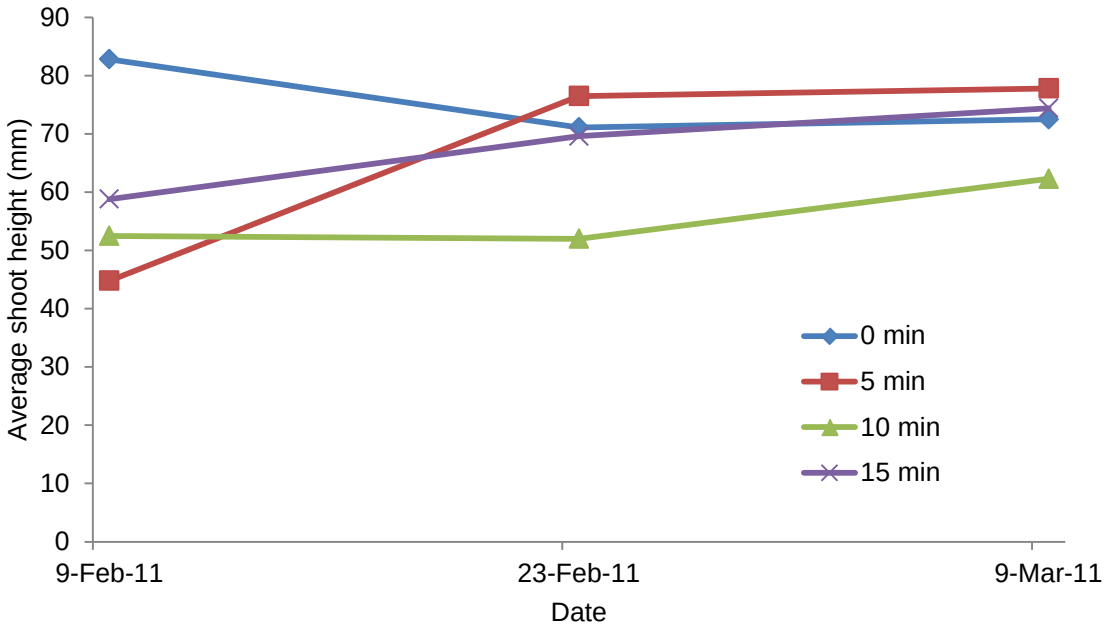


Figure 12.1 A summary comparison of average shoot height over time for each tread time.

Examining the data further using a two-way ANOVA revealed that there was no significant difference in shoot height between dates or between tread times nor was there any interaction between date and tread times (F = 1.47; df = 11, 94; P = 0.1572, Figure 12.1). Overall, the analysis indicated that treading over seagrass from zero to 15 minutes had no impact on shoot height over time.

Bottom core samples of shoot counts show no trend over time for tread levels of 10 minutes or less (Figure 12.2; Table 12.3). There is some evidence that tread levels of 15 minutes might have resulted in a decrease in shoot count. However, given the low sample size, more data are required to say that this trend was not due to random chance.

Table 12.3 Total shoot count from bottom core samples for each date and tread level combination.

Date/Tread time	0 min	5 min	10 min	15 min
9-Feb-11	22	19	12	23
23-Feb-11	17	4	17	12
9-Mar-11	30	16	4	8

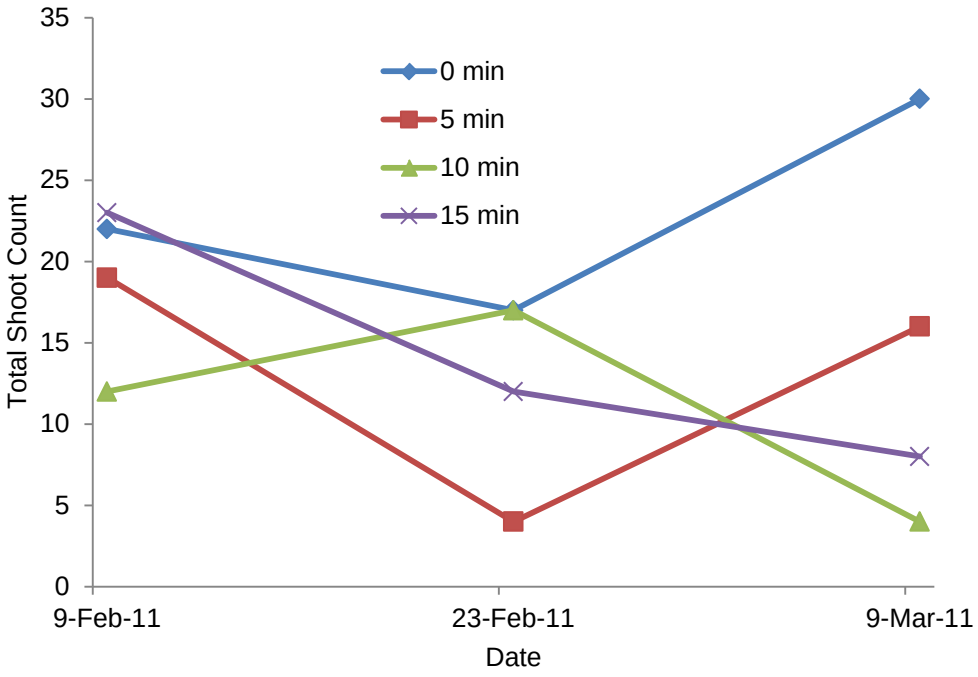


Figure 12.2 Trends in total shoot count for different tread levels over time.

In general if fishing disturbances are large scale, juvenile scallops may be at risk, causing a decrease in adult abundances the following year. These fishing disturbances can result in impacts to SAVs thus impacting bay scallop populations. Mechanical clam harvest and clam raking removes SAVs. Bay scallop dredging reduces shoot counts and SAV biomass, especially in soft bottom. Other studies indicate that although bay scallop dredging causes significant displacement of SAV in the short-term there is no difference between the dredging and hand harvest after one month (Bishop et al. 2005). Dredging also results in some removal of juvenile bay scallops while hand harvest does not. But harvesting by hand appears to be more efficient than dredging, an opinion that has been voiced to NCDMF staff by bay scallop fishermen in the past. Based on the results of the proof of concept study on treading, additional testing is required to address impacts of treading.

Both hand harvest and dredging are methods used to harvest bay scallops in North Carolina. The NCDMF Fisheries Director has proclamation authority to set harvesting means and methods for scallop harvest. Dredging is allowed at the highest densities of scallops and only later in the season after hand harvest of scallops has occurred. Harvest will open on a high tide so that propeller scarring is minimized in the shallow areas at the very beginning of dredging season.

VI. PROPOSED RULE(S)

No rule changes are proposed.

VII. PROPOSED MANAGEMENT OPTIONS

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

1. *Status quo* (manage fishing gear based on scallop densities)
   + Allows flexibility of harvest gears based on population levels
   - Potential impacts from dredging to bay scallop juvenile and adult populations
   - Potential adverse impacts to SAV from dredging and treading

2. Allow dredging only
   + Allows fishermen to stay dry during cold weather
   - Potential loss of SAVs by decreasing biomass and displacement of shoots
   - Potential damage to SAVs by propeller scarring
   - Potential loss of juvenile bay scallops because of dredge disturbance
   - Potential loss of juvenile bay scallops because of shoot displacement
   - Disadvantages users of other gears

3. Allow hand harvest only
   + More efficient method of harvest
   + No impact to juvenile scallops
   - Unclear impact to SAV
   - Fishermen are exposed to cold water because of wading
   - Disadvantage users of other gears

4. Allow no harvest of bay scallops to protect SAV
   + Reduces impacts to SAV from bay scallop harvest
   + Reduces loss of juvenile scallops
   - No allowance for harvest
   - No economic benefit to the communities

VIII. RECOMMENDATION

MFC Selected Management Strategy
- *Status quo* (manage fishing gear based on scallop densities)

AC - Allow existing bay scallop harvest methods subject to population estimates, habitat conditions, perceived harvest impacts and regional considerations.

NCDMF - *Status quo* (manage fishing gear based on scallop densities)

IX. RESEARCH RECOMMENDATION

- Complete a more comprehensive study on treading and impacts of treading on juvenile and adult bay scallops.

X. LITERATURE CITED

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Prepared by Trish Murphey, trish.murphey@ncdenr.gov, 252-808-8091
Date: December 18, 2012
Date, Revised: February 13, 2013 AC recommendations
Date, Revised Again: June 24, 2013 Modified the research recommendations based from AC input
Date, Revised Again: August 20, 2013 NCDMF recommendation
Date, Revised Again: February 21, 2014 MFC preferred management strategy

12.2 BAY SCALLOP HARVEST MANAGEMENT[2]

February 21, 2014

I. ISSUE

Consider specific triggers to determine an open season in areas south of Bogue Sound and review current harvest measures in place for all areas.

II. ORIGINATION

Recommendation in Amendment 1 of the Bay Scallop FMP and the bay scallop advisory committee.

[2] Presented to: PDT 2/26/13 and 5/28/13; RAT Subgroup 3/22/13; RAT 4/4/13 and 5/2/13; AC 4/15/13, 8/12/13, and 1/21/14; MRT 8/19/13 and 1/27/14.

III. BACKGROUND

Low landings of bay scallops in the past twenty years are likely the result of several environmental disturbances. The first, and only, red tide in North Carolina's recorded history persisted from October 1987 to February 1988. The red tide resulted in the closure of 1,480 km^2 of North Carolina waters to shellfish harvesting (Tester and Fowler 1990). 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 killed both adult and newly recruited bay scallops resulting in 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 further reduction in harvest occurred following the 1999 and 2003 hurricane season. In 1999 tropical storm Dennis saturated the ground and weeks later Hurricane Floyd caused massive flooding, which exceeded the 500 year flood levels in eastern North Carolina. During the 2003 hurricane season Hurricane Isabel made landfall near the northern portion of Core Sound. Following these events, landings were reduced to extremely low levels. There are only two data sources available for estimating annual bay scallop abundance, commercial landings and a fishery independent sampling program. .

Very little data exists on recreational bay scallop harvest. A 1991 phone survey conducted by the Marine Recreational Fisheries Statistics Survey (MRFSS) indicated that 3% of households in coastal North Carolina participated in recreational shellfishing (D. Mumford, NCDMF, personal communication). Recreational data are being collected by MRFSS for finfish, but the survey does not currently collect shellfish data. This lack of recreational shellfish harvest data makes it extremely difficult to address potential management issues such as harvest limits, size limits, and gear restrictions on shellfish in the recreational fishery. The need for recreational harvest data eventually prompted the introduction of House Bill 1427 before the general assembly in 2004 to establish a recreational shellfish license. This license would apply to the harvest of shellfish only and would have been instituted on a trial basis for three years but the bill was never passed. Later in 2004, House Bill 831 approved a saltwater fishing license that mandated those individuals recreationally fishing for both finfish and shellfish must obtain a license. However, the state legislature revisited the issue in 2005 and replaced the saltwater fishing license with the CRFL. The CRFL, which was implemented on January 1, 2007, was only required when targeting finfish, thereby eliminating the creation of a sampling universe to be used to estimate shellfish harvest. As a result, NCDMF developed a small optional survey to obtain additional information on shellfish harvest from CRFL license holders at the point of license sale. The optional survey would ask whether the CRFL holder actively harvests crabs, oysters, clams, or scallops; and would identify a pool of individuals to survey at a later date with more specific questions regarding their harvest of shellfish. Unfortunately, this survey would neglect any individuals who fish exclusively for shellfish and would therefore not purchase a CRFL. 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 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. The 2007 Bay Scallop FMP and both the 2008 oyster and hard clam FMP amendments support the adoption of a mechanism that would provide data on recreational shellfish harvest (NCDMF 2007; NCDMF 2008a; NCDMF 2008b).

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.

Commercial landings data are the only fishery dependent data collected and recorded since the 1880s. Trip level information for commercial landings has been collected since 1994. There are no recreational harvest estimates available. Landings data 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). The 1972 to 2004 landings data provides the longest interval with an appropriate amount of high and low annual fluctuations to establish average landings estimates (Figure 12.3).

It is most appropriate to separate landings into the major water bodies because of fluctuations over time. Bogue Sound was the dominant area for bay scallop landings from 1972 to 1981 and accounted for 53% of the total landings (Figure 11.3; Note scaling differences between the landings axis on each graph). From 1982 to 1993, Core Sound became the dominant area 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. Average landings are shown across the entire time series (1972-2004), before the red tide event (1972-1986), and from the most recent time period which coincides with a fishery independent sampling program (1998-2004). These average landings estimates puts into perspective the fluctuations in annual landings over time and that the bay scallop stock has not been able to attain annual landings comparable to levels before the red tide in 1987-1988.

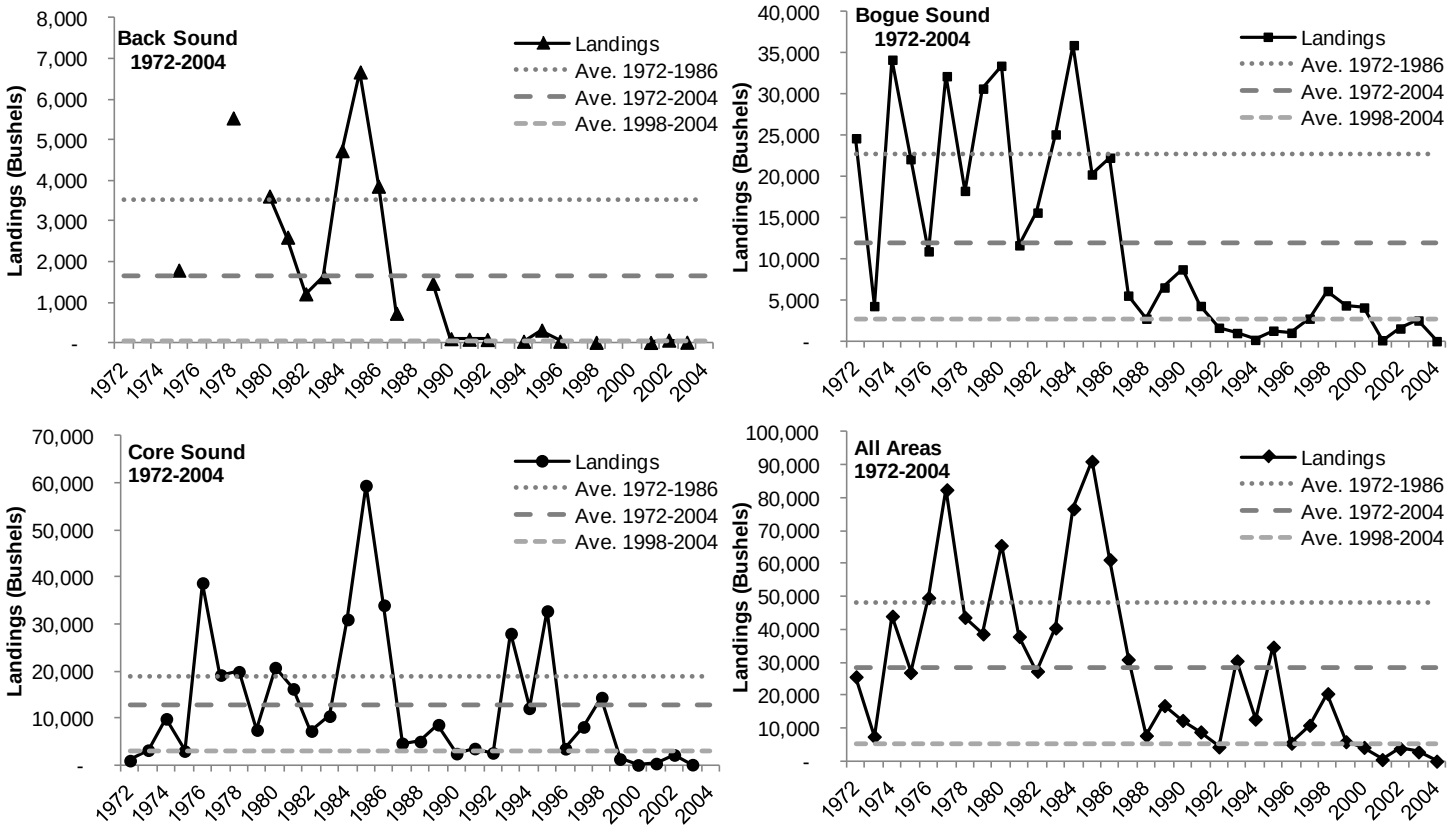

Figure 12.3 Bay scallop landings (bushels) for Back, Bogue, and Core sounds and all three areas combined showing average landings for three different time period: 1972-1986 (pre-red tide event), 1972- 2004, and 1998-2004. Please note scaling difference between the landings axis in each graph.

Intervention analysis, a form of time series analysis, is another method that expands on the average bay scallop landings over time and looks at changes that occurred after specific events compared to a typical mean derived from the analysis. Years are considered typical if they did not exhibit a significant deviation from the overall mean of a time series. The long-term average of statewide landings during typical years was 29,732 bushels (Figure 12.4). Landings of scallops from 1963 to 1969, shows 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 1987-1988 to 61% below the typical average. Further reductions in harvest were also seen following the 1999 hurricane season dropping the average landings to 93% below the typical average. Even further reductions occurred as of 2004 most likely due to Hurricane Isabel in September 2003, 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 the bay scallop populations, but that these events are *coincident* with significant changes in the bay scallop commercial landings time series.

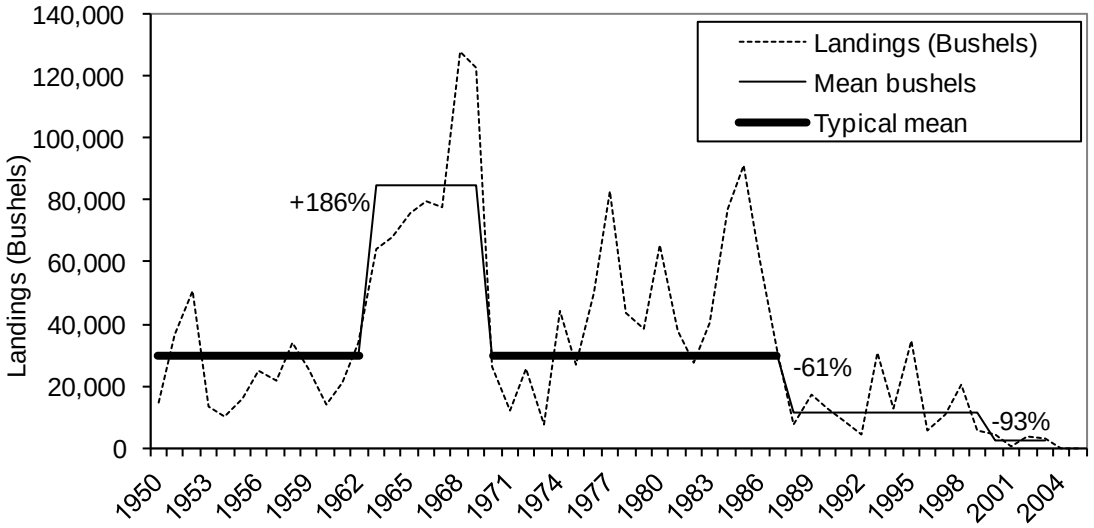

Figure 12.4 Overall statewide landings of bay scallops from 1950 to 2005 showing significant deviations from the "typical" mean of 29,732 bushels. NCDMF Trip Ticket Program.

Fishery independent sampling using a bay scallop dredge in the main harvest areas showed that most tows have small or zero catch, while only a few tows exhibit large catches producing a lognormal distribution, which is usual for most fishery catch data. The natural log (ln) of the catch per unit effort (lnCPUE), measured as the number of scallops per minute, is taken to avoid bias towards occasional large catches. A constant of 0.1 was added to all catches so that tows with zero catches can be included in the estimates of the mean since the natural log of zero is undefined. All tows during a trip are averaged to get a single value for each station and are referred to as a sample. This is done to avoid weighting some tows to each station more than others because the number of tows was not always consistent in duration. Each sample is averaged to get the estimated mean lnCPUE and standard deviation for each quarter (3-month period) in each area, annually in each area, and annually for all areas combined to produce candidates for indices of abundance.

A Pearson correlation analysis was conducted to determine the strength of the relationship between annual landings within the three main harvest areas and the index of abundance four times a year (Jan-Mar, Apr-Jun, Jul-Sep, and Oct-Dec) from the fishery independent sampling program using SAS version 9.1. Landings were lagged by one year since the sampling program collects the data prior to the fishery in January. For example, samples collected in 1984 should reflect of the landings in 1985. A positive correlation indicates that if one variable increases the other variable tends to increase (Cody and Smith 1997). A small or zero correlation coefficient indicates the two variables are not strongly related. A negative correlation indicates as one variable goes up the other variable goes down. All the correlations showed significance at alpha level of 0.1 (if the p-value is less than or equal to 0.1, this indicates a correlation) (Table 12.4). The strongest correlation of landings to the independent abundance indices occurred during the October-December sampling period for each area (Table 12.4). This time period for estimating abundance makes the most sense since it is less likely for the two year-classes to be selecting to the sampling gear.

Table 12.4 A Pearson correlation analysis to indicate the strength of the relationship between the NCDMF bay scallop independent sampling program to landings by waterbody and quarterly periods in the year.

		Landings			
Area	Quarter	r	r^2	p-value	n
Back					
	Jan-Mar	0.28757	0.0827	0.4898	8
	Apr-Jun	0.15551	0.02418	0.7686	6
	Jul-Sep	0.17605	0.03099	0.6046	11
	Oct-Dec	0.62497	0.39059	0.0719	9
	All months	0.31437	0.09883	0.3197	12
Bogue					
	Jan-Mar	0.53991	0.2915	0.1672	8
	Apr-Jun	0.09580	0.00918	0.8567	6
	Jul-Sep	0.29551	0.08733	0.3776	11
	Oct-Dec	0.62110	0.38577	0.0553	10
	All months	0.58608	0.34349	0.0452	12
Core					
	Jan-Mar	0.55939	0.31292	0.1494	8
	Apr-Jun	-0.29280	0.08573	0.5733	6
	Jul-Sep	0.27200	0.07398	0.4471	10
	Oct-Dec	0.58214	0.33889	0.1000	9
	All months	0.38624	0.14918	0.2149	12
All areas	All months	0.51082	0.26094	0.0897	12

The standardized scallop population level indicator was selected as a target for reopening the harvest season by the MFC in January 2009. This target was based on NCDMF sampling that occurred between the months of October and December in 1984 and 1985 for Back, Bogue, and Core sounds. NCDMF sampling collects bay scallops using a scallop dredge at select fixed stations in Core, Bogue, and Back sounds. One station equals a sample with multiple tows occurring at each station. Most tows have small or zero catch and only a few tows exhibit large catches, which is usual for most independent surveys. A constant of 0.1 was added to all tows including those with zero catch since the natural log of zero is undefined. An index of bay scallop abundance per minute was then calculated for each individual tow since there was varying tow times in the time series. The natural log (ln) was applied to the number of scallop per minute at the tow level and averaged to produce a standardized catch per unit effort (lnCPUE) to each sample, making each station comparable. This standardized CPUE also reduces bias in samples with different number of tows, varying tow times, and smoothes the data to reduce overestimating the average caused by only a few samples with large amounts of scallops in the catch. If the data were analyzed at the sample level and not at the tow level first the average could be overestimated or underestimated by tows with very large or no scallops in the catch.

Amendment 1 to the Bay Scallop FMP produced progressive harvest triggers based on varying scallop abundance levels in the previously set fishery independent sampling targets for Back, Bogue, and Core sounds (Figure 12.5). It also provided new indices for re-opening harvest in

other areas of the state (NCDMF 2010). Separation of the indices into the different regions is necessary due to the nature in the variations of commercial harvest and abundance through time. The October 1984-1985 time series was selected as the target abundance level for Bogue, Core, and Back sounds, the main harvest areas, because it reflected abundance levels prior to the red tide event in 1987-1988, when the typical average annual harvest was about 30,000 bushels of scallops (Figure 12.4). The target opening level for eastern Pamlico Sound was set by default by opening the area in 2009 based on only one sampling estimate in January 2009 using a quadrat of one square meter in size at set locations since 2008 (Figure 12.6). Adaptive management targets and progressive triggers were also desired for all areas south of Bogue Sound but limited sampling could not determine target abundance indicators for this region. The MFC selected the Bogue Sound progressive triggers for re-opening areas south of Bogue Sound until triggers could be developed for this region.

There have been concerns raised by the public that the established targets for Core, Bogue, and Back sounds are too high and attaining population levels before the red tide is no longer possible because of changes in water quality, habitat, and predation pressure. In 2008, the annual lnCPUE for Core Sound exceeded the target level based on the 1984-1985 time series. Bogue Sound bay scallop abundance is improving, however Back Sound continues to remain low (Figure 12.5).

The open season is allowed only from the last Monday in January through April 1st (Table 12.5). The MFC allowed hand harvest methods at all triggers for the commercial fishery with trip limits starting at 10 bushels per person per day not to exceed two harvest limits per fishing operation on Monday and Wednesday, with an additional day for harvest as abundance reaches the higher triggers. The maximum allowed commercial individual harvest limit is set at 15 bushels after reaching the 125% trigger. Scallop dredges are only allowed when the trigger is met at 125% of the target level from March 1 through April 1 at 15 bushels per day only on Tuesday and Thursday.

All areas except Pamlico Sound showed levels well below the 50% trigger for re-opening the 2010 bay scallop harvest season (Figure 12.5). Pamlico Sound was opened from February 1 through April 1, 2010 (Proclamation SC-1-2010) under Amendment 1 harvest restrictions (Figure 12.6). Commercial landings of bay scallops were so low (less than 100 bushels) in 2010 that the exact amount cannot be reported because of confidentiality. Landings are considered confidential if less than 3 dealers, participants, and/or vessels participated in the fishery. Bogue Sound and all areas south of Bogue Sound were allowed to open in 2013 because Bogue Sound reached just over the 50% trigger (Figure 12.5).

Recreational harvest seasons open by proclamation at the same time as the commercial fishery. Amendment 1 of the Bay Scallop FMP specifies that the daily harvest limit is one bushel per person per day not to exceed one bushel per recreational fishing operation and harvest can only occur from Thursday through Sunday each week (Table 12.6) (NCDMF 2010).

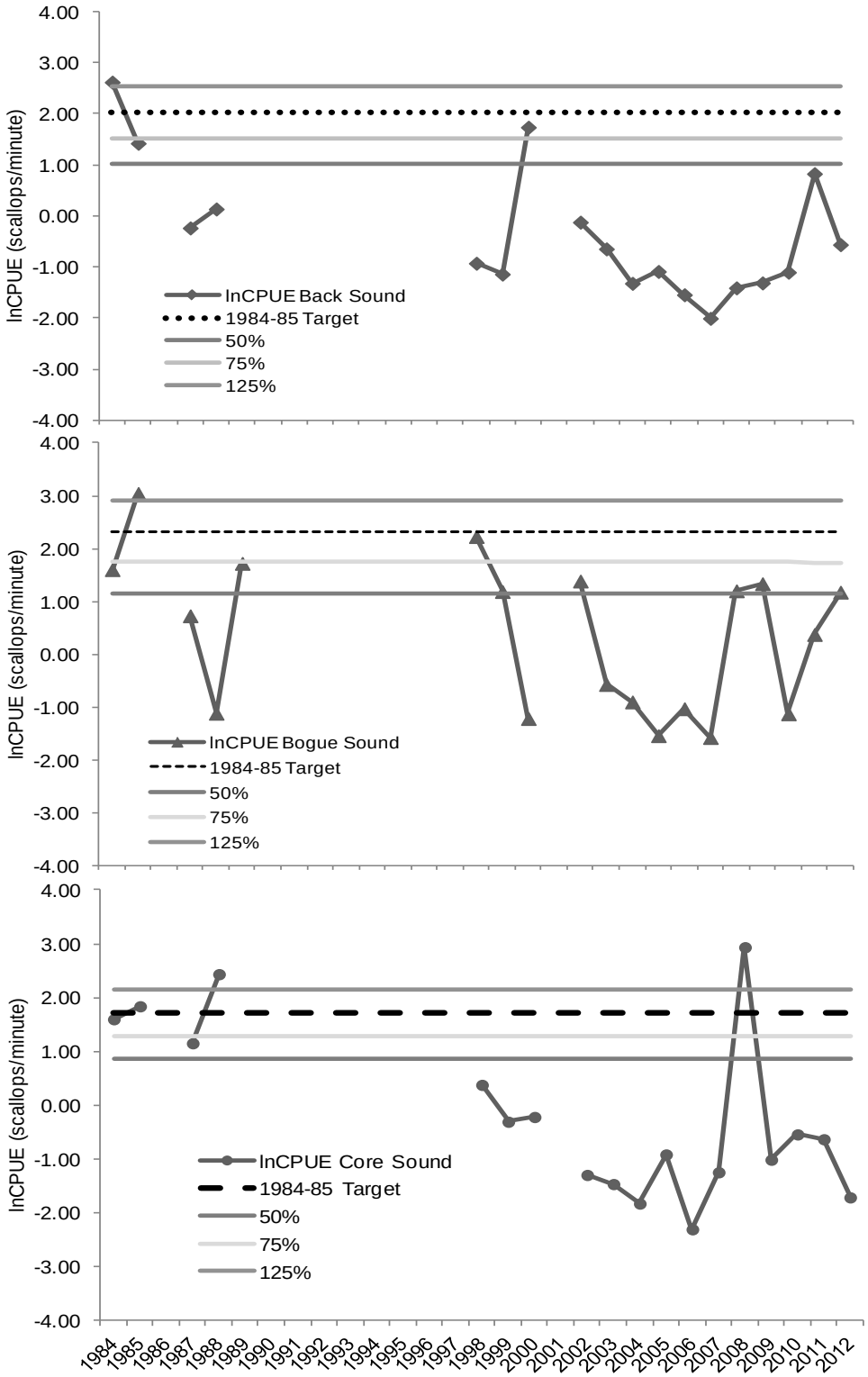

Figure 12.5 The mean number of scallops (lnCPUE)(scallops/minute) for Back, Bogue, and Core sounds during the October-December sampling time period and average lnCPUE (target) for the 1984-1985 period showing progressive triggers at 50%, 75%, and 125% of the target. Year indicates the sampling year which is used to determine the harvest season for the next calendar year.

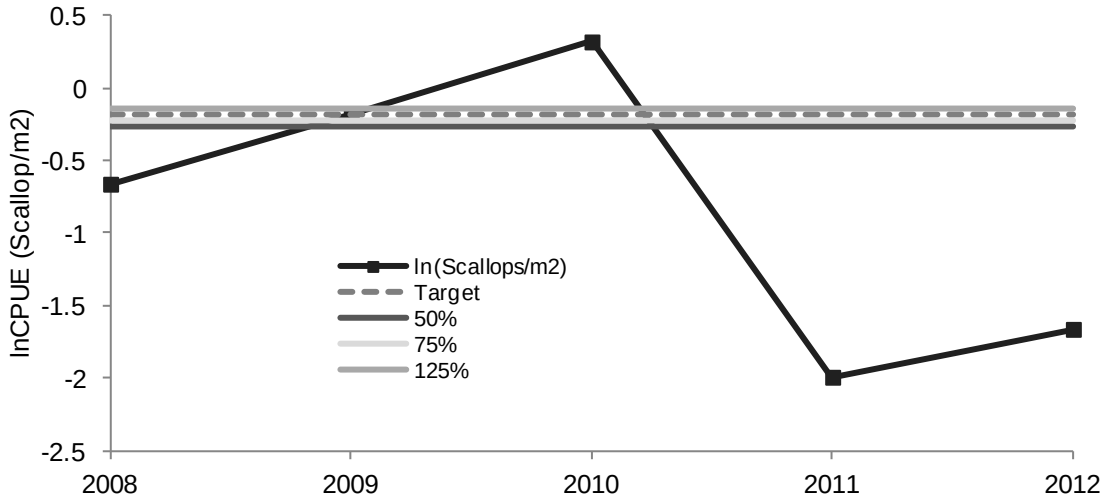

Figure 12.6 The mean number of scallops (lnCPUE)(scallops/m2) for Pamlico Sound during the January sampling time period and average lnCPUE (target) for the 2009 target showing progressive triggers at 50%, 75%, and 125% of the target. Year indicates the sampling year which is used to determine the harvest season for the same calendar year.

Table 12.5 Marine Fisheries Commission selected adaptive management measures for opening the bay scallop commercial fishery in Amendment 1. The harvest levels are based on progressive triggers derived from the lnCPUE1984-1985 (Oct-Dec) target indicators for Core, Bogue and Back sounds and the lnCPUEJan 2009 target indicator for Pamlico Sound.

Progressive triggers and target	Trip limit	Days open in the week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater and less than 75% of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon and Wed	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
75% or greater and less than 125% of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon, Tues, Wed, and Thurs	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
125% or greater of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon, Tues, Wed, and Thurs	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
	15 bushels per person per day not to exceed 30 bushels per fishing operation	Mon and Wed	Bay scallop dredges as described by rule 15A NCAC 03K. 0503	Delay opening until first full week in March after hand harvest removes scallops from shallow waters to April 1st

Table 12.6 Marine Fisheries Commission selected adaptive management measures for opening the bay scallop recreational fishery based on progressive triggers derived from the $lnCPUE_{1984\text{-}1985\ (Oct\text{-}Dec)}$ target indicators for Core, Bogue and Back sounds and the $lnCPUE_{Jan\ 2009}$ target indicator for Pamlico Sound.

Progressive triggers and target	Trip limit	Days open in week	Allowed gears	Season
Less than 50% target	No allowed harvest			
50% or greater of target	1 bushel per person per day not to exceed 1 bushel per recreational fishing operation	Thurs, Fri, Sat, and Sun	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st

Opening under this selected management strategy recruitment is still an issue in the population even with limited fishing effort. Abundance is still highly variable from year to year and survival of bay scallops to the harvest season is tenuous. Also public comments expressed that scallop dredges should be allowed to be used earlier in the harvest levels because it is a more effective means to harvest scallops both in effort to the fishermen and impacts to grassbeds than hand harvest.

IV. AUTHORITY

North Carolina General Statutes

113-134	Rules
113-182	Regulations of fishing and fisheries
113-201	Legislative findings and declaration of policy; authority of Marine Fisheries Commission
143B-289.52	Marine Fisheries Commission – powers and duties

N.C. Marine Fisheries Commission Rules 2013 (15A NCAC)

03K .0102(1)	PROHIBITED RAKES
03K .0105(a)	RECREATIONAL HARVEST OF 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. DISCUSSION

North Carolina's bay scallop stocks are listed as a species of concern in the annual Stock Status Report because of the population declines. Species are designated by NCDMF as concern because of incomplete or unavailable stock assessments, declining landings, or are of concern due to outside influences that cannot be controlled such as disease, habitat degradation, weather, or the nature of the fishery. 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. 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. Although prolific spawners like scallops can repopulate quickly, scientists

now believe their numbers can get so low that recovery can be prolonged if they are not allowed undisturbed opportunities to multiply (Arnold et al. 1998).

There are two specific components for review in this issue paper: 1. Consider a specific trigger for areas south of Bogue Sound, and 2. Review current harvest measures in place in all areas and both the commercial and recreational user groups. Many public comments have been received since adoption of Amendment 1 to introduce scallop dredges earlier in the harvest triggers as a management measure.

The areas south of Bogue Sound are not known as main harvest areas for bay scallops. Looking at the 1972 to 2012 time series, the maximum annual harvest from areas south of Bogue Sound was 6,676 bushels of bay scallops and accounted for 10% of the statewide landings. Fourteen of the 34 years from 1972 to 2005, when the season was opened annually, no commercial landings were recorded for any of the areas south of Bogue Sound. For most years, commercial harvest of bay scallops from the southern region accounted for less than 5% of the statewide total commercial landings.

Sampling was initiated in New River (2 set stations) and Topsail Sound (1 set station) in October 2009, using the same gear and sampling design as used in Core, Bogue, and Back sounds. The number of scallops per 2-minute tow ranged from 0 to 198 scallops and is the highest number seen for the entire time series since (Figure 12.7). Since 2009 the majority of the tows in October retained no scallops. The lnCPUE of the October 2009 samples was calculated as 0.95 scallops per minute, if this is determined as the target to achieve re-opening the season in these areas then the progressive triggers set at 50%, 75%, and 125% of this target level, as used in all other regions of the state, are 0.48, 0.71, and 1.19 scallops/minute respectively (Figure 12.7). The MFC selected target opening level for eastern Pamlico Sound was set by default by opening the area in 2009 based on only one sampling estimate in January 2009 (NCDMF 2010).

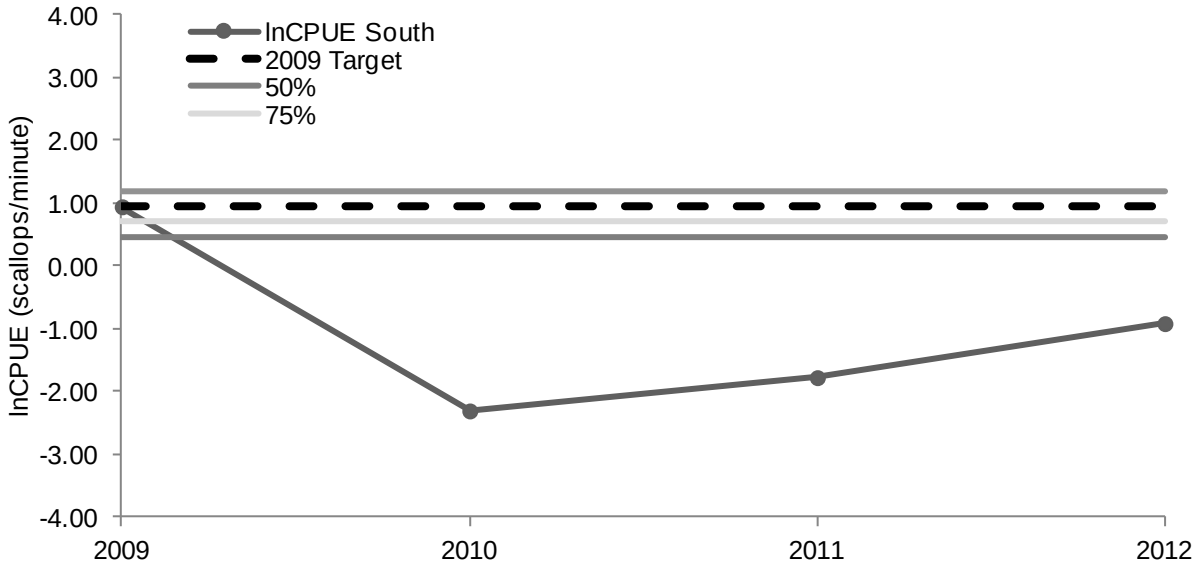

Figure 12.7 The mean number of scallops (lnCPUE)(scallops/minute) for New River and Topsail Sound stations combined during October showing progressive triggers at 50%, 75%, and 125% of the target lnCPUE of 2009. Year indicates the sampling year which is used to determine the harvest season for the next calendar year.

One of the biggest difficulties with choosing an estimate of abundance to determine re-opening is whether the sampling is a true reflection of abundance through a long enough time series, especially in areas with great annual variability like the regions south of Bogue Sound and even Pamlico Sound. Using an indicator of abundance from a main harvest area where abundance is likely much higher than an area where landings historically were low or non-existent to open that area is likely inappropriate. The internal waters south of Bogue Sound are not as productive for bay scallops as the main harvest areas.

Re-opening based on abundance indices, harvest seasons, trip limits, and gear limitations have been the management measures used by NCDMF for bay scallops. There are other regulatory measures that can be considered in the management of bay scallops. These include: size limits, seasonal or area closures, further gear restrictions, prohibited take or a combination of these measures.

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). Massachusetts requires an annual growth ring. Connecticut and New York, require an annual growth ring plus a minimum size limit of 2-inches, and 2 ¼ -inches respectively (Appendix 15.4). The annual growth ring is caused by the slow growth during the first winter of life. North Carolina issued a minimum size limit of 2-inches from 1915 to 1918 (Gutsell 1928) and none since.

Seasonal or area closures

Seasonal closures are intended to protect a portion of the stock in order to increase biomass and/or potential spawning for the next generation with the least impact to fishermen. This management measure has been used by NCDMF for bay scallops in order to also improve the economic yield to fishermen by opening the season when meat counts (number of scallop adductor meats/pound) are 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 by delaying harvest in January improves on the value of the harvest.

Shorter openings in a small area of Back Sound, North River, and the Straits occurred from in 2002 and 2003 to allow harvest before the cownose ray migration and resulting predation. Four days were open for commercial hand harvest from August 19 through August 28, 2002 and two days in September, less than 700 bushels were landed. One weekend in August and one weekend in September were opened for recreational harvest in 2002. Harvest was allowed again in the same small areas in 2003 with four days in August and 2 days in September with no recorded commercial landings. Recreational harvest was allowed for two weekends in August in 2003 also in these small areas. This rule is still in place to allow opening of the season from August 1 through September 15 by hand methods only and allows harvest before the fall spawning period of bay scallops. The current season opening under Amendment 1 is allowed from the last Monday in January to April 1st. The season allows for the completion of spawning and an increase in meat size in order to obtain the highest yield.

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).

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 New River and White Oak River (NCDMF 2008b). This strategy is considered a precautionary approach to management in that it allows some harvest to continue in areas where lower productivity occurs and protects 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 areas where bay scallops are harvested in North Carolina and accounted for 97% of the landings from 1994 to 2004.The areas where bay scallops exist now have become more compressed than in the past and the 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 recruitment and survival to adults.

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 to harvest scallops. 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. There are no restrictions on the number of scallops dredges that can be pulled at a time, and fishermen have been known to use up to six on a vessel. Concern for habitat loss makes scallop dredging an intensely managed portion of the fishery in the past and typically was only allowed to harvest two days a week. No dredging was allowed in Bogue Sound from 1993 to 1997. Beginning in 2000, dredging was delayed until later in the season after scallops were harvested out of the shallow areas. No mechanical harvest occurred in 2001.

Current management of the commercial fishery under Amendment 1 delays opening to scallop dredges until the 125% trigger is met in a region (Table 11.5). The recreational fishery is limited to hand harvest methods only now, as in the past. The intention of delaying harvest to dredges was to reduce propeller scarring and dragging dredges through grassbeds (submerged aquatic vegetation) in the shallow water areas because scallops will likely have already been removed by hand harvesters. Higher bay scallops catches occur from dredges than from hand methods. Public comments have been received that scallop dredges are more effective at reaching their daily harvest limit with less impacts to habitat and leaves some scallops behind for further spawning in the spring time. Also hand harvesting methods exposes commercial a fishermen to cold water conditions that could impact their health and safety.

Prohibited take

Prohibited take began in 2006 and continued until 2008 as part of the FMP until a fishery independent sampling indictor could be used to evaluate adult bay scallop abundance and ultimately determine if the fisheries could be reopened. A prohibited take strategy was initiated because widespread low levels of scallop abundance showed populations should be protected until sampling determined some recovery. No commercial landings were reported during the open harvest season in 2005 statewide. Sampling in 2008 and public input showed the number of scallops had improved in some areas and initiated the target estimates of abundance for re-opening the areas if sampling showed abundance above the selected targets. Whether the prohibited take period can be directly linked to the higher abundance of scallops due removal of fishing effort is unknown.

VI. PROPOSED RULE(S)

MFC Selected Management Strategy:

15A NCAC 03K .0501 BAY ~~SCALLOPS – SEASONS AND~~ SCALLOP HARVEST ~~LIMITS~~ MANAGEMENT

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

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

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

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

(1) Specify ~~number of days;~~time;

(2) Specify ~~areas;~~area;
(3) Specify means and ~~methods which may be employed in the taking;~~methods;
(4) Specify ~~time period; and~~open seasons for the taking of bay scallops during the period beginning the last Monday in January and ending the last Friday in May;
(5) Specify size; and
~~(5)~~(6) Specify the quantity, but shall not exceed possession of more than ~~20~~ 15 standard U.S. bushels per person per day or a total of ~~40~~ 30 standard U.S. bushels in any combined commercial fishing operation per day.

History Note: *Authority G.S. 113-134; 113-182; ~~113-221;~~ 113-201; 113-221.1; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. April 1, 2015; February 1, 2008.

VII. PROPOSED MANAGEMENT OPTIONS

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

1. Status quo (Continue progressive triggers with adaptive harvest levels in all areas and Bogue Sound trigger for areas south)
   + Insures some abundance level is in place when the fisheries are open
   + Reduces impacts to habitat that may be caused by bay scallop dredges
   - Areas south of Bogue Sound reliant on abundance triggers met for Bogue Sound
   - No economic benefit to communities until the triggers are reached
   - Dredges only allowed after the highest trigger is met
   - Current progressive triggers may not be appropriate

2. Continue current progressive triggers with adaptive harvest levels in all areas and modify the harvest management measures
   + Insures some abundance level is in place when the fisheries are open
   + Insures regional management continues to allow openings only in areas that reach certain levels of abundance
   - Current progressive triggers may not be appropriate
   - Potential to confuse the public with shifts in harvest management
   - No economic benefit to communities until the triggers are reached

3. Consider different targets and triggers for all areas
   + Insures some level of abundance is in place when the fisheries are open
   - No economic benefit to communities until triggers are reached
   - May not be appropriate trigger estimates for sustainable harvest
   - Not many longterm estimates of abundance available for use

4. 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
   - Leaves resource to other predators

5. Eliminate the August 1 through September 15 season open period in rule
   + Ensures fall spawning is complete
   + No additional resources required to implement

+ Likely improves future economic yield to fishermen
+ No reporting burden on fishermen or dealers
- Some loss of bay scallops to predation before harvest season

6. Consider a specific target level and progressive triggers for areas south of Bogue Sound based on limited sampling.
   + Bases harvest openings on information specific to that region
   + Follows regional management strategy already in place in other areas of the state
   - May not be an appropriate target estimate to determine sustainable management measures

7. Closures
   a. Permanent area closures
      + Reduce harvest impacts to some of the habitat
      + Reduce harvest impacts on part of the bay scallop population
      + No additional resources required to implement
      + No reporting burden on fishermen or dealers
      - Forces commercial 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

   b. Rotational area closures
      + Reduce harvest impacts to habitat
      + No additional resources required to implement
      + No reporting burden on fishermen or dealers
      + Reduce impacts on some of the bay scallop population
      - Requires knowledge of consistent high and low productive areas of abundance to be effective
      - Forces commercial 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

8. Gear restrictions
   + Reduce impacts on habitat
   + Reduce impacts on part of the bay scallop population
   + 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

9. Require recreational shellfish harvesters to be licensed to provide a sampling universe for surveys
   + 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

VIII. RECOMMENDATION

Marine Fisheries Commission Selected Management Strategy

- Support improving the reliability of the data for the recreational scallop harvest
- Eliminate the August 1 through September 15 season open period in rule
- Modify the daily commercial harvest possession limit in Rule 15A NCAC 03K .0501 to a quantity of no more than 15 standard U.S. bushels per person per day not to exceed 30 standard U.S. bushels in any combined commercial fishing operation per day to be consistent with the adaptive management measures trip limits
- Expand sampling in all regions and manage harvest conditionally in areas south of Bogue Sound until adequate sampling can determine a harvest trigger for management
- Continue current progressive triggers with adaptive harvest levels in all areas, except areas south of Bogue Sound, and modify harvest management measures as shown in Table 12.7 and Table 12.8 below. And continue to improve the statistical rigor of the abundance index.
- Keep dredges at the 75% trigger harvest level in Table 12.7

NCDMF and AC

- Support improving the reliability of the data for the recreational scallop harvest
- Eliminate the August 1 through September 15 season open period in rule
- Modify the daily commercial harvest possession limit in Rule 15A NCAC 03K .0501 to a quantity of no more than 15 standard U.S. bushels per person per day not to exceed 30 standard U.S. bushels in any combined commercial fishing operation per day to be consistent with the adaptive management measures trip limits

AC

- Expand sampling in the southern region but separate Bogue Sound and areas south of Bogue Sound as a separate unit and prohibit harvest in areas south of Bogue Sound until adequate sampling can determine a reopening trigger
- Continue the current progressive triggers with adaptive harvest levels in all areas and modify harvest management measures as shown in Table 12.7 and Table 12.8 below. Contingent upon increased October to December sampling can improve the statistical rigor of the lnCPUE.
- Remove dredges from the 75% trigger harvest level in Table 12.7 below

NCDMF

- Expand sampling in all regions and manage harvest conditionally in areas south of Bogue Sound until adequate sampling can determine a harvest trigger for management
- Continue current progressive triggers with adaptive harvest levels in all areas, except areas south of Bogue Sound, and modify harvest management measures as shown in Table 12.7 and Table 12.8 below. And continue to improve the statistical rigor of the abundance index.
- Keep dredges at the 75% trigger harvest level in Table 12.7 below

Table 12.7 Adaptive management measures for opening the bay scallop commercial fishery as the selected management strategy of the Marine Fisheries Commission. The harvest levels are based on progressive triggers derived from the lnCPUE1984-1985 (Oct-Dec) target indicators for Core, Bogue and Back sounds and the lnCPUEJan 2009 target indicator for Pamlico Sound. Underlined items show where changes have occurred from the adaptive management measures in Amendment 1.

Progressive triggers and target	Trip limit	Days open in the week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater of target but less than 75% of target	5 bushels per person per day not to exceed 10 bushels per fishing operation	Mon and Wed	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
75% or greater of target but less than 125% of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon, Tues, Wed, and Thur	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon and Wed	Bay scallop dredges as described by rule 15A NCAC 03K. 0503	Delay opening until first full week in March after hand harvest removes scallops from shallow waters to April 1st
125% or greater of target	15 bushels per person per day not to exceed 30 bushels per fishing operation	Mon, Tues, Wed, and Thur	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
	15 bushels per person per day not to exceed 30 bushels per fishing operation	Mon and Wed	Bay scallop dredges as described by rule 15A NCAC 03K. 0503	Delay opening until the third full week in February after hand harvest removes scallops from shallow waters to April 1st

Table 12.8 Adaptive management measures for opening the bay scallop recreational fishery as the selected management strategy of the Marine Fisheries Commission. The harvest levels are based on progressive triggers derived from the $lnCPUE_{1984\text{-}1985\ (Oct\text{-}Dec)}$ target indicators for Core, Bogue and Back sounds and the $lnCPUE_{Jan\ 2009}$ target indicator for Pamlico Sound. Underlined items show where changes have occurred from the adaptive management measures in Amendment 1.

Progressive triggers and target	Trip limit	Days open in week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater of target	1/2 bushel per person per day not to exceed 1 bushel per recreational fishing operation	Seven days a week	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st

IX. RESEARCH RECOMMENDATION

- Survey fishermen that use a commercial license for personal consumption
- Collect more information on the value of the spring spawn to the population

X. LITERATURE CITED

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Date, Revised Again: February 21, 2014 MFC preferred management strategy

12.3 ALLOW BAY SCALLOP SEASON, HARVEST LIMIT, AND PRE-DEALER SALE OF SEED EXEMPTIONS FOR SHELLFISH LEASEHOLDERS AND AQUACULTURE OPERATIONS[3]

March 6, 2014

I. ISSUE

Introduce new shellfish leaseholder rules to exempt bay scallop harvest from the public commercial season and daily harvest limits, and allow the sale of bay scallop seed for further grow out.

II. ORIGINATION

A fishery resource grant project principal investigator to NCDMF staff in 2010.

III. BACKGROUND

Today the majority of shellfish leases are held by commercial fishermen to supplement their income from public harvest areas by holding shellfish to improve the meat condition and/or sell during better market conditions. An increased interest in bay scallop culture in North Carolina has been observed in recent years. With bay scallop populations being low, fishermen are seeking alternative methods to harvest bay scallops. Commercial culture of bay scallops is administered through the shellfish lease program. Commercial bay scallop culture is not currently practiced on any North Carolina shellfish leases.

NCDMF rules are in place that exempts oysters and clams from season and harvest restrictions in oyster and clam aquaculture operations. Bay scallop aquaculture operations are not exempt from the regular commercial season and daily harvest limits, which limits leaseholders to harvest their product only during the open public harvest period. One pilot study to culture bay scallops in Core Sound found very high mortality before grow out to a marketable size and the surviving bay scallops would likely expire naturally before the harvest season could be opened because of their short lifespan (Hooper 2011).

Traditional shellfish culture techniques such as providing settlement substrate, relaying, and transplanting are not effective or not available for bay scallops. Therefore, most bay scallop research has focused on aquaculture and aquaculture operations appear to be the most viable technique for production of bay scallops by shellfish leaseholders. As with aquaculture operations for oysters and clams, hatchery reared seed is required to become a permitted bay scallop aquaculture operation. Occasionally, situations arise where aquaculture operations sell shellfish still needing further rearing by lease holders and culturists. If scallops are raised through the use of coastal waters, either in raceways, upwellers, or overboard, they are subject to the provisions of G.S. 113-168.4 and the sale transaction must be through a licensed fish dealer.

They are also subject to the requirement for generation of a trip ticket pursuant to G.S. 113-168.2. NCDMF has discouraged the recording of seed shellfish sales on trip tickets to avoid

[3] Presented to: PDT 2/26/13 and 5/28/13; RAT Subgroup 3/22/13; RAT 4/4/13, 5/2/13, and 3/6/14; AC 5/13/13, 8/12/13, and 1/21/14. MRT 8/19/13 and 1/27/14.

multiple counting of seafood products since these shellfish will be sold again and recorded on a trip ticket when they are sold for public consumption.

IV. AUTHORITY

North Carolina General Statutes

113-134	Rules
113-182	Regulations of fishing and fisheries
113-201	Legislative findings and declaration of policy; Authority of Marine Fisheries Commission
113-168.4	Sale of fish
113-169.1	Permits for gear, equipment, and other specialized activities authorized
143B-289.52	Marine Fisheries Commission -- powers and duties

N.C. Marine Fisheries Commission Rules 2013 (15A NCAC)

03I .0101(2)(a)	Aquaculture operation
03O .0501	Procedures and requirements to obtain permits
03O .0502	Permit conditions; General

V. DISCUSSION

The MFC is on record in the 2001 North Carolina Oyster and Hard Clam Fishery Management Plans that it is in the public interest to encourage and develop shellfish culture for the public benefit insofar as it does not interfere with traditional fishing practices (NCDMF 2008a; NCDMF 2008b). Shellfish culture, if properly managed, has the potential to increase seafood production, employment in the seafood industry, and improve fisheries habitat. The North Carolina Blue Ribbon Advisory Council on Oysters (BRACO) recommended emphasis on oyster culture as the best measure to address problems of increasing demand and decreasing stocks (BRACO 1995). Allowing bay scallops to be harvested by shellfish aquaculture operations within their leases outside of the public open season and above the daily harvest limits would benefit leaseholders economically, encourages production for markets outside of the regular season, may take some pressure off the natural stock, and makes the management practice consistent with other shellfish species grown out on private leases.

An exemption from the requirement to sell to a licensed dealer of any seafood sold for further grow out is necessary to avoid counting the same product many times until sold for final consumption. Multiple recordings of sale of the same shellfish would artificially inflate the landings data that are used in evaluating the health of shellfish populations.

VI. PROPOSED RULE

MFC Selected Management Strategy

15A NCAC 03K .0111 PERMITS TO USE MECHANICAL METHODS FOR SHELLFISH ON SHELLFISH LEASES OR FRANCHISES

(a) Permits to Use Mechanical Methods for Shellfish on Shellfish Leases or Franchises shall be issued in compliance with the general rules governing all permits in 15A NCAC 03O .0500. The procedures and requirements for obtaining permits are also found in 15A NCAC 03O .0500.

(b) It is unlawful to harvest shellfish by the use of mechanical methods from shellfish leases or franchises without first obtaining a Permit to Use Mechanical Methods for Shellfish on Shellfish Leases or Franchises.

History Note: *Authority G.S. 113-134; 113-169.1; 113-182; 143B-289.52;*
Eff. April 1, 2015.

15A NCAC 03K .0206 PERMITS TO USE MECHANICAL METHODS FOR OYSTERS OR CLAMS ON SHELLFISH LEASES OR FRANCHISES

~~(a) Permits to Use Mechanical Methods for Oysters or Clams on Shellfish Leases or Franchises shall be issued in compliance with the general rules governing all permits in 15A NCAC 03O .0500. The procedures and requirements for obtaining permits are also found in 15A NCAC 03O .0500.~~

~~(b) It is unlawful to harvest oysters by the use of mechanical methods from shellfish leases or franchises without first obtaining a Permit to Use Mechanical Methods for Oysters or Clams on Shellfish Leases or Franchises.~~

History Note: *Authority G.S. 113-134; 113-182; 143B-289.52;*
Eff. October 1, 1992;
Temporary Amendment Eff. September 1, 2000;
Amended Eff. August 1, *2002;*
Repealed Eff. April 1, 2015.

15A NCAC 03K .0303 PERMITS TO USE MECHANICAL METHODS FOR OYSTERS OR CLAMS ON SHELLFISH LEASES OR FRANCHISES REQUIREMENT

~~(a) Permits to Use Mechanical Methods for Oysters or Clams on Shellfish Leases or Franchises shall be issued in compliance with the general rules governing all permits in 15A NCAC 03O .0500. The procedures and requirements for obtaining permits are also found in 15A NCAC 03O .0500.~~

~~(b) It is unlawful to harvest hard clams by the use of mechanical methods from shellfish leases or franchises without first obtaining a Permit to Use Mechanical Methods for Oysters or Clams on Shellfish Leases of Franchises.~~

History Note: *Authority G.S. 113-134; 113-182; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. September 1, 1991;
Temporary Amendment Eff. September 1, 2000;
Amended Eff. August 1, 2002;
Repealed Eff. April 1, 2015.

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 from public bottom during the following periods:

(1) From the last Monday in January through the last Friday in May; and
(2) From August 1 through September 15 by hand harvest methods only as described by proclamation.

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

(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) Specify the 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.

History Note: *Authority G.S. 113-134; 113-182; ~~113-221;~~ 113-201; 113-221.1; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. April 1, 2015; February 1, 2008.

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 03K .0105. Bay scallops taken on Saturdays or Sundays from shellfish leases or franchises in accordance with G.S. 113-208 are exempt from this Rule.

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. April 1, 2015; August 1, 2000.

15A NCAC 03K .0507 MARKETING SCALLOPS TAKEN FROM PRIVATE SHELLFISH ~~BOTTOMS~~BOTTOM

(a) It is unlawful to sell, purchase or possess scallops during the closed season without the lease or franchise holder delivering to the purchaser or other recipient a certification, on a form provided by the Division, that the scallops were taken from a valid shellfish lease or franchise. Certification forms shall be furnished by the Division to lease and franchise holders upon request.

(b) It is unlawful for lease or franchise holders or their designees to take or possess scallops from public bottom while possessing aboard a vessel scallops taken from shellfish leases or franchises.

History Note: *Authority G.S. 113-134; 113-182; 113-201; 143B-289.52;*
Eff. April 1, 2015.

15A NCAC 03K .0508 SCALLOP SEASON AND HARVEST LIMIT EXEMPTION

The following exemptions and restrictions shall apply to the possession, sale, purchase or transport of scallops produced in an aquaculture operation:

(1) Possession and sale of scallops by a scallop aquaculture operation shall be exempt from restrictions set under 15A NCAC 03K .0501, .0504, and .0505.

(2) Purchase and possession of scallops from a scallop aquaculture operation shall be exempt from restrictions set under 15A NCAC 03K .0501, .0504, and .0505.

(3) It is unlawful for a person to possess, sell, purchase, or transport scallops described in Sub-Items (1) and (2) of this Rule unless in compliance with all conditions of the Aquaculture Operation Permit.

History Note: *Authority G.S. 113-134; 113-182; 143B-289.52;*
Eff. April 1, 2015.

15A NCAC 03O .0501 PROCEDURES AND REQUIREMENTS TO OBTAIN PERMITS

(a) To obtain any Marine Fisheries permit, the following information is required for proper application from the applicant, a responsible party or person holding a power of attorney:

(1) Full name, physical address, mailing address, date of birth, and signature of the applicant on the application. If the applicant is not appearing before a license agent or the designated Division contact, the applicant's signature on the application shall be notarized;

(2) Unexpired picture identification of applicant, responsible party and, when applicable, person holding a power of attorney. Acceptable forms of picture identification are driver's license, North Carolina Identification card issued by the North Carolina Division of Motor Vehicles, military identification card, resident alien card (green card) or passport or if applying by mail, a copy thereof;

(3) Full names and dates of birth of designees of the applicant who will be acting under the requested permit where that type permit requires listing of designees;

(4) Certification that the applicant and his designees do not have four or more marine or estuarine resource convictions during the previous three years;

(5) For permit applications from business entities:

(A) Business Name;

(B) Type of Business Entity: Corporation, partnership, or sole proprietorship;

(C) Name, address and phone number of responsible party and other identifying information required by this Subchapter or rules related to a specific permit;

(D) For a corporation, current articles of incorporation and a current list of corporate officers when applying for a permit in a corporate name;

(E) For a partnership, if the partnership is established by a written partnership agreement, a current copy of such agreement shall be provided when applying for a permit; and

(F) For business entities, other than corporations, copies of current assumed name statements if filed and copies of current business privilege tax certificates, if applicable; and

(6) Additional information as required for specific permits.

(b) A permittee shall hold a valid Standard or Retired Standard Commercial Fishing License in order to hold a:

(1) Pound Net Permit;

(2) Permit to Waive the Requirement to Use Turtle Excluder Devices in the Atlantic Ocean; or

(3) Atlantic Ocean Striped Bass Commercial Gear Permit.

(c) A permittee and his designees shall hold a valid Standard or Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to hold a:

(1) Permit to Transplant Prohibited (Polluted) Shellfish;

(2) Permit to Transplant Oysters from Seed Oyster Management Areas;

(3) Permit to Use Mechanical Methods for ~~Oysters or Clams~~ Shellfish on Shellfish Leases or Franchises;

(4) Permit to Harvest Rangia Clams from Prohibited (Polluted) Areas; or

(5) Depuration Permit.

(d) A permittee shall hold a valid:

(1) Fish Dealer License in the proper category in order to hold Dealer Permits for Monitoring Fisheries Under a Quota/Allocation for that category; and

(2) Standard Commercial Fishing License with a Shellfish Endorsement, Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to harvest clams or oysters for depuration.

(e) Aquaculture Operations/Collection Permits:

(1) A permittee shall hold a valid Aquaculture Operation Permit issued by the Fisheries Director to hold an Aquaculture Collection Permit.

(2) The permittee or designees shall hold appropriate licenses from the Division of Marine Fisheries for the species harvested and the gear used under the Aquaculture Collection Permit.

(f) Atlantic Ocean Striped Bass Commercial Gear Permit:

(1) Application for an Atlantic Ocean Striped Bass Commercial Gear Permit must be made prior to November 1 of each year. A person shall declare one of the following gears for an initial Atlantic Ocean Striped Bass Commercial Gear Permit and at intervals of three consecutive license years thereafter:

(A) gill net;

(B) trawl; or

(C) beach seine.

For the purpose of this Rule, a beach seine is defined as a swipe net constructed of multi-filament or multi-fiber webbing fished from the ocean beach that is deployed from a vessel launched from the ocean beach where the fishing operation takes place.

Gear declarations are binding on the permittee for three consecutive license years without regard to subsequent annual permit issuance.

(2) A person is not eligible for more than one Atlantic Ocean Striped Bass Commercial Gear Permit regardless of the number of Standard Commercial Fishing Licenses, Retired Standard Commercial Fishing Licenses or assignments held by the person.

(3) The annual, nonrefundable permit fee is ten dollars ($10.00).

(g) For Hire Fishing Permit:

(1) The permittee shall hold a valid certification from the United States Coast Guard (USCG) that allows carrying six or fewer passengers or a certification from the USCG that allows carrying more than six passengers;

(2) The permittee shall provide valid documentation papers or current motor boat registration or copies thereof for the vessel engaged as for-hire. If an application for transfer of documentation is pending, a copy of the pending application and a notarized bill of sale may be submitted.

(h) Applications submitted without complete and required information shall not be processed until all required information has been submitted. Incomplete applications shall be returned to the applicant with deficiency in the application so noted.
(i) A permit shall be issued only after the application has been deemed complete by the Division of Marine Fisheries and the applicant certifies to abide by the permit general and specific conditions established under ~~15A NCAC 03J .0501, 03J .0505, 03K .0103, 03K .0104, 03K .0107, 03K .0206, 03K .0303, 03K .0401, 03O .0502, and 03O .0503~~ 15A NCAC 03J .0501, .0505, 03K .0103, .0104, .0107, .0111, .0401, 03O .0502, and .0503 as applicable to the requested permit.
(j) The Fisheries Director, or his agent may evaluate the following in determining whether to issue, modify or renew a permit:

(1) Potential threats to public health or marine and estuarine resources regulated by the Marine Fisheries Commission;
(2) Applicant's demonstration of a valid justification for the permit and a showing of responsibility as determined by the Fisheries Director;
(3) Applicant's history of habitual fisheries violations evidenced by eight or more violations in 10 years.

(k) The Division of Marine Fisheries shall notify the applicant in writing of the denial or modification of any permit request and the reasons therefor. The applicant may submit further information, or reasons why the permit should not be denied or modified.
(l) Permits are valid from the date of issuance through the expiration date printed on the permit. Unless otherwise established by rule, the Fisheries Director may establish the issuance timeframe for specific types and categories of permits based on season, calendar year, or other period based upon the nature of the activity permitted, the duration of the activity, compliance with federal or state fishery management plans or implementing rules, conflicts with other fisheries or gear usage, or seasons for the species involved. The expiration date shall be specified on the permit.
(m) For permit renewals, the permittee's signature on the application shall certify all information as true and accurate. Notarization of signature on renewal applications is not required.
(n) For initial or renewal permits, processing time for permits may be up to 30 days unless otherwise specified in this Chapter.
(o) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries within 30 days of a change of name or address.
(p) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries of a change of designee prior to use of the permit by that designee.
(q) Permit applications are available at all Division Offices.

History Note: *Authority G.S. 113-134; 113-169.1; 113-169.3; 113-182; 113-210; 143B-289.52;*
Temporary Adoption Eff. September 1, 2000; May 1, 2000;
Eff. April 1, 2001;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2015; April 1, 2011; April 1, 2009; July 1, 2008; December 1, 2007; September 1, 2005; April 1, 2003; August 1, 2002.

G.S. 113-168.4. Sale of fish.

(a) Except as otherwise provided in this section, it is unlawful for any person who takes or lands any species of fish under the authority of the Commission from coastal fishing waters by any means whatever, including mariculture operations, to sell, offer for sale, barter or exchange these fish for anything of value without holding a license required to sell the type of fish being offered.
(b) Except as otherwise provided in this section, it is unlawful for any person licensed under this Article to sell fish taken outside the territorial waters of the State or to sell fish taken from coastal fishing waters. A person licensed under this Article may sell fish taken outside the territorial waters of the State or sell fish taken from coastal fishing waters under any of the following circumstances:
    (1) The sale is to a fish dealer licensed under G.S. 113-169.3.
    (2) The sale is to the public and the seller is a licensed fish dealer under G.S. 113-169.3.
    (3) The sale is of ~~oysters or clams from a hatchery or~~ fish reared in an aquaculture operation to the holder of an Aquaculture Operation Permit, an Under Dock Culture Permit, or a shellfish cultivation lease for further grow out.

(c) A person who organizes a recreational fishing tournament may sell fish taken in connection with the tournament pursuant to a recreational fishing tournament license to sell fish. A person who organizes a recreational fishing tournament may obtain a recreational fishing tournament license to sell fish upon application to the Division and payment of a fee of one hundred dollars ($100.00). It is unlawful for any person licensed under this subsection to sell fish to any person other than a fish dealer licensed under G.S. 113-169.3 unless the seller is also a licensed fish dealer. A recreational fishing tournament is an organized fishing competition occurring within a specified time period not to exceed one week and that is not a commercial fishing operation. Gross proceeds from the sale of fish may be used only for charitable, religious, educational, civic, or conservation purposes and shall not be used to pay tournament expenses. (1997-400, s. 5.1; 1998-225, s. 4.13; 2001-213, s. 2; 2009-433, s. 1.)

VII. PROPOSED MANAGEMENT OPTIONS

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

1. Leaseholder harvest exemptions
   a. *Status quo*
      +No burden on law enforcement for possession of bay scallops outside of the public harvest season
      - Not consistent with current management practices for other shellfish species grown out on leases
      - No economic benefit to shellfish leaseholders
      - Limits the opportunity to improve production of a lease
      - Limits the opportunity to take some pressure off the natural wild stock

   b. Exempt bay scallop harvest from leases from the regular season and harvest limits
      + Aligns bay scallop harvest practices with other shellfish species grown out on leases
      + Allows leaseholders to sell their product under better market conditions
      + Provides more opportunity to improve production of a lease
      + May take some pressure off the harvest of the natural wild stock
      - Enforcement of possession of bay scallops outside the public harvest season

2. Pre-dealer seed sale of bay scallops
   a. *Status quo*
      - Potential to artificially inflate landings data
      - Could provide inaccurate estimates on the health of the population

   b. Support an exemption from G.S. 113-168.4 (b) (3) when the sale is to lease or Aquaculture Operations permit holders for further rearing
      + Aligns rules with statutes and current practices
      + Keeps landings data composed of sales for consumption

VIII. RECOMMENDATION

MFC Selected Management Strategy

- Exempt bay scallop harvest from leases from the regular season and harvest limits
- Support an exemption from G.S. 113-168.4 (b) (3) when the sale is to lease or Aquaculture Operations permit holders for further rearing

NCDMF and AC

- Exempt bay scallop harvest from leases from the regular season and harvest limits
- Support an exemption from G.S. 113-168.4 (b) (3) when the sale is to lease or Aquaculture Operations permit holders for further rearing

IX. LITERATURE CITED

North Carolina Blue Ribbon Advisory Council on Oysters (BRACO). 1995. North Carolina oyster restoration and fishery management plan. North Carolina Department of Environment, Health, and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 116 pp.

NCDMF. 2008a. North Carolina Oyster Fishery Management Plan Amendment 2. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 286 p.

NCDMF. 2008b. North Carolina Hard Clam Fishery Management Plan Amendment 1. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 314 p.

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Date, Revised Again: March 22, 2013 RAT subgroup rule changes
Date, Revised Again: April 4, 2013 RAT first review
Date, Revised Again: May 2, 2013 RAT second review
Date, Revised Again: August 20, 2013 NCDMF recommendations and rule formats
Date, Revised Again: February 21, 2014 MFC preferred management strategy
Date, Revised Again: March 6, 2014 RAT third review

12.4 BAY SCALLOP STOCK ENHANCEMENT[4]

February 21, 2014

I. ISSUE

Consideration of bay scallop enhancement strategies to improve bay scallop populations.

II. ORIGINATION

Bay scallop plan development team.

III. BACKGROUND

In the 2007 Bay Scallop FMP the MFC selected the following bay scallop management strategies: 1) enhancement through spawner transplants from wild harvest stocks; and 2)

[4] Presented to: PDT 5/28/13; AC 6/24/13, 8/12/13, and 1/21/14; MRT 8/19/13 and 1/27/14.

enhancement through cultured release. Spawner transplants are wild bay scallops moved to create better opportunities for successful spawning. Cultured release is the planting of hatchery reared bay scallops to increase the potential for successful spawning and/or harvest. The MFC also recommended the Oyster Hatchery Planning Advisory Team consider production of other shellfish species in the Shellfish Research Hatchery. Rule 15A NCAC 03K .0103 was also changed to allow Shellfish Management Areas to serve as sanctuaries to increase spawning and disease resistance or to prevent predation on all shellfish not just oysters and clams. This rule change provides a mechanism to protect transplants and cultured, released bay scallops while spawning occurs.

Stock enhancement is achieved through different methods depending on the limiting factors of the stock. Limiting factors could include recruitment, habitat or elements that limit survival from spawn to juvenile or juvenile to adult. For example, the NCDMF currently incorporates a cultch planting program for oyster enhancement due to the fact that habitat for larval attachment is limited. As oyster stocks decline suitable substrate needed for larval attachment also declines, therefore, an enhancement strategy of rebuilding habitat was initiated. Recruitment patterns of bay scallops in the years after the red tide event in the late 1980s exhibit the pattern that would be predicted if spawning was inhibiting population size in Bogue Sound (Huber and Peterson 1992). Since this pattern still exists, it indicates enhancement of spawning success should be considered as a stock enhancement measure.

Spawner transplants and larval release are stock enhancement options worthy of expanded investigations. These strategies have been implemented mostly in the research arena and have yielded promising but not definitive results. Determination of the success of enhancement strategies involving larval release and spawner transplants requires an approach that will determine if success is from natural recruitment or enhancement. One method to measure enhancement success is to utilize genetic markers in cultured bay scallops. Genetic assessments are a crucial component of stock enhancement as they provide the most accurate analysis that perceived success is a reality (Arnold 2009). Genetic assessments can be costly and will require support from academia. Consideration of genetic diversity should also be noted to insure adequate variability in the natural stock when acquiring cultured stock.

Considerable effort has been invested in bay scallop enhancement to increase populations in several states along the east coast. Most applications involve research through universities to develop methods for accomplishing this endeavor. The prevailing idea attempts to establish a coalition of patchy adults to successfully spawn and propagate an individual area or the release of larvae within containments to maximize survivability to spawn. The MFC recommended strategies in the 2007 Bay Scallop FMP have not been acted upon due to lack of funding and the lack of a shellfish hatchery to produce seed. Funding will need to be obtained to fulfill these management strategies. A Shellfish Research Hatchery was established in 2008 at UNCW Center for Marine Science. An advisory committee was appointed including UNCW, NCDMF, North Carolina Coastal Federation, and industry stakeholders to make recommendations on research objectives. The mission of the Shellfish Research Hatchery is to conduct and facilitate research that will both inform and contribute to North Carolina's efforts to restore declining populations of ecologically and commercially important shellfish, and to build a sustainable shellfish aquaculture industry (UNCW 2009). While the Shellfish Research Hatchery currently is not producing bay scallop seed for industry, seed is being produced for research. Objectives within the Shellfish Research Hatchery Strategic Plan 2011-2016 are to identify hatchery-based research priorities for non-oyster species and to work with appropriate advisory committees to identify research needs that could be addressed using the facilities and abilities. Therefore, the framework has been set for the Shellfish Research Hatchery to aid in future development of bay

scallop enhancement programs which could supply individuals for spawner transplants and larval release.

Spawning sanctuaries promote growth and enhance survivability of spawning stock and increase their potential to establish populations beyond the sanctuary boundaries. Sanctuaries have already been established for oysters and provide a protected haven from harvest. The NCDMF currently has ten oyster sanctuaries encompassing 201.9 acres with 108 acres developed. These oyster sanctuaries have been designated under North Carolina Marine Fisheries Rule 15A NCAC 03K .0209 that prohibits harvest of oysters and clams and the use of trawls, long haul seines, and swipe nets.

In 2007, the MFC also voted to change Rule 15A NCAC 03K .0103 to allow Shellfish Management Areas to serve as sanctuaries to increase spawning success for all shellfish including bay scallops. This rule change provides a mechanism by which spawner transplants and cultured release bay scallops can be protected while spawning occurs. Criteria should be developed to determine best locations for these areas, which include physical factors (bottom type, currents, water depth), habitat (historical productivity, salinity, SAV), use compatibility (user conflict), and marking requirements. Recruitment models should be developed in order to identify specific areas that offer best rewards. The potential loss of fishing grounds due to designation of Shellfish Management Areas or sanctuaries will 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. It is still unknown how many acres of bottom need to be incorporated to create a sanctuary that will function properly. Valuable input from the public is needed in the development of these areas.

Marking Shellfish Management Areas or sanctuaries is another concern. Floating buoys on anchors are very susceptible to currents and wave actions which, in turn fail or travel off station. Although bay scallop Shellfish Management Areas or sanctuaries would be in shallower depths marking would still be a concern due to navigation and possible poaching. Shellfish Management Areas, sanctuaries and stockades are highly visible which can lead to illegally harvesting scallops that are concentrated in a small area. (Fegley et al. 2009).
Cownose ray predation of bay scallops is also an issue that could be addressed through Shellfish Management Areas or sanctuaries. Some scientists and fishermen believe that the number of cownose rays is rising (Myers et al. 2007). Research has determined that cownose rays feed in areas where bay scallops occur in high densities, greater than 70 scallops per square meter (Peterson et al. 2001; Powers and Gaskill 2005). Mortality of bay scallops occurs generally from August through September which corresponds with the southerly migration of cownose rays. This mortality occurs before spawning in bay scallops (Peterson et al. 2001; Powers and Gaskill 2005; Goodman et al. 2010). With the potential of cownose rays decimating individuals placed in areas for spawning or larval rearing, stockades or containment systems will need to be applied and researched to keep predation in check. 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 low density sites 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 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 (Deaton et al. 2010). Six fish habitats are discussed and designated in the CHPP

based on distinctive physical properties, ecological functions, and habitat requirements for living components of the habitat. Submerged aquatic vegetation is considered one of these habitats. 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; Fonseca and Uhrin 2008). Young scallops cannot tolerate highly silted substrates, and attachment to epibenthic surfaces 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 can use a variety of substrates for attachment and are not solely dependent on submerged vegetation (Gutsell 1930; Kirby-Smith 1970; Thayer and Stuart 1974; MacKenzie 2008). 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; Fonseca and Uhrin 2008). Several management recommendations in the Environmental Factors section (Section 10.0) are directly linked to SAV maintenance and enhancement that could be beneficial to protecting and improving habitat and water quality utilized by bay scallops.

IV. AUTHORITY

North Carolina General Statutes

113-134	Rules
113-182	Regulations of fishing and fisheries
113-201	Legislative findings and declaration of policy; Authority of Marine Fisheries Commission
113-204	Propagation of shellfish
143B-289.52	Marine Fisheries Commission -- powers and duties

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.

N.C. Marine Fisheries Commission Rules 2013 (15A NCAC)

03K .0103 Shellfish Management Areas

V. DISCUSSION

From 1992 to 1994, UNC Institute of Marine Science tested the hypothesis that recruitment limitation of bay scallops exists on a basin scale within North Carolina estuaries, which is consistent with the limited physical transport of their short-lived larvae (Peterson et al. 1996). This study was conducted when bay scallops had not initiated recovery from the red tide outbreak in 1987 to 1988. Bay scallops from wild stock donor sites were utilized as spawner transplants to receiver sites. On average, recruitment on two sites in Bogue Sound was 568% greater than in 1988 and 1989 when no transplantation had occurred. Adult density in Bogue Sound increased 258% following spawner transplantation as compared to a change of 8% in control sounds. Results imply recruitment limits population size in this system, suggesting that larval contribution from transplantation is the likely although unconfirmed instrument of successful enhancement of recruitment following spawner transplant (Peterson et.al. 1996).

Increasing spawners from release of cultured stock is another possible method for stock enhancement. This effort does not require taking an individual out of one local population to improve another. Large numbers of scallops can be produced though culture for enhancement however consideration should be taken to ensure genetic diversity in the population. Cultured release (Arnold et al. 2005) and wild transplants (Peterson et al. 1996) did not demonstrate definite long term success however the short-term benefits sometimes yielded large increases in localized population abundance through these approaches. Research from these studies suggest spawner transplants can be a viable enhancement strategy, however further research should be conducted before substantial funds are expended for this technique.

Given the lack of documented, long-term success of wild transplant and cultured release efforts, bay scallop larval release could be a feasible component for stock enhancement. Use of the larval life phase to rebuild populations of vertebrates and invertebrates has a long history worldwide (Arnold 2008). The release of ready-to-set pediveliger larvae as an enhancement strategy allows managers to increase localized patchy adults for future recruitment without the expense of raising the scallops to spawning size in a hatchery or taking wild stock from a population. Efforts in Pine Island Sound, Florida yielded promising results that indicate larval release is a less expensive, flexible, and logistically simple concept to enhancing local bay scallop populations (Arnold 2008). Four containment structures were positioned in grass beds with approximately 500,000 scallop pediveligers released in three of the structures, with one being a control (Leverone et al. 2004). Results indicated increased bay scallop abundance in all life stages sampled compared to the control site. In 2005, two years after initial release, enclosures produced bay scallops at densities 18 times higher than the average levels in Pine Island Sound over the past ten years (Arnold 2008). Hurricane Charley had a direct impact on the Pine Island Sound test sites. Although scallops remained within the enclosures during the event, environmental circumstances could have enhanced conditions for recruitment within the sound. If so, larval releases may not have been the only reason behind increase scallop abundance. Therefore, additional research applications along with genetic markers are needed to determine future success from the released larvae versus wild stock recruitment. (Arnold 2008).

Designated bay scallop sanctuaries would provide a platform to introduce spawners to an area where habitat would be protected and harvest would be prohibited. Shellfish Management Areas also can serve as time-limited sanctuaries and provide an opportunity for harvest once spawning occurs. Stockades with high densities of scallops placed inside these management areas have the potential for more productive spawning success since marine invertebrates exhibit low fertilization rates at low population densities (Levitan and Peterson 1995). Fegley et al. (2009) found that spawner sanctuaries established within stockades could be utilized to protect spawning adults susceptible to cownose ray predation. However, while stockades offer a protected environment from predators, they are often highly visible to the public and can be prone to illegal harvest (Fegley et al. 2009).

Although there have been reports of large-scale losses of SAV in North Carolina's low salinity tributaries on the mainland side of Pamlico Sound, the high salinity grass beds behind the barrier islands that are inhabited by bay scallops appear to remain relatively stable based on a comparison of mapping efforts through time. While a quantified change analysis is not available, based on the most recent data there appears to be an increase of SAV in some of the low salinity systems and southern range of SAV, which may be related to improved water clarity associated with the coastwide drought in 2007 to 2008. Preliminary review of the main areas of high salinity SAV, such as behind the Outer Banks in Pamlico Sound and Core Sound do not

indicate large change. However, there may have been a shift to increased patchiness of previously dense beds in Bogue Sound.

Efforts are being made to complete a coastwide analysis of annual change in distribution and abundance of SAV. A cooperative agency/academic research project (funded by Coastal Recreational Fishing License dollars) is investigating methods to measure change in SAV coverage and recommended that future monitoring be conducted in five year cycles in geographically stratified areas, with methods varying by zones. Aerial photography was recommended for high salinity areas while an acoustic method with underwater video for groundtruthing was recommended for the Albemarle Sound and western Pamlico Sound areas. Photography was taken to map SAV in 2007-2008 and again in 2012-2013. With better information available on light and other habitat requirements of SAV, it may also be possible to manage water quality for protection of SAV.

Changes in the amount or condition of high salinity seagrass beds will have a direct impact on bay scallop populations. Protection and enhancement of this habitat should be a priority for management of bay scallop populations. SAV restoration has been conducted in the Chesapeake Bay with varying degrees of success (see special section in Restoration Ecology-Shafer (ed.) 2010; Orth et al. 2006; Tettelbach et al. 2011). Carroll et al. (2008) found increased eelgrass productivity and leaf nitrogen in areas with added clams while Wall et al. (2011) found that bivalve filtration can mediate the effects of nutrient loading on eelgrass. Further research should be completed in NC to identify successful SAV enhancement techniques.

VI. PROPOSED RULE

No rule changes are proposed.

VII. PROPOSED MANAGEMENT OPTIONS

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

1. Status quo
   + No additional enforcement for patrol of enhancement efforts
   + No lost harvest area due to enhancement efforts
   - No programs targeting bay scallop enhancement
   - Continued possibility of low stocks

2. Transplantation of wild scallops from areas of high densities to areas of low densities
   + Potential increase in spawning stock in spawner-limited areas
   + Bypasses costly culture phase
   - Dependent on availability of wild stock
   - Reduction of local wild stock for enhancement
   - Need to protect bay scallops from predators and poaching
   - Difficult to evaluate success or failure
   - Chance of high mortality during transportation

3. Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms
   + Potential increase in spawning stock in spawner-limited areas on public bottom
   + No reduction of local wild stock for enhancement

+ Potential to increase bay scallop harvest
+ Aid in production requirements for shellfish lease holders
- Potential for lower prices of wild harvest

4. Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on public bottoms
   + Potential increase in spawning stock
   + No reduction of local wild stock for enhancement
   + Less cost of culture to spawning size in a hatchery
   + Ability to stock mass quantities
   - Need to protect bay scallops from predators and poaching
   - Increased expense due to culture
   - Requires extensive genetic testing to validate enhancement contribution

5. Enhancement through larval release
   + Potential increase in spawning stock
   + No reduction of local wild stock for enhancement
   + Less cost of culture to spawning size in a hatchery
   + Ability to stock mass quantities
   - Need to protect bay scallops from predators and poaching
   - Increased expense due to culture
   - Requires extensive genetic testing to validate enhancement contribution

6. Establish permanent sanctuaries for bay scallop
   + Provide protected habitat for spawning bay scallops
   + Provide protected habitat for spawner transplants and larval release
   + Provide protected area for NCDMF and Academic programs
   - Potential loss of traditional fishing grounds
   - Increased Marine Patrol enforcement
   - Need to protect bay scallops from predators and poaching

7. Construction of temporary fencing or stockade around concentrations of bay scallops for protection from predation
   + Concentrates spawners for increased fertilization success
   + Protects bay scallops from predation by cownose rays
   - Hazards to navigation
   - Maintenance of fencing
   - Increase potential for human interference
   - Cownose ray migration variable from year to year

8. Continue to support CHPP recommendations that enhance protection of existing bay scallop habitat
   + Monitoring of seagrass coverage exists
   + Protecting seagrass will improve water quality and sequester carbon dioxide from air
   + Protecting seagrass will increase SAV surfaces available for bay scallop larval recruitment
   + Will protect habitat important to many other important fishery species
   + Submerged aquatic vegetation aids in erosion control
   - Monitoring may not cover all bay scallop habitats
   - Additional funding required

9. Support programs that enhance bay scallop habitat by planting seagrass or other suitable settlement substrate
   + Will benefit many other important fishery species in addition to scallops
   + Enhances the ecosystem (e.g., nutrient cycling, food source, provide refuge, spawning and nursery habitat, and a corridor for migration between habitats
   + Could connect previously separated spawning groups of scallops
   + Improves water quality for scallops by removing suspended solids, improving water clarity, and increasing dissolved oxygen
   - Decrease areas for fishermen using bottom-disturbing fishing gear (e.g., trawls, dredges, etc.)
   - Seagrass plantings won't survive unless water quality conditions are adequate

VIII. RECOMMENDATION

MFC Selected Management Strategy

- Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms
- Contingent on results to distribute seed on private bottom, expand the pilot program to include public bottom
- Continue to support CHPP recommendations that enhance protection of existing bay scallop habitat
- Support programs that enhance bay scallop habitat by planting seagrass or other suitable settlement substrate

NCDMF and AC

- Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms
- Continue to support CHPP recommendations that enhance protection of existing bay scallop habitat
- Support programs that enhance bay scallop habitat by planting seagrass or other suitable settlement substrate

AC - Establish a pilot program with the Shellfish Research Hatchery to explore one or more of the following: 1. The potential of supplementation of both larvae and seed to public bottom; 2. Consider the use of stockades as a method to protect the bay scallops from cownose rays; and 3. Have oversight of the economic and biological metrics by the standing advisory committee.

NCDMF - Contingent on results to distribute seed on private bottom, expand the pilot program to include public bottom

IX. RESEARCH RECOMMENDATIONS

- Determine the spatial and biological characteristics of SAV beds that maximize their ecological value to the bay scallop for enhancement or conservation purposes
- Develop techniques to enhance SAV habitat to promote scallop survival

X. LITERATURE CITED

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13.0 RECOMMENDED MANAGEMENT STRATEGIES AND RESEARCH RECOMMENDATIONS

13.1 MANAGEMENT STRATEGIES

The selected management strategies and research needs listed below are organized according to the General Problem Statements in Section 5.2. Each strategy is followed by a reference to the Principal Issue(s) and Management Options from Section 12.0 and indicated in parentheses that supports it, followed by which Objective(s) it addresses from Subsection 4.1. An overall discussion of the environmental factors is in Section 11.0 with recommended management strategies for habitat and water quality found in Subsection 11.4.

13.1.1 INSUFFICIENT DATA

NCDMF will only be able to approximate management that prevents overfishing and achieves sustainable harvest until necessary data are collected. Data are lacking from the recreational fishery and some life history aspects of the population 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 6.0, Section 10.0, Issue 12.2), (Objectives 1, 3, 4, 6, and 7)]

13.1.2 ENVIRONMENTAL CONCERNS

Suitable and adequate habitat and water quality 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 issue deals with the impacts of scallop dredges versus fishermen treading on SAV. Fishery restrictions already exist for most of the gears used in North Carolina that are potentially damaging to SAV, but the impacts of treading on SAV during harvest is still unknown and requires further research.

[(Section 11.0 and Issues 12.1 and 12.4), (Objectives 2, 3, and 4)]

13.1.2.1 ISSUE: HABITAT

1. Identify and designate Strategic Habitat Areas (SHAs) that will enhance protection of the bay scallop.
2. Remap and monitor SAV coverage in North Carolina to assess distribution and change over time.
3. Restore coastal wetlands to compensate for previous losses and enhance water quality conditions for the bay scallop.
4. Work with CRC to revise shoreline stabilization rules to adequately protect riparian wetlands and shallow water habitat and significantly reduce the rate of shoreline hardening.
5. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV and other fish habitats.
6. Evaluate dock criteria siting and construction to determine if existing requirements are adequate for SAV survival and growth, and modify if necessary.
7. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.
8. Shallow areas where trawling is currently allowed should be re-examined to determine if additional restrictions are necessary.
9. Accelerate and complete mapping of all shell bottom in coastal North Carolina.

13.1.2.2 ISSUE: WATER QUALITY

1. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.
2. Reduce impervious surfaces and increase on-site infiltration of stormwater through voluntary or regulatory measures.
3. Provide more incentives for low-impact development.
4. 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.
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. Provide proper disposal of unwanted drugs, reduce insecticide and heavy metal run-off, and develop technologies to treat wastewater for antibiotics and hormones.
7. Discourage use of detergents in coastal waters, especially detergents with antimicrobial components.

13.1.2.3 ISSUE: IMPACTS OF TREADING ON SUBMERGED AQUATIC VEGETATION WHILE HARVESTING BAY SCALLOPS

1. *Status quo* (manage fishing gear based on scallop densities)
2. Allow dredging only
3. Allow hand harvest only
4. Allow no harvest of bay scallops to protect SAV

MFC Selected Management Strategy

- *Status quo* (manage fishing gear based on scallop densities)

13.1.3 MANAGEMENT

Continued low landings and minimal open harvest seasons 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. With bay scallop populations being low, fishermen are seeking alternative methods to produce bay scallops. An increased interest in bay scallop culture in North Carolina has been observed in recent years Bay scallops are often absent in the rules and planning procedures for shellfish leases and aquaculture operations.

[(Issue 12.2 and 12.3), (Objectives 1, 3, 4, 5, 6, and 7)]

13.1.3.1 ISSUE: BAY SCALLOP HARVEST MANAGEMENT

1. Status quo (Continue progressive triggers with adaptive harvest levels in all areas and Bogue Sound trigger for areas south)
2. Continue current progressive triggers with adaptive harvest levels in all areas and modify the harvest management measures
3. Consider different targets and triggers for all areas
4. Prohibited take
5. Eliminate the August 1 through September 15 season open period in rule
6. Consider a specific target level and progressive triggers for areas south of Bogue Sound based on limited sampling.
7. Closures
   a. Permanent area closures
   b. Rotational area closures
8. Gear restrictions
9. Require recreational shellfish harvesters to be licensed to provide a sampling universe for surveys

Marine Fisheries Commission Selected Management Strategy

- Support improving the reliability of the data for the recreational scallop harvest
- Eliminate the August 1 through September 15 season open period in rule
- Modify the daily commercial harvest possession limit in Rule 15A NCAC 03K .0501 to a quantity of no more than 15 standard U.S. bushels per person per day not to exceed 30 standard U.S. bushels in any combined commercial fishing operation per day to be consistent with the adaptive management measures trip limits
- Expand sampling in all regions and manage harvest conditionally in areas south of Bogue Sound until adequate sampling can determine a harvest trigger for management
- Continue current progressive triggers with adaptive harvest levels in all areas, except areas south of Bogue Sound, and modify harvest management measures as shown in Table 12.7 and Table 12.8 in the issue paper. And continue to improve the statistical rigor of the abundance index.
- Keep dredges in at the 75% trigger harvest level in Table 12.7 in the issue paper

Table 12.7 Adaptive management measures for opening the bay scallop commercial fishery as the selected management strategy of the Marine Fisheries Commission. The harvest levels are based on progressive triggers derived from the lnCPUE1984-1985 (Oct-Dec) target indicators for Core, Bogue and Back sounds and the lnCPUEJan 2009 target indicator for Pamlico Sound. Underlined items show where changes have occurred from the adaptive management measures in Amendment 1.

Progressive triggers and target	Trip limit	Days open in the week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater of target but less than 75% of target	5 bushels per person per day not to exceed 10 bushels per fishing operation	Mon and Wed	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
75% or greater of target but less than 125% of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon, Tues, Wed, and Thur	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon and Wed	Bay scallop dredges as described by rule 15A NCAC 03K. 0503	Delay opening until first full week in March after hand harvest removes scallops from shallow waters to April 1st
125% or greater of target	15 bushels per person per day not to exceed 30 bushels per fishing operation	Mon, Tues, Wed, and Thur	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
	15 bushels per person per day not to exceed 30 bushels per fishing operation	Mon and Wed	Bay scallop dredges as described by rule 15A NCAC 03K. 0503	Delay opening until the third full week in February after hand harvest removes scallops from shallow waters to April 1st

Table 12.8 Adaptive management measures for opening the bay scallop recreational fishery as the selected management strategy of the Marine Fisheries Commission. The harvest levels are based on progressive triggers derived from the $lnCPUE_{1984\text{-}1985\ (Oct\text{-}Dec)}$ target indicators for Core, Bogue and Back sounds and the $lnCPUE_{Jan\ 2009}$ target indicator for Pamlico Sound. Underlined items show where changes have occurred from the adaptive management measures in Amendment 1.

Progressive triggers and target	Trip limit	Days open in week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater of target	1/2 bushel per person per day not to exceed 1 bushel per recreational fishing operation	Seven days a week	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st

IX. RESEARCH RECOMMENDATION

- Survey fishermen that use a commercial license for personal consumption
- Collect more information on the value of the spring spawn to the population

13.1.3.2 ISSUE: ALLOW BAY SCALLOP SEASON, HARVEST LIMIT, AND PRE-DEALER SALE OF SEED EXEMPTIONS FOR SHELLFISH LEASEHOLDERS AND AQUACULTURE OPERATIONS

1. Leaseholder harvest exemptions
   a. *Status quo*

b. Exempt bay scallop harvest from leases from the regular season and harvest limits

2. Pre-dealer seed sale of bay scallops
   a. *Status quo*
   b. Support an exemption from G.S. 113-168.4 (b) (3) when the sale is to lease or Aquaculture Operations permit holders for further rearing

MFC Selected Management Strategy

- Exempt bay scallop harvest from leases from the regular season and harvest limits
- Support an exemption from G.S. 113-168.4 (b) (3) when the sale is to lease or Aquaculture Operations permit holders for further rearing

13.1.4 STOCK ENHANCEMENT

Currently, there is no enhancement program for bay scallops in North Carolina. A Shellfish Research Hatchery was established in 2008 at UNCW Center for Marine Science. While the Shellfish Research Hatchery currently is not producing bay scallop seed for industry, seed is being produced for research. The framework in the mission and objectives has been set for the Shellfish Research Hatchery to aid in future development of bay scallop enhancement programs which could supply individuals for spawner transplants and larval release.

[(Issue 12.4), (Objectives 1, 4, 5, and 6)]

13.1.4.1 ISSUE: BAY SCALLOP STOCK ENHANCEMENT

1. Status quo
2. Transplantation of wild scallops from areas of high densities to areas of low densities
3. Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms
4. Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on public bottoms
5. Enhancement through larval release
6. Establish permanent sanctuaries for bay scallop
7. Construction of temporary fencing or stockade around concentrations of bay scallops for protection from predation
8. Continue to support CHPP recommendations that enhance protection of existing bay scallop habitat
9. Support programs that enhance bay scallop habitat by planting seagrass or other suitable settlement substrate

MFC Selectred Management Strategy

- Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms
- Contingent on results to distribute seed on private bottoms, expand the pilot program to include public bottoms
- Continue to support CHPP recommendations that enhance protection of existing bay scallop habitat
- Support programs that enhance bay scallop habitat by planting seagrass or other suitable settlement substrate

13.2 SUMMARY OF RESEARCH RECOMMENDATIONS

The following research recommendations were compiled from the Status of the Stock Section 6.0, the Private Culture, Aquaculture, and Stock Enhancement Section 9.0, the Socioeconomic Aspects of the Bay Scallop Fishery Section 10.0, and the Environmental Factors Section 11.0 and issue papers listed in the Principal Issues and Management Options Section 12.0. The list below is presented in order as it would appear in draft Amendment 2 and the section or issue paper they come from is identified. The PDT reviewed and prioritized the research recommendations in accordance to the suggestion by the Biological Review Team research committee. The AC reviewed the draft research recommendations and provided input to prioritize these recommendations as well. The Management Review Team determined the final ranking. If there were differences between the PDT and AC priorities then the middle priority level was chosen between the two, if there was only one level difference the AC priority was chosen. If one group chose to delete the research recommendation but the other prioritized the item then the research recommendation remained with the ranking. The prioritization of each research recommendation is designated either a HIGH, MEDIUM, or LOW standing. A low ranking does not infer a lack of importance but is either already being addressed by others or provides limited information for aiding in management decisions. A high ranking indicates there is a substantial need, which may be time sensitive in nature, to provide information to help with management decisions.

Proper management of the bay scallop resource cannot occur until some of these research needs are met, the research recommendations include:

- Develop better methods to quantify the population including the means to have more precise measures of spatial and temporal variability at both within and between Sound scales - HIGH
- Collect information on larval recruitment and spat settlement – LOW
- Genetically identify how many separate bay scallop stocks exist in North Carolina - MEDIUM
- Examine the effects of scallop culture and oyster cultch on seagrass density – MEDIUM
- Perform socioeconomic surveys on commercial participants to determine specific business characteristics, the economics of working in the fishery, which issues are important to the participants, attitudes towards management of the fishery and general demographic information - LOW
- Determine a method to collect socioeconomic information on processors - LOW
- Collect information on the economic impact and value of the recreational bay scallop fishery - MEDIUM
- Determine the spatial and biological characteristics of SAV beds that maximize their ecological value to the bay scallop for enhancement or conservation purposes - LOW
- Develop techniques to enhance SAV habitat to promote scallop survival - LOW
- Conduct research to evaluate the role of shell hash and shell bottom in bay scallop recruitment and survival, particularly where SAV is absent - LOW
- Determine the concentrations of EDCs in known bay scallop habitats and impacts on bay scallops - LOW
- Assess the impacts of nutrient loading and algae on SAV and the life history of bay scallops - MEDIUM
- Determine levels of TSS, turbidity, chlorophyll *a,* and other parameters necessary to achieve desired water clarity and investigate the feasibility of a water quality standard for light attenuation required for SAV growth - LOW

- Complete a more comprehensive study on treading and impacts of treading on juvenile and adult bay scallops - HIGH
- Survey fishermen that use a commercial license for personal consumption – LOW
- Collect more information on the value of the spring spawn to the population - MEDIUM

13.3 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. This document is a review of the 2007 FMP and 2010 amendment 1.

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15.0 APPENDICES

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15.1 THE MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGY, OBJECTIVES FOLLOWED, AND REQUIRED ACTIONS IN THE 2007 NORTH CAROLINA BAY SCALLOP FMP

MANAGEMENT STRATEGY	OBJECTIVES	OUTCOME
INSUFFICIENT DATA		
1. Recommend produce a mechanism to obtain data on the recreational scallop harvest	1, 3, 5, and 6	Preliminary work conducted in License and Statistics section
2. Recommend continue prohibited take (started in January 2006) and evaluate the population status annually	1 and 3	Accomplished
3. Recommend sampling during the prohibited take period to define an independent sampling indicator for re-opening a harvest season	1, 3, and 4	Accomplished in early 2009 with fishery independent target levels of abundance for Core, Bogue, Back, and Pamlico sounds.
4. Recommend eliminating the December opening and compress the main season by beginning the last Monday in January	1, 4, and 6	Accomplished; Rule change to 15A NCAC 03K .0501 adopted Feb 1, 2008
ENVIRONMENTAL CONCERNS		
1. Identify and delineate Strategic Habitat Areas that will enhance protection of bay scallop	1, 2, and 4	Existing authority through CHPP implementation plan
2. Completely map all SAV habitat in North Carolina	1 and 2	Aerial imagery for NC coastal area collected through APNEP SAV mapping partnership and ongoing through Shellfish Mapping Program from Resource Enhancement Section
3. Remap SAV habitat in Core and Bogue sounds and assess change in distribution and abundance over time	1 and 2	Under evaluation. Aerial imagery for NC coastal area collected through APNEP SAV mapping partnership and ongoing through Shellfish Mapping Program from Resource Enhancement Section
4. Restore historical distribution and acreage of SAV wherever necessary	1, 2, and 4	Existing authority through 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	New stormwater rules adopted October 2008, and through existing authority of the CHPP implementation plan
6. Evaluate dock criteria to determin if existng requirments are adequate for SAV survival and growth and modify if necessary	2 and 4	Existing authority through CHPP implementation plan

15.1 (Continued) THE MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGY, OBJECTIVES FOLLOWED, AND REQUIRED ACTIONS IN THE 2007 NORTH CAROLINA BAY SCALLOP FMP

MANAGEMENT STRATEGY	OBJECTIVES	OUTCOME
ENVIRONMENTAL CONCERNS		
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 through 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	Study in Archer Creek and existing authority through 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 through 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 through 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 through CHPP implementation plan
12. Accelerate and complete mapping of all shell bottom in North Carolina	2	Ongoing under Resource Enhancement Section Shellfish Mapping Program
13. Protect shallow soft bottom habitat through proper siting of docks, marinas, and shoreline stabilization structures	2	CRC dock rule change and existing authority through 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 through CHPP implementation plan
15. Evaluate the effects of clam kicking and trawling on soft bottom habitat and bay scallops	2, 3, and 4	Unable to accomplish due to funding constraints
16. Prevent loss of additional riparian wetlands through the permitting process, land acquisition, or land use planning	2 and 6	Existing authority through CHPP implementation plan
17. Restore coastal wetlands to enhance water quality conditions for bay scallops	2 and 6	Existing authority through CHPP implementation plan
18. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry	2 and 6	Existing authority through CHPP implementation plan
19. Increase on-site infiltration of stormwater through voluntary or regulatory measures	2	Existing authority through CHPP implementation plan
20. Provide more incentives for low-impact development	2 and 6	Existing authority through CHPP implementation plan

15.1 (Continued) THE MARINE FISHERIES COMMISSION SELECTED MANAGEMENT

STRATEGY, OBJECTIVES FOLLOWED, AND REQUIRED ACTIONS IN THE 2007 NORTH CAROLINA BAY SCALLOP FMP

MANAGEMENT STRATEGY	**OBJECTIVES**	**OUTCOME**
ENVIRONMENTAL CONCERNS		
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	Accomplished. New coastal stormwater rule adopted October 2008
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	Accomplished. New coastal stormwater rule adopted October 2008
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 through 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	Ground truth sampling was conducted in Archer Creek to identify the seagrass areas. Proclamation authority for shrimp trawl management was used to redefine this area to protect SAV.
25. Recommend rule change to clarify wording to protect bay scallop habitat from bull rakes and hand tongs	1 and 2	Accomplished. Rule 15A NCAC 03K. 0102 and 15A NCAC 03K. 0304 adopted on Feb. 1, 2008
HARVEST CONCERNS		
1. Recommend collaborate with DEH and NOAA to monitor potential future red tide outbreaks	5 and 6	Ongoing
2. Recommend pilot research into various approaches to control cownose ray predation on bay scallops	1, 3, 4, and 5	University research proceeding in this area
3. Repeal the rule prohibiting soaking or swelling of bay scallops	1	Accomplished. Rule 15A NCAC 03K .0506 repealed on Feb. 1, 2008
STOCK ENHANCEMENT		
1. Recommend enhancement through spawner transplants of wild harvest stocks and by cultured release	4 and 5	Accomplished. Rule change to 15A NCAC 03K .0103 adopted on Feb. 1, 2008
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	Accomplished

15.2 BAY SCALLOP FMP AMENDMENT 2 PUBLIC INFORMATION BROCHURE

NOTE: The public information brochure was distributed via This Week at Fisheries March 11-15, 2013 news release and open to public comment from 3/11/13 through 4/11/13. No comments were received from the public or any of the MFC advisory committees during the open comment period.

Purpose

The Fisheries Reform Act of 1997 requires the division to prepare FMPs for adoption by the 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 Plan, 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. This requirement only applies to a plan for a fishery that is overfished and does not apply to a plan for a fishery where the biology of the fish or environmental conditions make ending overfishing 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.

North Carolina
Bay Scallop
Fishery Management Plan
Advisory Committee

Commercial

Eugene Ballance – Ocracoke

Recreational

John Speicher – Emerald Isle

Scientists

Troy Alphin – Wilmington

Stephen Fegley – Morehead City

Dennis Spitsbergen – Morehead City

Ami Wilbur – Wilmington

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North Carolina
Division of Marine Fisheries
Bay Scallop
Fishery Management Plan
Amendment 2

The FMP Process

This document provides information concerning an upcoming fishery management plan (FMP) amendment for bay scallops. The initial N.C. Bay Scallop FMP was approved by the N.C. Marine Fisheries Commission in 2007. There was an unscheduled Amendment 1 to the Plan in 2010 which dealt with harvest triggers. It is now time for a legally-required five year review. This amendment will be developed by the N.C. Division of Marine Fisheries, with the aid of an advisory committee (AC) consisting of representatives from the commercial and recreational fishing sectors, and the scientific community.

The draft FMP amendment 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 division and the AC will then review and incorporate comments received, as necessary, and produce a final draft of the FMP amendment. A series of public meetings will be held to invite public review and comment on the final draft prior to adoption by the Marine Fisheries Commission. Public hearings will be held to obtain comment on proposed rules to implement the final FMP recommendations.

Goal and Objectives

The goal of the Bay Scallop FMP is to implement a management strategy that restores the stock, maintains sustainable harvest, maximizes the social and economic value, and considers the needs of all user groups.

To achieve this goal, 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. Investigate methods and implications of bay scallop aquaculture;
6. Address social and economic concerns of all user groups;
7. 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 bottom algae. Predators of the bay scallop include cownose rays, blue crabs, starfish, whelks, and herring gulls.

North Carolina bay scallop stocks are listed as ***concern***[1], because of low abundance levels (Figure 1). They are considered an annual crop; therefore, there is no stock assessment. Bay scallops are traditionally harvested 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.

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

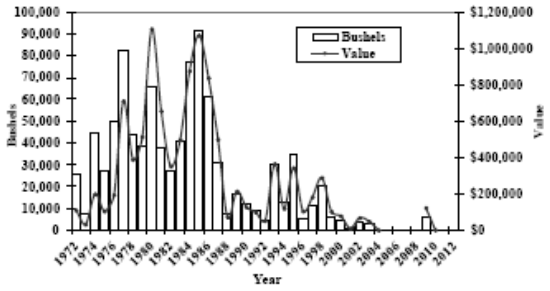

Figure 1. North Carolina bay scallop commercial landings (bushels) and value (dollars), 1972-2012.

* Landings are confidential for 2004 and 2010, less than 100 bushels harvested.

Current Management

Harvest cannot be opened unless at least 50 percent of the fishery independent sampling target index is reached for a region. Harvest triggers (minimum levels at which harvest could be allowed) are set at 50 percent, 75 percent and 125 percent of the target index within each water body (Pamlico, Core, Back and Bogue sounds and all areas south of Bogue Sound). If opened, the season can only occur from the last Monday in January through April 1 and there are daily harvest limits set for the commercial and recreational fisheries at each harvest trigger. No harvest has occurred in the past two years due to the scarcity of scallops.

Management Issues

Management recommendations for restoration and maintaining sustainable harvest of bay scallops are the most important issues to be addressed in the amendment. Management options such as season and area closures, examination of trigger levels, harvest methods and trip limits will be considered. Research on bay scallop culture and stock enhancement is also needed. Recent management issues include impacts of hand harvest versus dredge harvest and examining options for private leaseholders.

15.3 INTERNAL TIMELINE FOR AMENDMENT 2 OF THE BAY SCALLOP FISHERY MANAGEMENT PLAN

TASK (RESPONSIBLE PARTY)	TIMELINE
Appoint PDT (DMF Director)	June 2012
Determine management unit; identify initial issues; develop goal and objectives (PDT)	August 2012
Review FMP (PDT); assign individual PDT members to update FMP sections (PDT Leads)	August 2012
Determine if amendment is needed (PDT, FMP Coordinator)	August 2012
Develop timeline (PDT) and approve it (DMF Director)	August 2012
Solicit and submit FMP AC candidates to MFC Chairman (PDT Leads, MFC Liaison)	August-September 2012
Appoint FMP AC (DMF Director, MFC Chairman)	October 2012
Conduct first FMP AC meeting for orientation; discuss issues, goal and objectives (PDT, FMP AC)	November 2012
Appoint RAT subgroup (RAT Chairman)	December 2012
Present draft goal, objectives and list of issues to MRT and DMF Director for approval (PDT Leads)	January 2013
Present timeline to MFC; request approval of goal and objectives from MFC; solicit input on issues from MFC (PDT Leads, MFC)	February 28, 2013
Develop PIB (PDT, Public Affairs)	February 2013
Present draft PIB to FMP AC (PDT Leads)	March 2013
Finalize PIB (MRT, DMF Director) and send it to the public and ACs via email distribution list (PDT, Public Affairs)	March 2013
Finalize list of major issues; review management issues; develop issue papers; revise informational sections (PDT, FMP AC, RAT Subgroup)	January-August 2013
Establish PDT, FMP AC and DMF positions (PDT, FMP AC, MRT, DMF Director)	September 2013
Complete draft amendment and forward it to FMP AC (PDT)	October 2013

15.3 (Continued) INTERNAL TIMELINE FOR AMENDMENT 2 OF THE BAY SCALLOP FISHERY MANAGEMENT PLAN

TASK (RESPONSIBLE PARTY)	TIMELINE
Obtain MFC approval for review of draft amendment by public and regional ACs * (PDT Leads, MFC)	November 14, 2013
Post draft amendment on web site and present it at AC meetings 2013 (Public Affairs, PDT Leads)	November-December
Address public comments with FMP AC and revise draft amendment, if necessary (PDT, FMP AC)	January 2014
Present revised draft amendment to MRT and DMF Director for approval and final DMF position (PDT Leads)	February 2014
Incorporate final DMF position in revised draft amendment (PDT Leads)	By mid-February 2014
Present updated draft amendment to MFC for selection of preferred management options and approval for review by DENR Secretary and JLCGO (PDT Leads, MFC)	February 2014
Revise draft amendment with MFC comments, if necessary (PDT)	March 2014
Submit final draft amendment to DMF Director (PDT Leads, MFC Liaison)	March 2014
Submit final draft amendment to DENR Secretary (DMF Director)	March 2014
Forward final draft amendment to JLCGO (DENR Secretary)	March 2014
Incorporate DENR Secretary and JLCGO comments (PDT)	April 2014
Present final draft amendment and proposed rules to MFC; request approval for Notice of Text for Rulemaking (PDT Leads, MFC, FMP Coordinator)	May 2014
Publish proposed rules in *N.C. Register*	August 2014
Conduct public hearings on proposed rules	September 2014
Submit final draft amendment and permanent rules to MFC for final approval	November 2014
Rules reviewed by Office of Administrative Hearings Rules Review Commission	January 2015
Earliest effective date of rules	February 1, 2015

15.3 (Continued) INTERNAL TIMELINE FOR AMENDMENT 2 OF THE BAY SCALLOP FISHERY MANAGEMENT PLAN

TASK (RESPONSIBLE PARTY)	**TIMELINE**
Forward new rules to vendor for publication	February-March 2015
Proposed effective date of new rules	April 1, 2015

*Public meetings for the FMP will be held in each of the regional districts (northern and southern)

AC	Advisory committee
DMF	Division of Marine Fisheries
FMP	Fishery Management Plan
MFC	Marine Fisheries Commission
PDT	Plan Development Team (DMF staff)
PIB	Public Information Brochure
Secretary	Secretary of the Department of Environment and Natural Resources
JLCGO	Joint Legislative Commission on Governmental Operations
MRT	DMF Management Review Team
RAT	DMF Rules Advisory Team

15.4 BAY SCALLOP REGULATIONS OF OTHER ATLANTIC COAST STATES, JUNE 2012

State	Fishery	Other restrictions	Gear limit	Size limit	Trip limit	Open season	Area	Website address
Massachusetts	Commercial	Subject to change controlled by cities and towns	Subject to change controlled by cities and towns	Well-defined growth line	10 bu/day including annual shells, subject to modifcation by Town regulations	Oct 2 - Mar 31	Only designated clean waters	http://www.mass.gov/dfwele/dmf/commercialfishing/shellfsh.htm#abstracts
	Recreational	Subject to change controlled by cities and towns	Subject to change controlled by cities and towns	Well-defined growth line	Subject to change controlled by cities and towns	Oct 2 - Mar 31	Only designated clean waters	http://www.mass.gov/dfwele/dmf/recreationalfishing/rec_index.htm#shellfish
Rhode Island	Commercial	None that could be found	Dip nets only in November; dredges allowed only in Dec. cannot exceed 6 in number, max 28" width, & 36" in length	No seed possession	3 bu/day/boat.license	First Saturday of November and sunset of Dec 31	Only designated clean waters	http://www.dem.ri.gov/programs/bnatres/fishwild/mfsizes.htm#commer12 and http://www.dem.ri.gov/pubs/regs/regs/fishwild/rimf5.pdf
	Recreational	None that could be found	By hand only	No seed possession	1 bu/day	First Saturday of November and sunset of Dec 31	Only designated clean waters	http://www.dem.ri.gov/programs/bnatres/fishwild/mfsizes.htm#shellfish and http://www.dem.ri.gov/pubs/regs/regs/fishwild/rimf5.pdf
Connecticut	Commercial	Subject to change controlled by cities and towns	Restricted by local laws and vary by town	Must not pass through a 2-inch ID ring & must be an adult with a clearly defined growth ring	Restricted by local laws and vary by town	Restricted by local laws and vary by town	Only designated areas	http://web2.uconn.edu/seagrant/publications/fisheries/sfguide.pdf
	Recreational	Subject to change controlled by cities and towns	Restricted by local laws and vary by town	Must not pass through a 2-inch ID ring & must be an adult with a clearly defined growth ring	Restricted by local laws and vary by town	Restricted by local laws and vary by town	Only designated areas	http://web2.uconn.edu/seagrant/publications/fisheries/sfguide.pdf
New York	Commercial	Some local towns have additional restrictions on catch limits, size limits, season, type of gear and may require residency and additional permits.	Dredges allowed, 36 inch max. width. Use of mechanical means to retrieve dredge prohibited. Use of dredge prohibited on Sunday.	2-1/4 inch length from mid hinge to mid bill and an annual growth ring	10 bu/person 20 bu/boat per day	First Monday in November through March 31	Only open areas	http://www.dec.ny.gov/outdoor/29870.html
	Recreational	Some local towns have additional restrictions on catch limits, size limits, season, type of gear and may require residency and additional permits.	Vary on a town-by-town basis	2-1/4 inch length from mid hinge to mid bill and an annual growth ring	1 bu/day	First Monday in November through March 31	Only open areas	http://www.dec.ny.gov/outdoor/29870.html
New Jersey	Commercial	It is illegal to harvest shellfish on Sunday except in the seasonal waters of the Navesink and Shrewsbury rivers between Nov. 1 and April 30	hand implements only	None	None	No shellfishing on Sundays	Only from authorized waters	http://www.state.nj.us/dep/fgw/pdf/2012/digmar12.pdf
	Recreational	It is illegal to harvest shellfish on Sunday except in the seasonal waters of the Navesink and Shrewsbury rivers between Nov. 1 and April 30	Hand implements only	None	None	No shellfishing on Sundays	Only from authorized waters	http://www.state.nj.us/dep/fgw/pdf/2012/digmar12.pdf
Delaware	Commercial	Bay scallops were not included in the definition of shellfish	None	None	None	Year round	All areas open for bay scallops	http://regulations.delaware.gov/AdminCode/title7/3000/3700%20Shellfish/3701.shtml#TopOfPage
	Recreational	Bay scallops were not included in the definition of shellfish	None	None	None	Year round	All areas open for bay scallops	http://regulations.delaware.gov/AdminCode/title7/3000/3700%20Shellfish/3701.shtml#TopOfPage
Maryland	No taking of bay scallops is allowed							http://www.dnr.state.md.us/fisheries/regulations/regindex.asp
Virginia	Began a moratorium on the harvest of bay scallops on February 2, 1999							http://leg1.state.va.us/000/lst/LS624207.HTM
South Carolina	No regulations were found specific to bay scallops							http://www.dnr.sc.gov/regs/pdf/regs1213.pdf
Georgia	No specific regulations for bay scallops							http://www.coastalgadnr.org/sites/uploads/crd/pdf/marfish/27-4-190to199.pdf
Florida (Atlantic coast)	Commercial	All commercial fishing banned in state water sin 1994.						
	Recreational	Recreational harvest limited to areas in the Gulf						https://www.flrules.org/gateway/ChapterHome.asp?Chapter=68B-18

15.5 OVERVIEW OF THE BAY SCALLOP ADVISORY COMMITTEE, NCDMF, MFC REGIONAL AND STANDING ADVISORY COMMITTEES RECOMMENDATIONS AND PUBLIC COMMENT ON DRAFT AMENDMENT 2 OF THE BAY SCALLOP FMP

Issue		NCDMF	Bay Scallop AC	Southern AC	Northern AC	Habitat and Water Quality AC	Shellfish/Crustacean AC
12.1 Impacts of treading on submerged aquatic vegetation while harvesting scallops	1	*Status quo* (manage fishing gear based on scallop densities)	Allow existing bay scallop harvest methods subject to population estimates, habitat conditions, perceived harvest impacts and regional considerations	Same as NCDMF	Same as NCDMF	Same as Bay Scallop AC	Same as NCDMF
12.2 Bay scallop harvest management	1	Support improving the reliability of the data for the recreational scallop harvest	Same as NCDMF	Same as NCDMF	Same as NCDMF	No recommendation	Same as NCDMF
	2	Eliminate the August 1 through September 15 season open period in rule	Same as NCDMF	Same as NCDMF	Same as NCDMF	No recommendation	Same as NCDMF
	3	Expand sampling in all regions and manage harvest conditionally in areas south of Bogue Sound until adequate sampling can determine a harvest trigger for management.	Expand sampling in the southern region but separate Bogue Sound and areas south of Bogue Sound as a separate unit and prohibit harvest in areas south of Bogue Sound until adequate sampling can determine a reopening trigger	Same as NCDMF	Same as NCDMF	Same as NCDMF	Same as NCDMF
	4	Continue current progressive triggers with adaptive harvest levels in all areas, except areas south of Bogue Sound, and modify harvest management measures as shown in Table 12.7 and Table 12.8 in the issue paper	Continue the current progressive triggers with adaptive harvest levels in all areas and modify harvest management measures as shown in Table 12.7 and Table 12.8 in the issue paper. Contingent upon increased October to December sampling can improve the statistical rigor of the lnCPUE	Same as Bay Scallop AC with the addition of re-examine trigger levels to determine if biologically supported.	Same as NCDMF	No recommendation	Same as NCDMF
	5	NCDMF did not suuport Bay Scallop AC recommendation	At the 125% progressive trigger open the dredge season from the third full week in February through the last Friday in May (Table 12.7*)	Same as Bay Scallop AC	Same as NCDMF	No recommendation	Reject Bay Scallop AC recommendation
	6	Modify the daily commercial harvest possession limit in Rule 15A NCAC 03K .0501 to a quantity of no more than 15 standard U.S. bushels per person per day not to exceed 30 standard U.S. bushels in any combined commercial fishing operation per day to be consistent with the adaptive management measures trip limits.	Bay Scallop AC did not support NCDMF recommendation	Same as NCDMF	Same as NCDMF	No recommendation	Same as NCDMF

15.5 (Continued) OVERVIEW OF THE BAY SCALLOP ADVISORY COMMITTEE, NCDMF, MFC REGIONAL AND STANDING ADVISORY COMMITTEES RECOMMENDATIONS AND PUBLIC COMMENT ON DRAFT AMENDMENT 2 OF THE BAY SCALLOP FMP

Issue		NCDMF	Bay Scallop AC	Southern AC	Northern AC	Habitat and Water Quality AC	Shellfish/Crustacean AC
12.3 Allow bay scallop season, harvest limit, and pre-dealer sale of seed exemptionns forshellfish leaseholdersand aquaculture operations	1	Exempt bay scallop harvest from leases from the regular season and harvest limits	Same as NCDMF	Same as NCDMF	Same as NCDMF	Same as NCDMF	Same as NCDMF
	2	Support an exemption from G.S. 113-168.4 (b) (3) when the sale is to lease or Aquaculture Operations permit holders for further rearing	Same as NCDMF	Same as NCDMF	Same as NCDMF	Same as NCDMF	Same as NCDMF
12.4 Bay scallop stock enhancment	1	Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms	Same as NCDMF	Same as NCDMF	Same as NCDMF	Same as NCDMF	Same as NCDMF
	2	Establish a pilot program with the Shellfish Research Hatchery <u>to distribute cultured seed on public bottoms</u>	Establish a pilot program with the Shellfish Research Hatchery <u>to explore the potential of supplementation of both larvae and seed to public bottom, consider the use of stockades as a method to protect the bay scallops from cownose rays, and have oversight of the economic and biological metrics by the standing advisory committee</u>	Same as NCDMF	Same as NCDMF	Same as NCDMF	Reject both the NCDMF and Bay Scallop AC recommendations
	3	Continue to support CHPP recommendations that enhance protection of existing bay scallop habitat	Same as NCDMF	Same as NCDMF	Same as NCDMF	No recommendation. Note: These issues previously reviewed by this committee at length.	Same as NCDMF
	4	<u>Support programs that enhance bay scallop habitat by planting sea grass or other suitable settlement substrate</u>	Bay Scallop AC did not support NCDMF recommendation	Do not support programs that enhance bay scallop habitat by planting sea grass or other suitable settlement substrate.	Same as NCDMF	Same as NCDMF	Same as NCDMF
Research Recommendations		Support all research recommendations as drafted	Same as NCDMF	Support all research recommendations with the addition of studying the effects of predation by cownose rays and other sources of mortality.	Same as NCDMF	Same as NCDMF	Same as NCDMF
Public Comment				United National Fisherman's Association via email 1/8/14 : Grow juvenile bay scallops at Marine Resource Centers now aquariums. Also pay for the use of crab shedders to grow juvenile bay scallops to be planted from helicopters. Reducing the number of marine fisheries technicians by one would fund the growth of a billion bay scallops. The committee could address the effects of jet fuel dumped in the sounds prior to landing on bay scallops.	Plant seed bay scallops via helicopters, seems like it would be cost-effective at no more than about $5,000 to put out a billion seed. Habitat is natur and it is going to do what it wants to do. Cannot change the sea grass and substrate.	No public comment	No public comment

Table 12.7 Adaptive management measures for opening the bay scallop commercial fishery as suggested by the NCDMF and Bay Scallop Advisory Committee (AC)* for public comment in January 2014. The harvest levels are based on progressive triggers derived from the $lnCPUE_{1984\text{-}1985\ (Oct\text{-}Dec)}$ target indicators for Core, Bogue and Back sounds and the $lnCPUE_{Jan\ 2009}$ target indicator for Pamlico Sound. Underlined items show where changes have occurred from the adaptive management measures in Amendment 1. The 125% trigger for dredges has different recommendations by the NCDMF and AC for public comment.

Progressive triggers and target	Trip limit	Days open in the week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater of target but less than 75% of target	5 bushels per person per day not to exceed 10 bushels per fishing operation	Mon and Wed	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
75% or greater of target but less than 125% of target	10 bushels per person per day not to exceed 20 bushels per fishing operation	Mon, Tues, Wed, and Thur	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
	10 bushels per person per day not to exceed 20 bushels per fishing operation.	Mon and Wed	Bay scallop dredges as described by rule 15A NCAC 03K. 0503	Delay opening until first full week in March after hand harvest removes scallops from shallow waters to April 1st
125% or greater of target	15 bushels per person per day not to exceed 30 bushels per fishing operation	Mon, Tues, Wed, and Thur	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st
	15 bushels per person per day not to exceed 30 bushels per fishing operation	Mon and Wed	Bay scallop dredges as described by rule 15A NCAC 03K. 0503	NCDMF*: Delay opening until the third full week in February after hand harvest removes scallops from shallow waters to April 1st AC*: Delay opening until third full week in February after hand harvest removes scallops from shallow waters to the last Friday in May

* AC recommended extending the dredge season through the last Friday in May the NCDMF recommends the dredge season only goes through April 1st.

15.5 (Continued) OVERVIEW OF THE BAY SCALLOP ADVISORY COMMITTEE, NCDMF, MFC REGIONAL AND STANDING ADVISORY COMMITTEES RECOMMENDATIONS AND PUBLIC COMMENT ON DRAFT AMENDMENT 2 OF THE BAY SCALLOP FMP

Table 12.8 Adaptive management measures for opening the bay scallop recreational fishery as suggested by the NCDMF and Bay Scallop Advisory Committee for public comment in January 2014. The harvest levels are based on progressive triggers derived from the $lnCPUE_{1984\text{-}1985\ (Oct\text{-}Dec)}$ target indicators for Core, Bogue and Back sounds and the $lnCPUE_{Jan\ 2009}$ target indicator for Pamlico Sound. Underlined items show where changes have occurred from the adaptive management measures in Amendment 1.

Progressive triggers and target	Trip limit	Days open in week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater of target	1/2 bushel per person per day not to exceed 1 bushel per recreational fishing operation	Seven days a week	By hand, hand rakes, hand tongs, dip net, and scoops	Last Monday in January to April 1st

Additional Comments Received After Public Meetings

Shellfish fishermen from Bogue Sound (1-23-14):

- The biggest problem is cownose rays which come in the spring & fall. To take rays people should use a sturgeon net set at bars (shoals) and pay someone to fish it.
- Sampling should be expanded to the west of Wood Island (Bogue Sound) and other areas. Call him to take staff to the different places.
- A tickler chain should be added to the dredge (400-500 gauges) in front of the bar.
- In addition to the shellfish license, sell permits for a bushel so there will be more money for the Division and people will be able to get a mess of scallops to eat.

15.6 RULE CHANGES NECESSARY TO IMPLEMENT THE MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGY FOR AMENDMENT 2 OF THE BAY SCALLOP FISHERY MANAGEMENT PLAN

15A NCAC 03K .0111 is proposed for adoption as follows:

15A NCAC 03K .0111 PERMITS TO USE MECHANICAL METHODS FOR SHELLFISH ON SHELLFISH LEASES OR FRANCHISES

(a) Permits to Use Mechanical Methods for Shellfish on Shellfish Leases or Franchises shall be issued in compliance with the general rules governing all permits in 15A NCAC 03O .0500. The procedures and requirements for obtaining permits are also found in 15A NCAC 03O .0500.

(b) It is unlawful to harvest shellfish by the use of mechanical methods from shellfish leases or franchises without first obtaining a Permit to Use Mechanical Methods for Shellfish on Shellfish Leases or Franchises.

Authority G.S. 113-134; 113-169.1; 113-182; 143B-289.52

15A NCAC 03K .0206 is proposed for repeal as follows:

15A NCAC 03K .0206 PERMITS TO USE MECHANICAL METHODS FOR OYSTERS OR CLAMS ON SHELLFISH LEASES OR FRANCHISES

Authority G.S. 113-134; 113-182; 143B-289.52

15A NCAC 03K .0303 is proposed for repeal as follows:

15A NCAC 03K .0303 PERMITS TO USE MECHANICAL METHODS FOR OYSTERS OR CLAMS ON SHELLFISH LEASES OR FRANCHISES REQUIREMENT

Authority G.S. 113-134; 113-182; 143B-289.52

15A NCAC 03K .0501 if proposed for amendment as follows:

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

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

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

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

~~(b)~~ The Fisheries Director may, by proclamation, impose any or all of the following restrictions for ~~any~~ commercial or recreational ~~open season:~~bay scallop harvest from public bottom:

(1) ~~Specify number of days;~~ specify time;

(2) ~~Specify areas;~~ specify area;

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

(4) ~~Specify time period; and~~ specify open seasons for the taking of bay scallops during the period beginning the last Monday in January and ending the last Friday in May;

(5) specify size; and

~~(5)~~(6) ~~Specify the~~ specify quantity, but shall not exceed possession of more than ~~20~~ 15 standard U.S. bushels per person per day or a total of ~~40~~ 30 standard U.S. bushels in any combined commercial fishing operation per day.

Authority G.S. 113-134; 113-182; ~~113-221;~~ 113-201; 113-221.1; 143B-289.52

15.6 (Continued) RULE CHANGES NECESSARY TO IMPLEMENT THE MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGY FOR AMENDMENT 2 OF THE BAY SCALLOP FISHERY MANAGEMENT PLAN

15A NCAC 03K .0502 is proposed for amendment as follows:

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

(a) It is unlawful to take bay scallops between sunset and sunrise, or on Saturdays or Sundays, except as provided in 15A NCAC 03K .0105.

(b) Bay scallops taken on Saturdays or Sundays from shellfish leases or franchises in accordance with G.S. 113-208 are exempt from this Rule.

Authority G.S. 113-134; 113-182; ~~113-221;~~ 143B-289.52

15A NCAC 03K .0507 is proposed for adoption as follows:

15A NCAC 03K .0507 MARKETING SCALLOPS TAKEN FROM ~~PRIVATE~~ SHELLFISH ~~BOTTOM~~ LEASES OR FRANCHISES

(a) It is unlawful to sell, purchase or possess scallops during the closed season without the lease or franchise holder delivering to the purchaser or other recipient a certification, on a form provided by the Division, that the scallops were taken from a valid shellfish lease or franchise. Certification forms shall be furnished by the Division to lease and franchise holders upon request.

(b) It is unlawful for lease or franchise holders or their designees to take or possess scallops from public bottom while possessing aboard a vessel scallops taken from shellfish leases or franchises.

Authority G.S. 113-134; 113-182; 113-201; 143B-289.52

15A NCAC 03K .0508 is proposed for adoption as follows:

15A NCAC 03K .0508 SCALLOP SEASON AND HARVEST LIMIT EXEMPTION

The following exemptions and restrictions shall apply to the possession, sale, purchase or transport of scallops produced in an aquaculture operation:

(1) Possession and sale of scallops by a scallop aquaculture operation shall be exempt from restrictions set under 15A NCAC 03K .0501, .0504, and .0505.

(2) Purchase and possession of scallops from a scallop aquaculture operation shall be exempt from restrictions set under 15A NCAC 03K .0501, .0504, and .0505.

(3) It is unlawful for a person to possess, sell, purchase, or transport scallops described in Sub-Items (1) and (2) of this Rule unless in compliance with all conditions of the Aquaculture Operation Permit.

Authority G.S. 113-134; 113-182; 143B-289.52

15A NCAC 03O .0501 is proposed for amendment as follows:

15A NCAC 03O .0501 PROCEDURES AND REQUIREMENTS TO OBTAIN PERMITS

(a) To obtain any Marine Fisheries permit, the following information is required for proper application from the applicant, a responsible party or person holding a power of attorney:

(1) Full name, physical address, mailing address, date of birth, and signature of the applicant on the application. If the applicant is not appearing before a license agent or the designated Division contact, the applicant's signature on the application shall be notarized;

(2) Unexpired picture identification of applicant, responsible party and, when applicable, person holding a power of attorney. Acceptable forms of picture identification are driver's license, North

Carolina Identification card issued by the North Carolina Division of Motor Vehicles, military identification card, resident alien card (green card) or passport or if applying by mail, a copy thereof;

(3) Full names and dates of birth of designees of the applicant who will be acting under the requested permit where that type permit requires listing of designees;

(4) Certification that the applicant and his designees do not have four or more marine or estuarine resource convictions during the previous three years;

(5) For permit applications from business entities:

(A) Business Name;

(B) Type of Business Entity: Corporation, partnership, or sole proprietorship;

(C) Name, address and phone number of responsible party and other identifying information required by this Subchapter or rules related to a specific permit;

(D) For a corporation, current articles of incorporation and a current list of corporate officers when applying for a permit in a corporate name;

(E) For a partnership, if the partnership is established by a written partnership agreement, a current copy of such agreement shall be provided when applying for a permit; and

(F) For business entities, other than corporations, copies of current assumed name statements if filed and copies of current business privilege tax certificates, if applicable; and

(6) Additional information as required for specific permits.

(b) A permittee shall hold a valid Standard or Retired Standard Commercial Fishing License in order to hold a:

(1) Pound Net Permit;

(2) Permit to Waive the Requirement to Use Turtle Excluder Devices in the Atlantic Ocean; or

(3) Atlantic Ocean Striped Bass Commercial Gear Permit.

(c) A permittee and his designees shall hold a valid Standard or Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to hold a:

(1) Permit to Transplant Prohibited (Polluted) Shellfish;

(2) Permit to Transplant Oysters from Seed Oyster Management Areas;

(3) Permit to Use Mechanical Methods for ~~Oysters or Clams~~ Shellfish on Shellfish Leases or Franchises;

(4) Permit to Harvest Rangia Clams from Prohibited (Polluted) Areas; or

(5) Depuration Permit.

(d) A permittee shall hold a valid:

(1) Fish Dealer License in the proper category in order to hold Dealer Permits for Monitoring Fisheries Under a Quota/Allocation for that category; and

(2) Standard Commercial Fishing License with a Shellfish Endorsement, Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to harvest clams or oysters for depuration.

(e) Aquaculture Operations/Collection Permits:

(1) A permittee shall hold a valid Aquaculture Operation Permit issued by the Fisheries Director to hold an Aquaculture Collection Permit.

(2) The permittee or designees shall hold appropriate licenses from the Division of Marine Fisheries for the species harvested and the gear used under the Aquaculture Collection Permit.

(f) Atlantic Ocean Striped Bass Commercial Gear Permit:

(1) Application for an Atlantic Ocean Striped Bass Commercial Gear Permit must be made prior to November 1 of each year. A person shall declare one of the following gears for an initial Atlantic Ocean Striped Bass Commercial Gear Permit and at intervals of three consecutive license years thereafter:

(A) gill net;

(B) trawl; or

(C) beach seine.

For the purpose of this Rule, a beach seine is defined as a swipe net constructed of multi-filament or multi-fiber webbing fished from the ocean beach that is deployed from a vessel launched from the ocean beach where the fishing operation takes place.

Gear declarations are binding on the permittee for three consecutive license years without regard to subsequent annual permit issuance.

(2) A person is not eligible for more than one Atlantic Ocean Striped Bass Commercial Gear Permit regardless of the number of Standard Commercial Fishing Licenses, Retired Standard Commercial Fishing Licenses or assignments held by the person.

(3) The annual, nonrefundable permit fee is ten dollars ($10.00).

(g) For Hire Fishing Permit:

(1) The permittee shall hold a valid certification from the United States Coast Guard (USCG) that allows carrying six or fewer passengers or a certification from the USCG that allows carrying more than six passengers;

(2) The permittee shall provide valid documentation papers or current motor boat registration or copies thereof for the vessel engaged as for-hire. If an application for transfer of documentation is pending, a copy of the pending application and a notarized bill of sale may be submitted.

(h) Applications submitted without complete and required information shall not be processed until all required information has been submitted. Incomplete applications shall be returned to the applicant with deficiency in the application so noted.

(i) A permit shall be issued only after the application has been deemed complete by the Division of Marine Fisheries and the applicant certifies to abide by the permit general and specific conditions established under ~~15A NCAC 03J .0501, 03J .0505, 03K .0103, 03K .0104, 03K .0107, 03K .0206, 03K .0303, 03K .0401, 03O .0502, and 03O .0503~~ 15A NCAC 03J .0501, .0505, 03K .0103, .0104, .0107, .0111, .0401, 03O .0502, and .0503 as applicable to the requested permit.

(j) The Fisheries Director, or his agent may evaluate the following in determining whether to issue, modify or renew a permit:

(1) Potential threats to public health or marine and estuarine resources regulated by the Marine Fisheries Commission;

(2) Applicant's demonstration of a valid justification for the permit and a showing of responsibility as determined by the Fisheries Director;

(3) Applicant's history of habitual fisheries violations evidenced by eight or more violations in 10 years.

(k) The Division of Marine Fisheries shall notify the applicant in writing of the denial or modification of any permit request and the reasons therefor. The applicant may submit further information, or reasons why the permit should not be denied or modified.

(l) Permits are valid from the date of issuance through the expiration date printed on the permit. Unless otherwise established by rule, the Fisheries Director may establish the issuance timeframe for specific types and categories of permits based on season, calendar year, or other period based upon the nature of the activity permitted, the duration of the activity, compliance with federal or state fishery management plans or implementing rules, conflicts with other fisheries or gear usage, or seasons for the species involved. The expiration date shall be specified on the permit.

(m) For permit renewals, the permittee's signature on the application shall certify all information as true and accurate. Notarization of signature on renewal applications is not required.

(n) For initial or renewal permits, processing time for permits may be up to 30 days unless otherwise specified in this Chapter.

(o) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries within 30 days of a change of name or address.

(p) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries of a change of designee prior to use of the permit by that designee.

(q) Permit applications are available at all Division Offices.

Authority G.S. 113-134; 113-169.1; 113-169.3; 113-182; 113-210; 143B-289.52

15.7 SUGGESTED STATUTE CHANGES NECESSARY TO IMPLEMENT THE MARINE FISHERIES COMMISSION SELECTED MANAGEMENT STRATEGY FOR AMENDMENT 2 OF THE BAY SCALLOP FISHERY MANAGEMENT PLAN

G.S. 113-168.4. Sale of fish.

(a) Except as otherwise provided in this section, it is unlawful for any person who takes or lands any species of fish under the authority of the Commission from coastal fishing waters by any means whatever, including mariculture operations, to sell, offer for sale, barter or exchange these fish for anything of value without holding a license required to sell the type of fish being offered.

(b) Except as otherwise provided in this section, it is unlawful for any person licensed under this Article to sell fish taken outside the territorial waters of the State or to sell fish taken from coastal fishing waters. A person licensed under this Article may sell fish taken outside the territorial waters of the State or sell fish taken from coastal fishing waters under any of the following circumstances:

(1) The sale is to a fish dealer licensed under G.S. 113-169.3.

(2) The sale is to the public and the seller is a licensed fish dealer under G.S. 113-169.3.

(3) The sale is of ~~oysters or clams from a hatchery or~~ fish reared in an aquaculture operation to the holder of an Aquaculture Operation Permit, an Under Dock Culture Permit, or a shellfish cultivation lease for further grow out.

(c) A person who organizes a recreational fishing tournament may sell fish taken in connection with the tournament pursuant to a recreational fishing tournament license to sell fish. A person who organizes a recreational fishing tournament may obtain a recreational fishing tournament license to sell fish upon application to the Division and payment of a fee of one hundred dollars ($100.00). It is unlawful for any person licensed under this subsection to sell fish to any person other than a fish dealer licensed under G.S. 113-169.3 unless the seller is also a licensed fish dealer. A recreational fishing tournament is an organized fishing competition occurring within a specified time period not to exceed one week and that is not a commercial fishing operation. Gross proceeds from the sale of fish may be used only for charitable, religious, educational, civic, or conservation purposes and shall not be used to pay tournament expenses. (1997-400, s. 5.1; 1998-225, s. 4.13; 2001-213, s. 2; 2009-433, s. 1.)