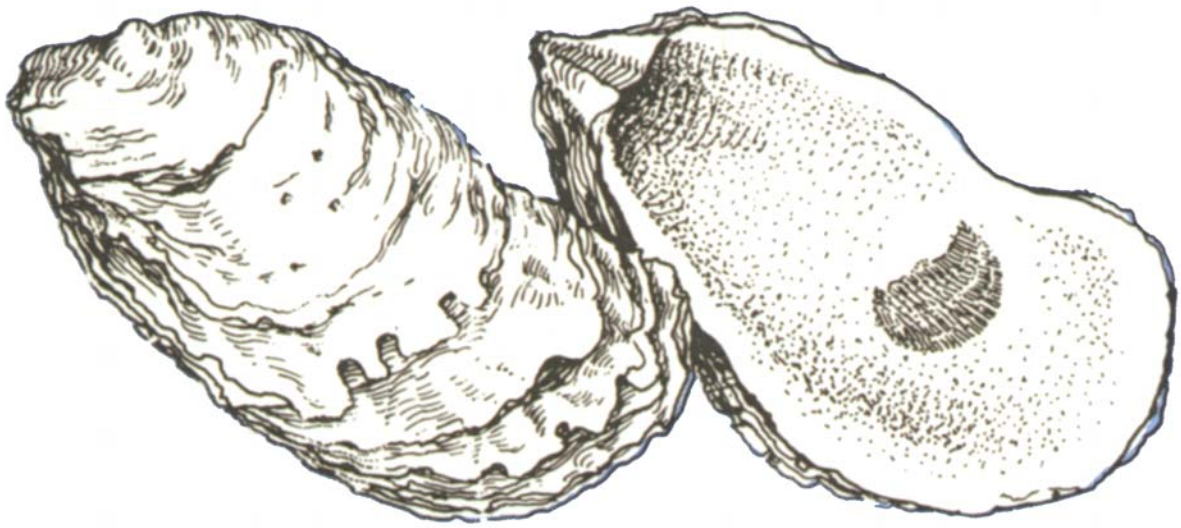
North Carolina
Fishery Management Plan

Oyster



June 2008

North Carolina
Oyster
Fishery Management Plan
AMENDMENT II

By

North Carolina Division of Marine Fisheries

North Carolina Department of Environment and Natural Resources
Division of Marine Fisheries
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Date
June 2008

July	2006	Timeline begins
June	2007	Revised with DMF comments
August	2007	Revised with AC comments
September	2007	First draft approved by MFC for public comment
November	2007	MFC selects preferred management options
November	2007	DENR Secretary and JLCSA review and comment
January	2008	MFC selects management strategies
January	2008	Draft rules approved for Notice of Text
June	2008	Amendment and rules adopted by the MFC

1.0 ACKNOWLEDGMENTS

Amendment II to the North Carolina (NC) Oyster Fishery Management Plan (FMP) was developed by the NC Department of Environment and Natural Resources (DENR) Division of Marine Fisheries (DMF) under the direction of the NC Marine Fisheries Commission (MFC) with the advice of the Shellfish Advisory Committee (AC). Deserving special recognition are the members of the Shellfish Advisory Committee and the Plan Development Team who contributed their time and knowledge to this effort.

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2.0 TABLE OF AMENDMENTS

2.1 AMENDMENT I

The Criteria for the Designation of Oyster Harvest Methods adopted as an appendix to the 2001 Oyster FMP as part of the management strategy to **adopt criteria for the further designation of areas limited to hand harvest methods and designate those areas by rule** was amended 1/31/2003 to change the depth criterion from 10 feet to 6 feet. This change was made to more accurately reflect the depths customarily used by North Carolina hand harvest fishermen.

2.2 AMENDMENT II

The following are the oyster management strategies selected by the MFC after a thorough review of the issues affecting the NC eastern oyster stock during the statutory five-year FMP review. These strategies comprise Amendment II to the NC Oyster Fishery Management Plan adopted June 26, 2008. A more complete listing of the issues and management strategies is presented in Table 4.1 and rules to implement Amendment II are found in Section 13.1.

MFC SELECTED MANAGEMENT STRATEGIES OYSTER FMP AMENDMENT II
HARVEST ISSUES
Recommend no change to the open shellfish harvest license
Recommend a 15 bushel hand/mechanical harvest limit in Pamlico Sound mechanical harvest areas outside the bays, 10 bushel hand/mechanical harvest limit in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound.
Define recreational shellfish gear
Allow no sale of weekend shellfish harvest except from leases
Propose repeal of G.S. 113-169.2 license exemption.
Set recreational limits in rule and proclamation
Require all shellfish to be tagged at the dealer level
Adopt a new rule limiting mechanical harvest of other shellfish to areas where and season when mechanical harvest gear for shellfish is allowed in existing fisheries
10 bushel mechanical gear harvest limit in the Pamlico Sound bays with a six week (mid November through December) season (until triggers are established)
Collect more data comparing the effects of 50 and 100 pound dredges prior to making a decision on this issue
Change existing rule to set the latest season closure date at March 31
PRIVATE CULTURE ISSUES
Leave regulations as is for depuration facilities.
Utilize user coordination plans for shellfish lease issuance coast wide
Support private oyster larvae monitoring programs

Support construction of an integrated system of shellfish hatcheries and remote-setting sites
Develop a subsidized, fee-for-service disease diagnosis program.
Update seed oyster management in statutes and rule.
Monitor seeded oyster sanctuaries for cownose ray predation.
Propose an exemption from G.S. 113-168.4(b)(1) when the sale is to lease, UDOC permit, or Aquaculture Operations Permit holders for further rearing
Require an examination with a passing score based on pertinent information in the training package irrespective of whether the applicant has obtained instruction voluntarily or is reviewing the information independently
Request that appropriate agencies such as the Oyster Hatcheries and N.C. Sea Grant conduct shellfish lease training as part of their educational and outreach activities
Modify G.S. 113–201 to include a requirement of an examination with a passing score for persons acquiring shellfish leases by lawful transfers unless they have a shellfish lease that is currently meeting production requirements
Encourage harvesters to take volunteer time and temperature control measures on their product.
Change the current rule specifying a three year running production average to a five year production average and change the statutory provision for a ten year lease contract to a five year contract
Limit acreage per shellfish lease application 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 Lat./Long. 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 or family holdings
No change to rules affecting the issuance of permits for culturing shellfish in closed harvest areas
INSUFFICIENT DATA
Recommend no change (status quo) to collect information on recreational harvest of shellfish through a license
ENHANCEMENT ACTIVITIES
Expand and evaluate the number of designated oyster sanctuaries to increase oyster populations
Include current and future oyster sanctuaries into North Carolina Fisheries Rules For Coastal Waters Subchapter 03R.
Plant and monitor seed oysters on existing oyster sanctuary/artificial reef sites.

ENVIRONMENTAL ISSUES
Review the results of the completed USACE EIS on the proposed introduction of Suminoe oysters in Chesapeake Bay and consult with sister states concerning use of these non-native oysters
Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation and co-ordinate with sister agencies
Recommend DWQ to designate Use-Restoration waters in conditionally closed waters where moderate contamination and healthy shellfish beds are present and develop strategies to restore and protect those waters
Recommend DWQ designate Use-restoration waters in areas where moderate contamination and appropriate shellfish culture conditions are present and develop strategies to restore and protect those waters
Recommend to the DWQ to accept a lower threshold of 10,000 square feet to coastal stormwater rules
Recommend a naturally vegetative riparian buffer width of 50 feet
Recommend the exclusion of all wetlands (coastal and non-coastal), from the built-upon area calculations
Provide educational materials to harvesters in license offices and on DMF webpage, through other training opportunities, and through DMF Port Agent contact with harvesters and dealers and include other state and federal regulatory agencies to reach all coastal waters users
Leave current management practices in place for Ward Creek
Recommend repeal of G.S. 113-207 (a) and (b) to end the requirement that all oyster rocks must be posted by the Department
Recommend that conservation leasing for constructed oyster rock habitat be studied by DENR counsel for development of a proper mechanism and to develop siting criteria

3.0 TABLE OF CONTENTS

3.1 LIST OF TABLES

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3.3 LIST OF ACRONYMS

AC – Advisory Committee
AEC – Areas of Environmental Concern
ASMFC – Atlantic States Marine Fisheries Commission

BMP – Best Management Practice
BRACO – Blue Ribbon Advisory Committee on Oysters

CAMA – Coastal Area Management Act
CHPP – Coastal Habitat Protection Plan
COE – United States Army Corp of Engineers
CPI – Consumer Price Index
CPUE – Catch Per Unit Effort
CRC – North Carolina Coastal Resources Commission
CRFL – Coastal Recreational Fishing License

DCM – North Carolina Division of Coastal Management
DEH - North Carolina Department of Environmental Health
DEHNR - North Carolina Department of Environment, Health and Natural Resources
DENR – North Carolina Department of Environment and Natural Resources
DMF – North Carolina Division of Marine Fisheries
DO – Dissolved Oxygen
DWQ- North Carolina Division of Water Quality

EFH – Essential Fish Habitat
EMC – North Carolina Environmental Management Commission
EPA – United States Environmental Protection Administration

FDA – United States Food and Drug Administration
FMP – Fishery Management Plan
FRA – Fishery Reform Act
FRG – Fishery Resource Grant
FY – Fishing Year

GIS – Geographical Information System
GS – General Statute

HBR – Hatchery Based Restoration
HQW- High Quality Waters

IWW – Intracoastal Waterway
ISSC – Interstate Shellfish Sanitation Conference

JLCSA – Joint Legislative Commission for Seafood and Aquaculture

MFC – North Carolina Marine Fisheries Commission
MRFSS- Marine Recreational Fisheries Statistical Survey
MSC – Moratorium Steering Committee
MSX – Multinucleated Sphere Unknown

NC – North Carolina
NCAC – North Carolina Administrative Code
NCOHP – North Carolina Oyster Hatchery Program
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NPDES - National Pollution Discharge Elimination System
NSSP – National Shellfish Sanitation Program
NSW – Nutrient Sensitive Waters

ORW – Outstanding Resource Waters

PDT – Plan Development Team

PNA – Primary Nursery Area
PPI – Producer Price Index
PPT – Parts Per Thousand

RAT – Rules Advisory Team
RCGL – Recreational Commercial Gear License
RSCFL – Retired Standard Commercial Fishing License

SAFMC – South Atlantic Fishery Management Council
SAV – Submerged Aquatic Vegetation
SCFL – Standard Commercial Fishing License
SHA – Strategic Habitat Area
SMA – Shellfish Management Area
SOMA – Seed Oyster Management Area
SR – Shellfish Resource Waters
SSR – Stock Status Report

TSS – Total Suspended Solids

UDOC – Under Dock Oyster Culture
UNC – University of North Carolina
UNC-CH – University of North Carolina, Chapel Hill
UNCW – University of North Carolina, Wilmington
URW – Use Restoration Waters
USFWS – United States Fish and Wildlife Service
USMP- Universal Stormwater Management Program

VMPB – Virginia Marine Products Board

WRC – North Carolina Wildlife Resources Commission
WS – Water Supply

4.0 EXECUTIVE SUMMARY

Oyster Stock Status: DMF designates Eastern oyster as a species of concern. Species of concern exhibit one or more of the following: incomplete or unavailable stock assessments, increased or decreased effort and landings, and susceptibility to indirect influences such as disease, habitat degradation, weather, water quality or life history concerns. Oysters are believed to be vulnerable to overharvest because of several factors negatively impacting their survival. There are insufficient data to conduct an oyster stock assessment in North Carolina.

Stock Status Factors:	Northern Area	Southern Area
	Persistent Dermo infections	High harvest pressure
	Oyster habitat degradation	Oyster habitat degradation

Problem Areas: (A) Harvest issues – (1) Mechanical harvest and clam harvest habitat effects, (2) Habitat value higher than harvest value, (3) Increase application of rule authority, (4) Educate harvesters on best practices. (B) Private culture – (1) Insufficient industry support, (2) Improve lease administration, (3) Increase harvest through depuration. (C) Insufficient data – Unable to conduct stock assessment. (D) Enhancement activities – (1) Improve, increase methods, (2) Plant seed on sanctuaries. (E) Environmental issues – Increase efforts to restore water quality.

Public Fishery Aspects: Landings from 1999-2005 are comprised of 82% hand-harvested oysters primarily from the southern part of the state. Landings have trended slightly upward since the 1999/2000 season with increases in both hand and mechanical gear harvest.

Private Fishery Aspects: Investigation of other states with successful programs showed NC does not adequately support private oyster cultivation. During 1999–2005, 13% of the State's oysters were produced on shellfish leases and franchises.

Recreational Fishery: The size and extent of the recreational fishery are unknown but considered to be significant in the southern area.

Economic Status: Oyster landings have recovered moderately in recent years and were valued at $2.2 million in 2006.

Management Options: Section 10.0 provides background and discussion of the 24 issues considered by DMF staff and the Advisory Committee in drafting the recommendations.

Sustainable Harvest: Although there is insufficient data to calculate sustainable harvest levels for the oyster fishery, the available indicators show that harvest is not excessive (Section 6.2.1). The MFC chose to keep harvest strategies consistent with recent years except for lowering daily limits in the portions of Pamlico Sound bays open to mechanical harvest to 10 bushels per day. It is also recommended to increase shellfish sampling programs to determine triggers for closing the harvest season.

4.1 SYNOPSIS OF MANAGEMENT STRATEGIES

The MFC selected management strategies from the DMF and AC management recommendations as shown below. They also approved all the recommendations concerning habitat and water quality listed in the Environmental Factors section on pages 121-123.

Table 4.1 MFC Selected Management Strategies

MFC SELECTED MANAGEMENT STRATEGIES	ISSUE/SECTION	OBJECTIVES ADDRESSED	REQUIRED ACTION
HARVEST ISSUES			
Recommend no change to the open shellfish harvest license	10.1.1 Effects of an Open Harvest License on Shellfish Fisheries	4 and 8	No action required
Recommend a 15 bushel hand/mechanical harvest limit in Pamlico Sound mechanical harvest areas outside the bays, 10 bushel hand/mechanical harvest limit in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound.	10.1.2 Mechanical and Hand Harvest Trip Limit Differences	2 and 7	DMF Proclamation
Define recreational shellfish gear	10.1.3 Recreational and Weekend Shellfish Harvest Provisions	2, 4 and 7	Amend 15A NCAC 03I .0101
Allow no sale of weekend shellfish harvest except from leases	10.1.3 Recreational and Weekend Shellfish Harvest Provisions	2 and 4	Amend 15A NCAC 03K .0106
Propose repeal of G.S. 113-169.2 license exemption.	10.1.3 Recreational and Weekend Shellfish Harvest Provisions	4 and 7	Amend G.S. 113-169.2 and 15A NCAC 03K .0105
Set recreational limits in rule and proclamation	10.1.3 Recreational and Weekend Shellfish Harvest Provisions	4 and 7	Amend 15A NCAC 03K .0105 and use DMF proclamation authority

Require all shellfish to be tagged at the dealer level	10.1.4 Require all Shellfish (out-of-state) at Dealer Level to be Tagged	4	Adopt proposed 15A NCAC 03K .0109
Adopt a new rule limiting mechanical harvest of other shellfish to areas where and season when mechanical harvest gear for shellfish is allowed in existing fisheries	10.1.5 Mechanical Harvest of Other Shellfish	1, 4, and7	Adopt proposed 15A NCAC 03K .0108
10 bushel mechanical gear harvest limit in the Pamlico Sound bays with a six week (mid November through December) season (until triggers are established)	10.1.6 Increase Dredging Restrictions in Pamlico Sound Bays	1, 4 and 7	DMF proclamation authority
Collect more data comparing the effects of 50 and 100 pound dredges prior to making a decision on this issue	10.1.6 Increase Dredging Restrictions in Pamlico Sound Bays	1, 4 and 7	Cooperative sampling efforts with industry
Change existing rule to set the latest season closure date at March 31	10.1.7 Change of Dates for Oyster Season	1, 4 and 7	Amend 15A NCAC 03K .0201
PRIVATE CULTURE ISSUES			
Leave regulations as is for depuration facilities.	10.2.1 Shellfish Depuration Plants	1 and 5	No action required
Utilize user coordination plans for shellfish lease issuance coast wide	10.2.2Allocation of Areas for Shellfish Leases	2, 4, 6 and8	No action required **Funding required**
Support private oyster larvae monitoring programs	10.2.3Technical Support for Shellfish Leaseholders	2	Coordination with growers and researchers
Support construction of an integrated system of shellfish hatcheries and remote-setting sites	10.2.3 Technical Support for Shellfish Leaseholders	1, 2, 3, 6, and 9	No new action required **Funding required**

Develop a subsidized, fee-for-service disease diagnosis program.	10.2.3 Technical Support for Shellfish Leaseholders	2 and 6	No action required
Update seed oyster management in statutes and rule.	10.2.4 Seed Oyster Management Areas	1 and 2	Amend 15A NCAC 03I .0101 and 03K .0103. Adopt proposed 15A NCAC 03K .0208 and 03R .0115 Amend G.S. 113-203
Monitor seeded oyster sanctuaries for cownose ray predation.	10.2.5 Cownose Ray Interactions and Their Effect on Clams and Oysters	2 and 6	DMF monitoring
Propose an exemption from G.S. 113-168.4(b)(1) when the sale is to lease, UDOC permit, or Aquaculture Operations Permit holders for further rearing	10.2.6 Status of Pre-Dealer Seed Shellfish Sales	2 and 9	Amend G.S. 113-168.4(b)(1)
Require an examination with a passing score based on pertinent information in the training package irrespective of whether the applicant has obtained instruction voluntarily or is reviewing the information independently	10.2.7 Leaseholder Educational Training	2 and 9	Amend G.S. 113-202 Amend 15A NCAC 03O .0202
Request that appropriate agencies such as the Oyster Hatcheries and N.C. Sea Grant conduct shellfish lease training as part of their educational and outreach activities	10.2.7 Leaseholder Educational Training	2 and 9	No action required
Modify G.S. 113–201 to include a requirement of an examination with a passing score for persons acquiring shellfish leases by lawful transfers unless they have a shellfish lease that is currently meeting production requirements	10.2.7 Leaseholder Educational Training	2 and 9	Amend G.S. 113-201

Encourage harvesters to take volunteer time and temperature control measures on their product.	10.2.8 Education on Shellfish Health Risks	2 and 5	No new action required
Change the current rule specifying a three year running production average to a five year production average and change the statutory provision for a ten year lease contract to a five year contract	10.2.9 Modify Shellfish Lease Provisions	2	Amend G.S. 113-202 Amend 15A NCAC 03O .0201
Limit acreage per shellfish lease application to 5 acres	10.2.9 Modify Shellfish Lease Provisions	1 and 2	Rule change to 15A NCAC 03O .0201
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	10.2.9 Modify Shellfish Lease Provisions	1 and 2	Amend G.S. 113-202 Amend 15A NCAC 03O .0201and 15A NCAC 03O .0210
Require Lat./Long. coordinates on lease corner locations as part of the requirement of a registered land survey	10.2.9 Modify Shellfish Lease Provisions	1 and 2	Amend G.S. 113-202 Amend15A NCAC 03O .0203
Develop regional lease acreage caps based on established use of water bodies	10.2.9 Modify Shellfish Lease Provisions	1 and 2	Amend G.S. 113-202
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 or family holdings	10.2.9 Modify Shellfish Lease Provisions	1 and 2	Amend G.S. 113-202
No change to rules affecting the issuance of permits for culturing shellfish in closed harvest areas	10.2.10 Movement of Cultured Seed Shellfish from Polluted Waters	2 and 3	No action required Referred to Shellfish Committee

INSUFFICIENT DATA			
Recommend no change (status quo) to collect information on recreational harvest of shellfish through a license	10.3.1 No Data on Recreational Harvest of Shellfish	4	No action required
ENHANCEMENT ACTIVITIES			
Expand and evaluate the number of designated oyster sanctuaries to increase oyster populations	10.4.1 Oyster Sanctuary Development/ Construction	1, 2, 3, and 9	No new action required
Include current and future oyster sanctuaries into North Carolina Fisheries Rules For Coastal Waters Subchapter 03R.	10.4.1 Oyster Sanctuary Development/ Construction	1, 2, 3, and 9	Amend 15A NCAC 03I .0101 and 03K .0103 Adopt 15A NCAC 03K .0208 and 03R .0115
Plant and monitor seed oysters on existing oyster sanctuary/artificial reef sites	10.4.1 Oyster Sanctuary Development/ Construction	1, 2, 3, and 9	No new action required
ENVIRONMENTAL ISSUES			
Review the results of the completed USACE EIS on the proposed introduction of Suminoe oysters in Chesapeake Bay and consult with sister states concerning use of these non-native oysters	10.5.1 Non-Native Oyster Introduction Issue	2, 3, 4, 6	No new action required
Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation and co-ordinate with sister agencies	10.5.2 Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	5	Existing authority through the CHPP implementation plan
Recommend DWQ to designate Use-Restoration waters in conditionally closed waters where moderate contamination and healthy shellfish beds are present and develop strategies to restore and protect those waters	10.5.2 Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	5	Existing authority through the CHPP implementation plan

Recommend DWQ designate Use-restoration waters in areas where moderate contamination and appropriate shellfish culture conditions are present and develop strategies to restore and protect those waters	10.5.2 Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	2 and 5	Existing authority through the CHPP implementation plan
Recommend to the DWQ to accept a lower threshold of 10,000 square feet to coastal stormwater rules	10.5.2 Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	5	Existing authority through the CHPP implementation plan
Recommend a naturally vegetative riparian buffer width of 50 feet	10.5.2 Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	5	Existing authority through the CHPP implementation plan
Recommend the exclusion of all wetlands (coastal and non-coastal), from the built-upon area calculations	10.5.2 Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	5	Existing authority through the CHPP implementation plan
Provide educational materials to harvesters in license offices and on DMF webpage, through other training opportunities, and through DMF Port Agent contact with harvesters and dealers and include other state and federal regulatory agencies to reach all coastal waters users	10.5.3 Education on Public Health Risks of Eating Shellfish and Overboard Discharge of Waste	2 and 5	No new action required
Leave current management practices in place for Ward Creek	10.5.4 Ward Creek Shellfish Management Area	1, 2, 3 and 7	DMF proclamation
Recommend repeal of G.S. 113-207 (a) and (b) to end the requirement that all oyster rocks must be posted by the Department	10.5.5 Oyster Rock Management Options	1, 2, and 4	Repeal G.S. 113-207 (a) and (b)

Recommend that conservation leasing for constructed oyster rock habitat be studied by DENR counsel for development of a proper mechanism and to develop siting criteria	10.5.5 Oyster Rock Management Options	1, 2, 6 and 8	Study by DENR

5.0 INTRODUCTION

The Eastern oyster (*Crassostrea virginica*) occupies a unique position in the estuaries of North Carolina because its colonization of bottomlands creates a productive habitat and the animal itself is harvested as a food item. Oyster harvest has been an important source of food in coastal areas since before recorded history. Oyster harvesting in North Carolina was the most valuable shellfishery in the state until the 1970s. Until recently, most of the focus on oysters has been on means and methods of continuing their exploitation. As oyster stocks continue to decline in many areas, scientists are beginning to realize their value as a source of turbidity reduction, nitrogen and phosphorus release, food for filter feeders and predators, substrate for other filter feeders and bacteria, and as a stabilizing force in the sediments of the estuary.

The Eastern oyster has been called the quintessential estuarine animal. It can tolerate a wide range of salinity, temperature, turbidity, and dissolved oxygen levels, making it well adapted to the ever-changing conditions of the estuary. The genus *Crassostrea* has survived for 135 million years. The health of North Carolina's oyster populations is a good indicator of the overall health of our estuaries, and all prudent measures should be taken to ensure a viable oyster resource.

5.1 RECOMMENDED MANAGEMENT PROGRAM

5.1.1 MANAGEMENT AUTHORITY

The North Carolina Marine Fisheries Commission (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. 143B-289.51; 113-131). North Carolina General Statutes 113-134, 113-182 and 143B-289.52 give the MFC broad authority to promulgate rules for the management of marine and estuarine resources, including oysters, in coastal fishing waters. General Statute 113-201 also empowers the MFC to make rules and take all steps necessary to develop and improve the cultivation, harvesting and marketing of shellfish in North Carolina both from public grounds and private beds. The authority to implement rules governing sale, possession, transportation, storage, planting, and handling of oysters as necessary to regulate the lawful transplanting of oysters and oyster seed is also vested in the MFC (G.S. 113-203).

General Statute 143B-289.52 allows the MFC to delegate authority to implement its rules governing fishing practices "which may be affected by variable conditions" to the Director of DMF by issuing public notices called "proclamations." Proclamation authority has been

established for the Director of DMF to manage the oyster fishery providing a powerful and flexible tool for oyster fishery management. Other authorities for management of the State's oyster resources have been given to the Secretary of DENR including the authority to grant shellfish bottom leases under G.S. 113-202 and water column leases over existing shellfish bottom leases and franchises under G.S. 113-202.1 and G.S. 113-202.2. Propagation of shellfish by DENR both for public harvest or planting on private beds is authorized under G.S. 113-204. Public involvement through recreational oyster culture under private docks is authorized with a permit from the Fisheries Director in G.S. 113-210.

The Fisheries Reform Act of 1997 and amended in 2004 (FRA) establishes a process for preparation of coastal fisheries management plans in North Carolina. The FRA states "the goal of the plans shall be to ensure the long term viability of the State's commercially and recreationally significant species or fisheries. Each plan shall be designed to reflect fishing practices so that one plan may apply to a specific fishery, while other plans may be based on gear or geographic areas. Each plan shall:

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

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

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

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

Sustainable harvest is defined in the FRA as "The amount of fish that can be taken from a fishery on a continuing basis without reducing the stock biomass of the fishery or causing the fishery to become overfished."

Overfished is defined as "The condition of the 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."

Overfishing is defined as "Fishing that causes a level of mortality that prevents a fishery from producing a sustainable harvest."

5.1.2 GOAL AND OBJECTIVES

The goal of the NC Oyster FMP is to manage the State's oyster population so that it achieves sustainable harvest and maximizes its role in providing ecological benefits to NC's estuaries. To achieve this goal, it is recommended that the following objectives be met:

1. To identify, restore, and protect oyster populations as important estuarine habitat.

2. To manage and restore oyster populations to levels capable of maintaining sustained production through judicious use of natural oyster resources, enhancement of oyster habitats, and development and improvement of the private oyster fishery.

3. To minimize the impacts of oyster parasites through better understanding of oyster disease, better utilization of affected stocks, and use of disease resistant oysters.

4. To consider the socioeconomic concerns of all groups utilizing the oyster resource, including market factors.

5. To recommend improvements to coastal water quality to reduce bacteriological-based harvest closures and to limit other pollutants to provide a suitable environment for healthy oyster populations.

6. To identify and encourage research to improve understanding of oyster population ecology and dynamics, habitat restoration needs, and oyster aquaculture practices.

7. To identify, develop, and promote efficient oyster harvesting practices that minimize damage to the habitat.

8. To initiate, enhance, and continue studies to collect and analyze economic, social, and fisheries data needed to effectively monitor and manage the oyster resource.

9. To promote public awareness regarding the ecological value of oysters and encourage public involvement in management and enhancement activities.

5.1.3 SUSTAINABLE HARVEST STRATEGY

Although there is insufficient data to calculate sustainable harvest levels for the oyster fishery, the available indicators show that harvest is not excessive (see Section 6.2). The MFC chose to keep harvest strategies consistent with recent years except for lowering daily limits in the portions of Pamlico Sound bays open to mechanical harvest to 10 bushels per day. It is also

recommended to increase shellfish sampling programs to determine triggers for closing the harvest season.

5.1.4 MANAGEMENT MEASURES AND RULES

The MFC selected management strategies are presented in Section 4.1. Draft rules to implement the management strategies are presented in Section 13.1.

5.1.5 MONITORING REQUIREMENTS

Monitoring requirements established in Amendment II include the following:

- Monitor seed oyster sanctuaries for cownose ray predation
- Monitor seed oysters planted on oyster sanctuaries
- Monitor mechanical harvest of oysters to establish triggers for closing the season
- Support a cooperative oyster larvae monitoring program
- Develop a method to monitor recreational harvest for stock assessment purposes

These monitoring requirements are in addition to established oyster monitoring programs.

5.1.6 RESEARCH NEEDS

- Develop peer reviewed, standardized monitoring metrics and methodologies for oyster restoration and stock status assessments
- Conduct studies on the impacts of current oyster dredging practices on oyster habitat
- Conduct studies on the effects of oyster dredge weight and size on habitat disturbance and oyster catches
- Determine a protocol and triggers for closures of oyster harvesting areas
- Conduct stock assessments of oysters located within polluted areas to determine feasibility of depuration operations
- Review current DEH rules to update to current depuration technologies.
- Explore new technologies for off-bottom oyster culturing methods
- Develop new types of biomarkers that can be used to select more effectively for disease-resistant genetic oyster stock
- Develop disease-resistant or fast-growing strains of oysters
- Establish an oyster brood stock development program
- Develop methods to determine resistance of shellfish stocks to various diseases
- Assess survival and productivity of relayed oysters vs. natural recruitment on planted cultch
- Investigate timing of oyster spatfall, larval dispersal and transport
- Determine the hydrodynamics of areas for oyster restoration, culture activities and sanctuaries
- Collect population information on cownose rays
- Explore uses of cownose rays for food in the pet food industry and the human food industry
- Explore uses of cownose rays as a source of chondroitin/glucosamine or oil for pet and human supplements

- Investigate markets for cownose rays
- Investigate areas of sanctuary placement (shallow/deep), size, and impacts to the local fishing grounds.
- Determine sanctuary size, profile, and amount of material needed
- Determine the cost of an oyster sanctuary project (private vs. state)
- Investigate larval oyster dispersal and transport.
- Investigate oyster spat settlement success on different cultch materials
- Continue research on means and methods for reduction of non-point source pollution and mitigation of pollutant effects in the estuary.
- Determine the effect of shellfish filtering capacities on water quality parameters, such as bacteria, nutrients and sediments.
- Support collaborative research to more efficiently track bacterial sources for land-based protection and restoration efforts.
- Quantify the impact of current fishing practices on oyster habitat suitability in North Carolina.
- Determine the impact of docks siting practices and bottom disturbing activities on nearby habitats and on the shifting boundaries of habitat itself so that protective buffer distances can be established.
- Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units (i.e., docks, bulkhead sections)

5.2 GENERAL PROBLEM STATEMENT

The Blue Ribbon Advisory Council on Oysters (BRACO) examined the problems affecting oyster production and found the following. "The council concludes that there is no single explanation for the progressive loss of oysters over the past century. It is clear that many aspects of the state's development contributed to the decline. Habitat destroyed by oyster harvesting has not been adequately replaced by oyster enhancement programs. Public trust waters have not been effectively developed for oyster culture. Coastal lands have been developed for agriculture, forestry and residences with little regard for impact on oysters or other aquatic resources. Currently used systems for treatment of point and non-point discharges into coastal waters do not assure adequate water quality for oyster growing areas. Markets for oysters have declined as consumers have responded to reports of adverse effects of eating raw oysters. Furthermore, the problems that have afflicted oysters in North Carolina are geographically widespread. They are especially critical in neighboring mid-Atlantic regions with similar climatic conditions, such as the Chesapeake Bay. The ongoing decline of the Eastern oyster throughout its range can be attributed to outbreaks of oyster diseases, in large part weather-driven; to failure to preserve oyster reef habitat against degradation; to overharvest; and to substantial deterioration of coastal water quality." (Frankenberg 1995)

5.2.1 HARVEST ISSUES

The use of mechanical gear to harvest oysters has been a controversial issue since its introduction. The perception is that mechanical harvesting damages oyster rocks and therefore, long term oyster growth and survival. More recently, oyster fishermen have cited clam

harvesting as damaging to oysters and their habitat in intertidal areas. Quantitative research is needed to address both of these issues.

The habitat value that oysters provide has also brought into question the wisdom of allowing any oyster harvest. Since oysters are the primary source of natural, hard substrate in North Carolina's coastal waters and are responsible for significant amounts of water filtration, it may be prudent to restrict some oyster habitat from any harvesting disturbances and further limit mechanical harvest methods in other areas. Specific issues, options, and potential actions are outlined in Section 10.0.

5.2.2 PRIVATE CULTURE

The BRACO analyzed information from states and countries with successful oyster culture programs and concluded that North Carolina did not provide sufficient support, either in access to resources or technical services, to establish a productive oyster culture industry. Oyster culturists often encounter difficulties obtaining a shellfish leases and find the requirements for maintaining and managing the lease site burdensome. The BRACO found that the best hope for maintaining the oyster resource in the face of current disease challenges is through private culture and recommended that improvements to the shellfish lease program be given the highest priority.

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 bottomlands will overtake their fishing grounds and tourist industry and residential groups that feel shellfish leases are unsightly and restrict access to water resources. Specific issues, options, and potential actions are outlined in Section 10.0.

5.2.3 INSUFFICIENT ASSESSMENT DATA

The data necessary for a robust estimate of oyster standing stock and sustainable harvest do not yet exist. Recreational harvest and socioeconomic data is totally lacking. Collection of appropriate data will need to be initiated in order for future oyster stock status designations to be based on quantitative assessments of population trends. **The statutory obligation to maintain sustainable harvest in the oyster fishery cannot be calculated until the appropriate data are collected.** Specific issues, options, and potential actions are outlined in Section 10.0. A discussion of options for gathering data necessary to determine optimum yield appears in Section 6.2.2.

5.2.4 ENHANCEMENT ACTIVITIES

Since the 2001 Oyster FMP was approved, the NC General Assembly has restored Shellfish Rehabilitation Funding, approved new funding to plan construction of oyster hatcheries and set aside funds specifically for the construction of oyster sanctuaries and recycling of oyster shells. DMF and the MFC must create the management tools to effectively establish and protect these

enhanced oyster habitats and implement the new enhancement programs.

5.2.5 ENVIRONMENTAL ISSUES

Oysters are the primary component of shell bottom habitat described in detail in the Coastal Habitat Protection Plan, or CHPP (Street et al. 2005). The CHPP provides information on many aspects of shell bottom habitat. Shell bottom is defined in the CHPP as "estuarine intertidal and subtidal bottom composed of surface shell concentrations of living or dead oysters (*Crassostrea virginica*), hard clams (*Mercenaria mercenaria*), and other shellfish." The CHPP also includes management recommendations that will be reiterated and expanded upon in this plan. While the interdependency of all habitats is important to oysters, some habitats are of particular importance because they are actually inhabited by oysters. Those habitats include water column, estuarine bottoms that support the oyster's growing or accumulative community weight (Jenkins et al. 1997), and wetlands. Threats to these habitats are discussed in the Section 9.0.

Threats to oyster bottom habitat include mobile bottom disturbing fishing gear, hand harvest methods, water-dependent development, mining, dredge material disposal, and introduced or nuisance species. Water quality threats include excess turbidity/sedimentation, nutrient enrichment, toxic chemicals/organisms, and microbial contamination. Other threats include fishing activities, associated turbidity/sedimentation, and microbial contamination (shellfish harvest area closure).

5.3 DEFINITION OF MANAGEMENT UNIT

The management unit includes the Eastern oyster (*Crassostrea virginica)* and its fisheries in all waters of coastal North Carolina.

5.4 EXISTING PLANS, STATUTES, AND RULES

5.4.1 PLANS

The 1994 Session of the NC General Assembly created the Blue Ribbon Advisory Council on Oysters (BRACO) to study and make recommendations concerning policies and management of the States oyster resources. Senate Bill 1403 established the nineteen-member council to assist the MFC and the Joint Legislative Commission on Seafood and Aquaculture (JLCSA) by making recommendations on:

(1) Restoration of oyster production on public beds
(2) Development of aquaculture production of oysters
(3) Management of oyster reefs to maximize production
(4) Zoning and protective measures concerning oyster reefs and culture operations
(5) Marketing and economic development of oysters
(6) Development of value-added products and processing
(7) Changes in the leasing of oyster bottoms and water columns for culture

(8) Expenditure of public funds in relation to private funding of oyster production
(9) Development of a management plan for the restoration of the oyster resource

An Oyster Restoration and Fishery Management Plan was produced in October 1995 to answer the ninth charge given by the General Assembly. The plan contained detailed recommendations on the first eight charges. The general objectives of the plan were to: (1) examine past and current management, enhancement, and harvest strategies, (2) discuss possible causes of the decline in oyster harvests, (3) propose new management, enhancement, and harvest strategies to improve production and utilization of existing resources, and (4) develop a plan for the restoration of the oyster resource. Much of the material presented in this FMP is drawn from the plan prepared by the BRACO.

The 2001 NC Oyster FMP Amendment I currently guides oyster fishery management in the State pursuant to the Fisheries Reform Act of 1997as amended in 2004. This document is the culmination of a thorough review of the existing Oyster FMP and any revisions to the plan resulting from this review will be designated as Amendment II.

5.4.2 STATUTES (North Carolina General Statutes)

G.S. 113-168.2. Standard Commercial Fishing License.

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

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

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

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

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

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

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

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

This General Statute establishes a license requirement and establishes a $50.00 fee for dealing in oysters. Dealer's licenses are restricted to North Carolina residents.

G.S. 113-182.1. Fishery Management Plans.

Requires the Department to prepare and the MFC to adopt FMPs for all commercially or recreationally significant species.

G.S. 113-184. Possession and transportation of prohibited oyster equipment.

During the regular closed oyster season, oyster dredges are not allowed on boats except for use on privately held shellfish bottoms.

G.S. 113-187. Penalties for violations of Article and Rule.

The penalties for shellfishing in areas closed due to pollution are set in this statute.

G.S. 113-201.1 Definitions

Provides definitions for: natural shellfish beds, riparian owner, shellfish, single family unit, and water column.

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. Sets requirements and fees.

G.S. 113-202.1. Water column leases for aquaculture.

Allows shellfish leaseholders 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. 113-203. Transplanting of oysters and clams.

Requirements for transplanting shellfish to private beds are established in this statute. The procedure for establishing seed oyster management areas is also defined.

G.S. 113-205.	Registration of grants in navigable waters; exercise of private fishery rights. Authority is established in this statute for the MFC to make rules governing utilization of private shellfish bottomlands arising out of shellfish franchises.
G.S. 113-206.	Chart of grants, leases and fishery rights; overlapping leases and rights; contest or condemnation of claims; damages for taking of property. This statute provides for resolution of submerged lands conflicts including shellfish leases and franchises.
G.S. 113-207.	Clamming on posted oyster rocks forbidden; penalty. This statute prohibits damage to oysters and oyster rocks by clam harvesting on posted areas.
G.S. 113-208.	Protection of private shellfish rights. This statute establishes a maximum $5,000 fine and six months in prison for theft from a shellfish lease.
G.S. 113-209.	Taking polluted shellfish at night or with prior conviction forbidden; penalty. This statute establishes the act of taking polluted shellfish under certain conditions as a Class I felony.
G.S. 113-210.	Under dock oyster culture. Establishes a permit that allows dock owners to attached up to 90 square feet of oyster cultivation containers under their docks in open harvest areas. Training is required.
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 Environmental Management Commission, Coastal Resources Commission, and MFC to adopt and follow the plans.

5.4.3 RULES [All references are from North Carolina Fisheries Rules for Coastal Waters Chapter 15A North Carolina Administrative Code (NCAC).]

1. Definitions (03I .0101)

a. 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.

b. Mechanical methods for oystering: includes but is not limited to dredges, patent tongs, stick rakes, and other rakes when towed by engine power and any other method that utilizes mechanical means to harvest oysters.

c. Depuration: purification or the removal of adulteration from live oysters, clams, and mussels by any natural or artificially controlled means.

d. 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.

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

f. Intertidal oyster bed: a formation regardless of size or shape, formed of shell and live oysters of varying density.

2. Prohibited Shellfish Areas/Activities (03K .0101)

This rule establishes proclamation authority to prohibit taking, possessing or selling oysters from prohibited (polluted) areas as recommended by the Division of Environmental Health. Out-of-state oysters taken from polluted waters may not be possessed or sold in this state.

3. Prohibited Rakes (03K .0102)

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

4. Shellfish/Seed Management Areas (03K .0103)

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

5. Permits for Planting Shellfish from Polluted Area (03K.0104)

This rule establishes a six-week season for relaying of prohibited (polluted) oysters from designated areas to privately controlled bottomlands. Permits and closure of private bottomlands to harvest is required.

6. Harvest of Crabs and Shellfish (03K .0105)

This rule allows harvest of one bushel of oysters per person per day, not to exceed two bushels per vessel per day to be taken without a commercial license during regular open seasons including Sundays.

7. Taking or Unloading Oysters and Clams on Sunday or At Night (03K .0106)

Commercial oyster harvest is prohibited on Sunday, and any oyster harvest is illegal between sunset and sunrise on any day. An exception for unloading oysters until two hours after sunset is made for New Hanover, Brunswick, and Pender counties.

8. Depuration of Shellfish (03K .0107)

Oysters may be taken from prohibited areas for depuration in an approved depuration plant only when the oysters would otherwise be lost due to maintenance dredging operations. Specifications for approved depuration plants can be found in Rules Governing the Sanitation of Shellfish 15A NCAC 18A Section .0700. Proclamation authority, permits, and transportation guidelines are established. Supervision by DMF and the Division of Environmental Health is required.

9. Open Season (03K .0201)

The oyster season may begin on October 15 and may extend through May 31. The specific dates are set by proclamation and the Fisheries Director may also specify days, areas, harvest methods, daily time periods and limit the quantity. A maximum limit of 50 bushels per fishing operation is set.

10. Size Limit and Culling Tolerance (03K .0202)

The size limit for oysters is set by proclamation but can be no less than a shell length of 2.5 inches. Oysters less than the legal size limit, dead shell, and any oyster cultch material must be culled from the catch where the harvest took place. A 10 percent tolerance limit by volume is allowed. Oysters imported for shucking purposes are exempt from this rule.

11. Dredges/Mechanical Methods Prohibited (03K .0204) (03R .0108)(03J .0303) (03N .0104)

Roanoke Sound, the shallow area behind the Outer Banks from Oregon Inlet to Core Sound, Pamlico Sound bays generally less than 6 feet deep, Core Sound and its tributaries, Back Bay, The Straits, Back Sound, North River, Newport River, Bogue Sound, White Oak River, and all

of the coastal waters of Onslow, Pender, New Hanover, and Brunswick counties are closed to mechanical harvest of oysters except on private bottom by permit. Only one oyster dredge may be used per vessel and mechanical methods for oyster harvest are not allowed between sunset and sunrise. Oyster dredges can weigh no more than 100 pounds. Dredges or mechanical methods for oyster harvest are prohibited in any of the primary nursery areas described in 15A NCAC 3R .0103.

12. Marketing Oysters Taken from Private Shellfish Bottoms (03K .0205)

Culling of oysters from private beds to the minimum size limit is required during the regular open oyster season. A permit for harvesting from private beds is required at any time and a certification form must accompany oysters sold during the closed season.

13. Permits to Use Mechanical Methods for Oysters or Clams on Shellfish Leases and Franchises (03K .0206)

This rule makes if unlawful to use mechanical methods on a lease or franchise without a permit. Procedures and requirements for obtaining permits are found in 03O .0500.

14. Oyster Size and Harvest Limit Exemption (03K .0207)

This rule establishes a size limit exemption for oysters raised in an aquaculture operation.

15. 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.

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

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

17. Shellfish Lease Application Processing (03O .0203)

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

18. Marking Shellfish Leases and Franchises (03O .0204)

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

19. Lease Renewal (03O .0205)

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

20. Lease Protest (03O .0206)

Commenting and formal protest procedures on lease applications are specified.

21. Production Report (03O .0207)

Production information requirements and reporting dates are given.

22. 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.

23. 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.

24. Shellfish Franchises (03O .0210)

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

25. Protection of Private Shellfish Interest (03O .0211)

Makes it unlawful to use a trawl, long haul seine, swipe net, dredge or mechanical method for oysters or clams on a lease or franchise unless it is duly authorized.

26. Permit Conditions; Specific (03O .0503)

a. Aquaculture Operations/Collection Permit - Requires an Aquaculture operation Permit to conduct Aquaculture Operations.

b. Under Dock Oyster Culture Permit – Requires this permit to conduct recreational oyster culture under private docks.

5.4.4 OTHER JURISDICTIONS

The Department of Health and Human Services Commission for Health Services is responsible for adopting regulations for the protection of the public health establishing sanitation requirements for the harvesting, processing and handling of shellfish and crustaceans. The Division of Environmental Health, Shellfish Sanitation Section is responsible for North Carolina's compliance with the National Shellfish Sanitation Program (NSSP) of the U.S. Food and Drug Administration. Based on data from the Shellfish Sanitation Section , the State Health Director recommends closures of coastal waters to shellfish harvest; DMF implements the closures by proclamation, and enforcement of those closures is conducted by DMF Marine Patrol officers. DMF and DEH, Shellfish Sanitation Section participate in the Interstate Shellfish Sanitation Conference (ISSC) as voting delegates setting guidelines for the NSSP.

Other than the Food, Drug and Cosmetic Act, under which the NSSP operates, the Lacey Act of 1981 probably has the most authority over shellfish. The National Marine Fisheries Service (NMFS) enforces the Lacey Act, which prohibits import, export, and interstate transport of illegally taken fish and wildlife, which includes illegally possessed oysters.

The Atlantic States Marine Fisheries Commission (ASMFC) approved a plan in 1989 to control the transfer and introduction of shellfish, although it has no authority over shellfish in the states. The plan supports state regulation. A key plan provision is the training of state biologists in detection and management of shellfish diseases. The intent is to reduce introductions of diseases and pests from contaminated areas into waters free of such organisms.

6.0 STATUS OF THE STOCK

6.1 GENERAL LIFE HISTORY

6.1.1 DISTRIBUTION

The eastern oyster (*Crassostrea virginica*) occurs naturally along the western Atlantic Ocean from the Gulf of St. Lawrence to the Gulf of Mexico, Panama and the Caribbean Islands (Figure 6.1)(Carlton and Mann 1996; MacKenzie 1997; Jenkins et al., 1997; Bahr and Lanier 1981). Eastern oysters have also been described from Panama, Venezuela, Brazil and Argentina along the Caribbean Sea and the western Atlantic Ocean in Central and South America (Wallace 2001). Carriker and Gaffney (1996) report eastern oysters are distributed in the western Atlantic from Brazil northward through the Caribbean, and Gulf of Mexico to the St. Lawrence River estuary in eastern Canada, a range of some 8,000 km. However, Gaffney (P. M. Gaffney, Univ. of Delaware, pers. comm. 2005) reports that the southern distribution of *C. virginica* can only be verified genetically to the northern Yucatan Peninsula of the Gulf of Mexico at present and other genetically distinct *Crassostrea* species might occur in the Caribbean.

Within this range oysters colonize a wide variety of habitats limited primarily by salinity but also by depth. Opinion on optimum salinity range for the species varies but falls between 14 and 28 parts per thousand (ppt), although oysters may be found growing in salinities as low as 5 ppt and as high as 40 ppt (Galtsoff 1964; Wallace 1966). Oysters can tolerate extremes in salinity for varying periods depending on temperature (Loosanoff 1965). In the central Atlantic region eastern oysters are found from intertidal areas to depths up to eight meters (MacKenzie 1997).

In North Carolina, oysters are found from extreme southeastern Albemarle Sound near the northern end of Roanoke Island southward through Croatan, Roanoke, and Pamlico sounds and the estuaries of the southern part of the state to the South Carolina border (Figure 6.2). North Carolina's oyster stocks are composed of both intertidal and subtidal populations. The intertidal populations (oysters growing between the mean high and low tide levels) are characteristic of the oyster stocks of the South Atlantic Bight (Figure 6.3). These intertidal populations are found principally from Cape Lookout southward. However, notable exceptions are the subtidal oyster rocks found in the Newport, White Oak, and New river systems (Figure 6.2). Other scattered subtidal populations are found in some of the larger systems farther south. North of Cape Lookout, oyster resources are almost exclusively subtidal (oysters growing below the mean low water level). This region is primarily influenced by wind driven tides, and the few intertidal oysters found in the area are in close proximity to inlets. In the immediate vicinity of inlets, the horse or crested oyster, *Ostreola equestris*, is often confused with small eastern oysters.

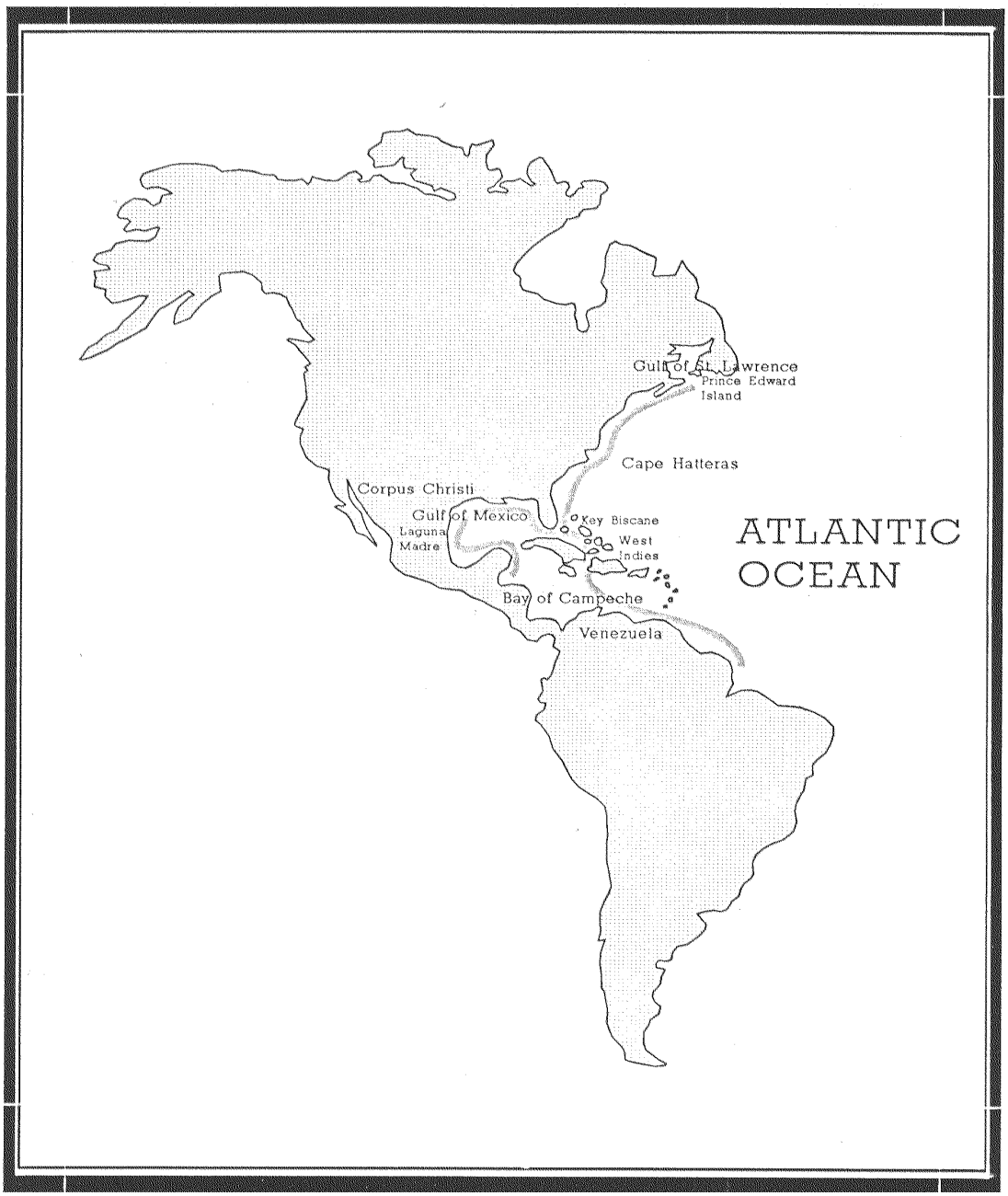

Figure 6.1. Distribution of *Crassostrea virginica* (shaded line) (Bahr and Lanier 1981).

Figure 6.2. Coastal North Carolina showing locations referenced in this document.

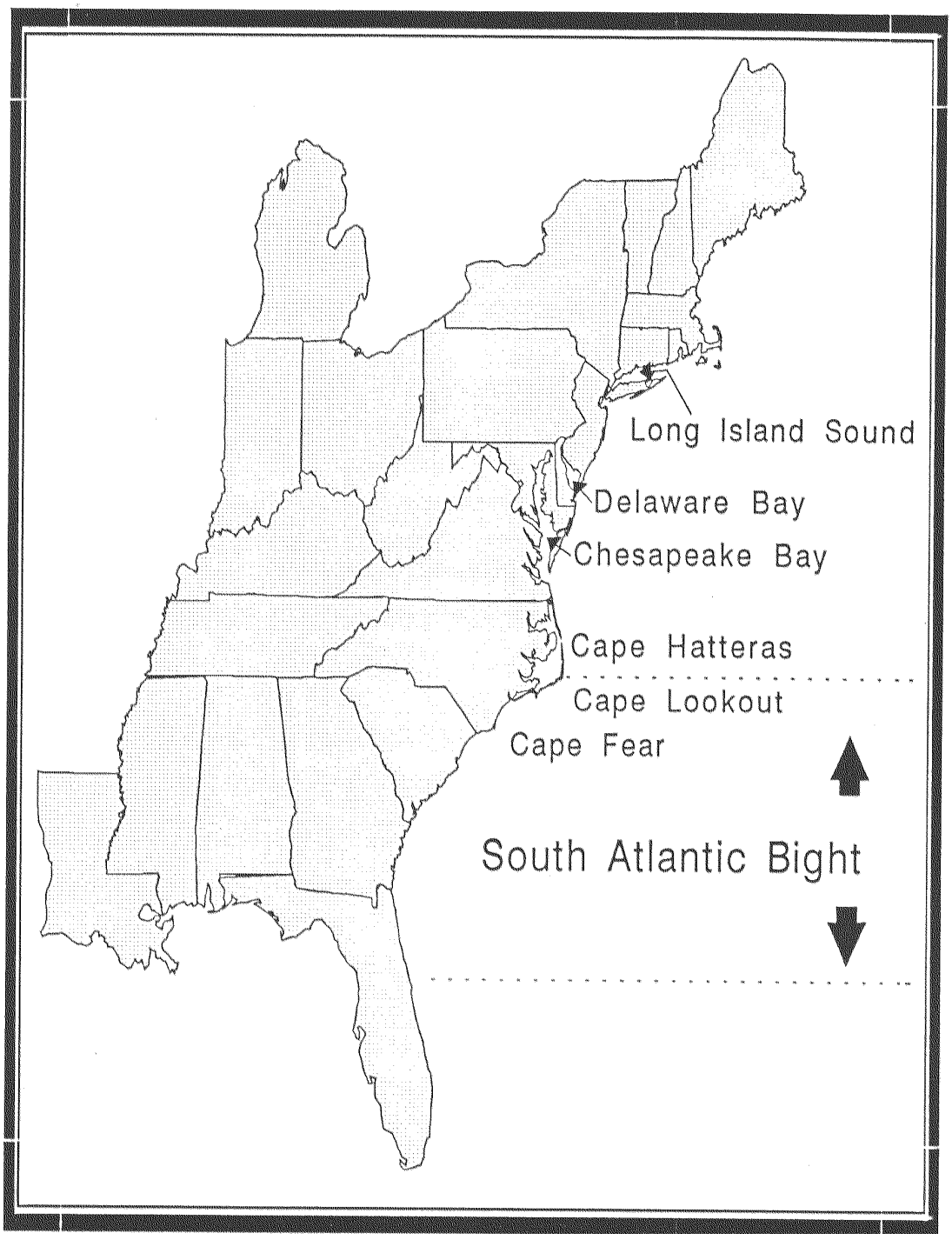

Figure 6.3. United States East Coast showing locations of oyster harvest activity prior to 1900 and the South Atlantic Bight.

Figure 6.4. Left and right valves of a subtidal Eastern oyster illustrating the purple pigmented adductor muscle scar in the interior of the cupped left valve and radial ridges on the exterior of the right valve. (Photo credit: Robert Howells, Texas Parks and Wildlife Department)

6.1.2 MORPHOLOGY

Oyster shell morphology varies greatly depending on substrate and habitat conditions. Oyster shells tend to be elongated and thin and have few radial ridges where they grow in intertidal and high salinity areas. Shells of oysters grown in subtidal and lower salinity environments tend to be rounded and thick with visible radial ridges (Stanley and Sellers 1986). The interior of the shell contains a purple-pigmented adductor muscle scar that differentiates eastern oysters from similar species (Figure 6.4). Eastern oyster larvae settle on the left valve and this valve is generally more cupped than the right that is normally found on top. There is no gap between the shells when the two valves are completely closed (Yonge 1960; Galtsoff 1964).

Eastern oyster bodies (meats) have no siphon, a small foot, a relatively small adductor muscle and fillibranch gills with interlamellar junctions (Galtsoff 1964). These characteristics differentiate the species from other bivalves except the crested oyster, *Ostreola equestris*.

6.1.3 POPULATION STRUCTURE

Oyster stocks cannot be identified on the basis of morphological differences. Initial electrophoretic analysis indicated there were three stocks of oysters on the East and Gulf coasts. North Carolina's stock was thought to be part of the Atlantic coast stock, which extends from Maine to Key Biscayne, Florida. Other stocks were identified along the West Coast of Florida to Corpus Christi, Texas, and in the lower Laguna Madre, Mexico (ASMFC 1988).

While the current predominant view maintains that there is insufficient information to conclude that distinct physiological races of *Crassostrea virginica* exist (Kennedy et al. 1996), there is a growing body of genetic evidence there is an Atlantic/Gulf population structure with the transition zone between the two populations occurring south of Cape Canaveral near Stuart and West Palm Beach, Florida (Reeb and Avise 1990; Karl and Avise 1992; Hare and Avise 1996; Hoover and Gaffney 2005). A change in genetic frequencies between Gulf and Atlantic

populations has also been found in other species including red drum, hermit crab, southern flounder, king mackerel and snapping shrimp. Sea level retreat during glacial events in the Quaternary period created land barriers isolating the Gulf of Mexico from the Atlantic Ocean along the Florida peninsula about 1.2 million years ago and initiated this biological phenomenon (Eastern Oyster Biological Review Team 2007).

Another genetically distinct population is believed to occur in the Laguna Madre area of Texas (Groue and Lester 1982). This distinct genetic structure may be due to adaptation to the hyper saline conditions in this waterbody as well as isolation from oyster populations to the north.

6.1.4 REPRODUCTION AND RECRUITMENT

Oysters are typically dioecious (separate sexes), but have the ability to change sexes once each year usually when the gonad is undifferentiated (Thompson et al. 1996). Kennedy 1993 found that natural oyster populations maintain relatively balanced sex ratios but other researchers suggest that stress such as food limitation results in a higher ratio of males (Bahr and Hillman 1967; Davis and Hillman 1971). The sex of nearby oysters may also influence individual oyster sex determination (Smith 1949; Menzel 1951). A large number of first year spawners are typically males (Galtsoff 1964). Larger older oysters tend to have higher percentages of females. Gonads may be developed in oysters only two to three months old. Fully developed oysters entering their first summer season may spawn, but substantial portions of young-of-the-year oysters are not sexually mature (Galtsoff 1964).

Formation of eggs and sperm is stimulated by increasing water temperatures during the spring of the year (Galtsoff 1964; Kennedy et al. 1996). Fecundity estimates range from 2 million eggs for a 4 cm (1.5 in) oyster to 45 million for an oyster 7 cm (2.8 in) in length (Kennedy et al. 1996). Oysters may spawn several times per season making absolute determination of fecundity difficult. Fecundity estimates are also complicated because the gonad is diffuse and invades other tissues (Kennedy et al. 1996). Larger oysters allocate a greater percentage of their food intake to egg production (Kennedy et al. 1996).

Based on optimum spawning temperatures, there are three recognized spawning groups of oysters: one from the Gulf of Mexico and Florida that spawns near 25°C, and two from the east coast that spawn at 16°C and 23°C respectively (Atlantic States Marine Fisheries Commission 1988). Chestnut (1954) reported oyster spawning taking place in North Carolina beginning at 20°C (June), with peak spawning at 25°C (August/September). Salinities greater than 10 ppt are also typically required for spawning (Breuer 1962).

Under normal conditions, male oysters spawn first in response to various physical stimuli and environmental conditions. Female oysters are stimulated to spawn specifically by the presence of oyster sperm. Fertilization must take place shortly thereafter in the surrounding waters, or the unfertilized eggs lose their viability. Fertilized eggs develop through trochophore and veliger larval stages typically over a period of two to three weeks but may last up to two months (Hopkins 1931). The more popular larval development stage names, straight hinge (early stage) and umbo, eyed, and pediveleger (advanced stages), refer to obvious morphological characteristics at the different stages.

According to Galtsoff (1964), larvae can migrate vertically in the water column and may be able to maintain their position in the estuary by avoiding certain temperature or salinity changes. On the other hand, Korringa (1952) conducted laboratory experiments that showed oyster larvae had little control over the ultimate direction of their movement. Oyster larvae have been documented to travel at least 30 miles (Bahr and Lanier 1981). Andrews (1983) found that larval dispersion and the ultimate fate of the larvae are strongly dependent on prevailing currents and flushing rates of estuaries. Kennedy et al. (1996) concluded that larval swimming might supplement the effects of passive transport and enhance larval retention in estuaries. Patterns of larval distribution in North Carolina estuaries have not been documented.

As the larval stage ends, oysters must locate a suitable attachment point or perish. Several sites may be investigated before an oyster larva cements itself to the substrate (Kennedy 1996). Several environmental factors, including light, salinity, temperature, and current velocity, may influence the setting of larval oysters (Hidu and Haskins 1971). Oyster larvae also respond positively to a protein on the surface of oyster shells and tend to set more readily near other recently set spat (Kennedy et al. 1996). These adaptations are apparently important to a reef-building animal that requires close proximity for successful spawning. Larval oysters tend to set in the intertidal zone where salinities are above 20 ppt (Mackin 1946; Menzel 1955) and set subtidally when salinities are below 20 ppt. (Loosonoff 1952; Menzel 1955). Generally, spatfall is higher in intertidal areas and in areas where salinities are in the high range of spat tolerance (Bahr and Lanier 1981). Ortega et al. (1990) found higher spatfall on deep-water cultch planting sites in the Albemarle-Pamlico estuary, although these results could be influenced by a difference in cultch planting methods between deep and shallow subtidal sites.

Chestnut (1954) reported recruitment peaks generally occurring in June, the latter part of August and possibly another peak in October. Ortega et al. (1990) found recruitment in western Pamlico Sound to be continuous, concentrated in one peak or concentrated in two peaks depending on year and location. Generally peaks occurred in June (lesser) and September-October (greater). Munden (1975) reported that spat monitors located in Morehead City and Wilmington did not show a decline in availability of spat during the summer of 1972 until September. Kennedy (1986) examined spawning and recruitment literature from various locations between Prince Edward Island, Canada, and the west coast of Florida and found that intensity and success of spawning and settlement varied with location and year in an essentially unpredictable manner.

6.1.5 GROWTH

Oyster growth is highest during the first six months after setting and gradually declines throughout the life of the oyster (Galtsoff 1964). Seasonally, adult oysters grow most rapidly during spring and fall in North Carolina. Shell growth was found to cease when water temperatures reach 28°C and slowed down when temperatures decreased to 5°C (Chestnut 1954). Ortega et al. (1990) examined data from 1979-1989 and found that spat from all western Pamlico Sound sites attained lengths of 10-40 mm during the first year and reached marketable size (76 mm) by the end of three years. Godwin (1981) reported growth rates of transplanted intertidal seed oysters averaging 10 to 20 mm per quarter with a maximum of 40

mm in three months. Varying growth rates have been observed in different areas and under different conditions in North Carolina but are undocumented. Regional differences in oyster growth have been reported in Chesapeake Bay (Kennedy and Breisch 1981). Roegner and Mann (1975) found no correlation between daily growth rates of juvenile oysters and oyster density, suggesting that competition through crowding does not affect oyster growth rates for the densities tested. Growths rates in other East and Gulf coast regions produce market size oysters in time periods ranging from 18-24 months in the Gulf of Mexico (Hofstetter 1977; Berrigan et al. 1991) to 4-5 years in Long Island Sound (Shumway 1996).

6.2 STOCK STATUS

North Carolina commercial oyster landings have been in decline for most of the past century (Figure 6.5). This decline was likely initiated by overharvest and compounded by habitat disturbance, pollution, and disease. The DMF has designated Eastern oyster as a species of concern. Species designated by DMF with a concern status exhibit one or more of the following: incomplete or unavailable stock assessments, increased effort, declining landings, truncated age distribution, or are negatively impacted by biotic and/or abiotic factors (example: water quality, habitat loss, disease, life history, predation, etc). Oysters are believed to be vulnerable to overharvest because several factors negatively impact their survival. There are insufficient data to conduct an oyster stock assessment in North Carolina.

6.2.1 STOCK STATUS INDICATORS

An oyster stock assessment was attempted in 1999, but the necessary data were lacking to determine levels of sustainable harvest. Since there were no significant changes in the types and quantity of data collected, an oyster stock assessment could not be achieved in 2006. Collection of appropriate data should be initiated in order to conduct a stock assessment and determine levels of sustainable harvest.

As the current data are inadequate for calculation of sustainable harvest, methods for calculating a proxy for sustainable harvest were examined. Federal and other state management agencies often use information from logbooks, fishery independent surveys, and other sources to establish MSY proxies (the unit of management for many other management agencies). In North Carolina, current available data consist of commercial landings and trip data. Landings data for oysters go back as far as 1887, although considerable gaps occur in the data set (Figure 6.5). The landings data are continuous since 1950. While landings records reflect population abundance to a limited extent, the relationship is confounded by changes in effort, gear technology, aquaculture contributions, and market demand. Trip tickets cover a much shorter time frame (1994 to present), and previously trip ticket data was used to estimate the catch per trip as an index of abundance. The error involved in this approach is potentially quite large, since the amount of effort expended in an average trip may differ from year to year and even among trips within the same year and water body. Therefore, indices constructed using the commercial landings as the catch and trips as effort may reflect changes in gear technology, aquaculture and other market demands, weather conditions, and differences in trip duration as well as possible changes in stock condition. Regional indices may be more

appropriate because of the possibility of multiple unit stocks within the state, however actual stock units have not been determined.

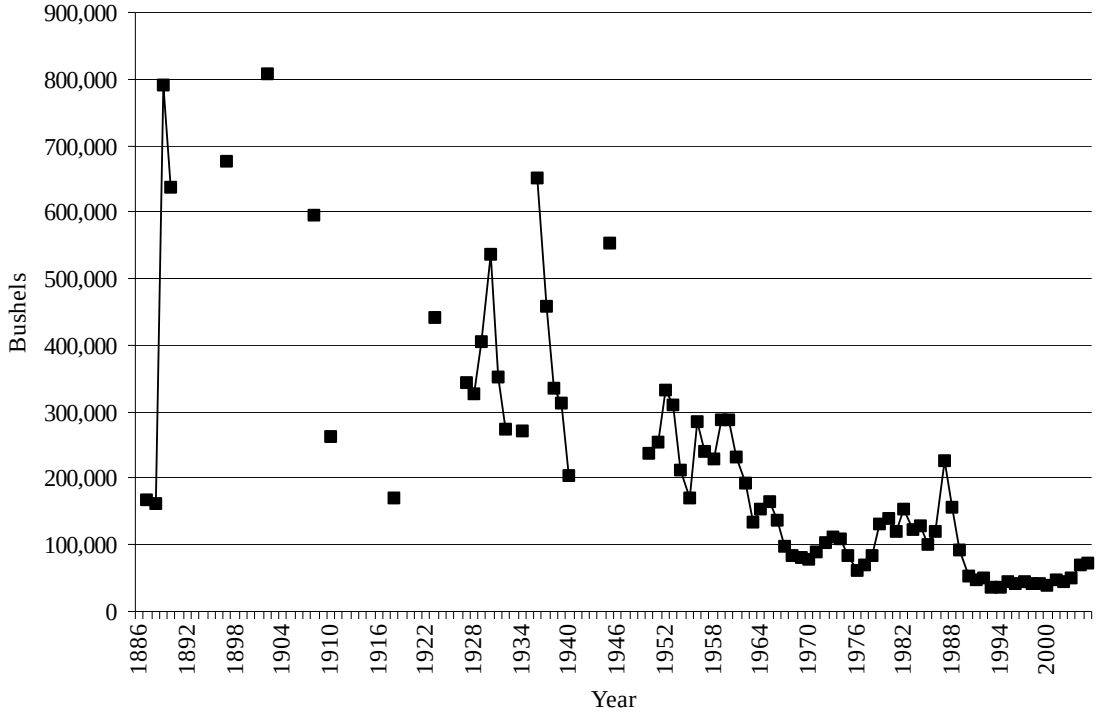

Figure 6.5. North Carolina oyster landings in bushels, 1886-2005 (DMF Trip Ticket Program).

The apparent sustainability of current harvest levels in a given water body may be detected by examining trends in landings and effort data. Additionally, localized trends in mechanical or hand harvest must be analyzed separately in order to assess whether trends are likely to be gear specific or extend to the entire water body. The average catch per trip for the period 1994-2005 for either hand harvest or mechanical harvest was calculated in each of the major water bodies from which oysters were harvested. In order to compare water bodies, the catch per trip was expressed as a proportion of the trip limit. The indices were calculated by multiplying the total number of trips by the regulated trip limit. The theoretical maximum catch limit was divided into the observed catch to determine the proportion (as a percent) of the actual catch to the total allowed harvest limit per trip. The mean catch per trip was expressed as a percentage of the trip limit. This is necessary as there were differences in trip limit between years and within a season. There were also two different harvest limits by gear type. The individual limit was used, but operations of two or more people caused the index to appear over the legal limit through legitimate practices. Currently the trip ticket data do not contain consistent information on crew number or trip duration. Since the confounding effect of variable effort per trip cannot be avoided, it was assumed that effort per trip did not increase or decrease significantly over the time period.

For hand gears, the landings time series need to be continuous from 1994-2005. Thirteen waterbodies with continuous hand gear landings for the time series are analyzed in Figure 6.6. The percent of the trip limit in eight of the waterbodies showed no change from year to year (Figure 6.6). Bogue Sound showed an increasing trend in the percent of the trip limit to 2002, then a decline to the present. Cape Fear River experienced year-to-year fluctuations with an overall declining trend since 1999. The annual percent to trip in Masonboro Sound appeared steady throughout the time series but closer examination showed a decline since 2000. The catch proportion to the trip limit in Newport River had an increasing trend in 2000 and 2001, then declined similar to earlier years in the time series. Finally, the percent of the trip limit in White Oak River showed an increasing trend over five years in the middle of the time series and a lower percent to trip limit at the beginning and end of the time series.

Of the five waterbodies exhibiting declining trends, Cape Fear River and White Oak River had less than 110 trips per season per waterbody since the 1995/1996 season. The recent declines in the percent to trip limit in the Cape Fear and White Oak Rivers may be an artifact of declining directed effort rather than an actual decline in oyster abundance. The remaining waterbodies show increasing trends in catches and trips in spite of decreasing CPUE (Figure 6.7). The likely reason is that the increase in trips has been slightly greater than the increase in the number of trips with the trip limit. The slight decreases could be the result of decreasing oyster stocks because of overharvest. However, that would assume that all trips are attempting to reach the limit, which may not be occurring. Newport River is typically an area fished by full-time shellfishermen (M. D. Marshall, DMF, pers. comm. 2007). Bogue Sound may have seen a decrease in multiperson operations, which would decrease the overall proportion in relation to number of trips, and has seen an increase in the proportion of trips that frequently land less than the trip limit by choice (C. L. Davis, DMF, pers. comm. 2007). It is important to keep in mind that these indices can be influenced by market conditions, weather conditions, or other factors. All other indices show relatively flat, variable trends.

Only three waterbodies, Bay River, Neuse River and Pamlico Sound, had sufficient continuous data for mechanical harvest analysis (Figure 6.8). Bay River had experienced a recent increase in the last few years of the time series, but has low numbers of trips throughout. The low numbers of trips can lead to magnification of a single highly successful trip that does not occur in waterbodies with many trips. Mechanical harvest as a percent to the trip showed some year-to-year fluctuation in the time series. The proportion of harvest to the trip in Pamlico Sound remained unchanged throughout most of the time period. It should be noted that Pamlico Sound trends are buffered by the fact that the area is so large and oyster harvest can decline in one area while increasing in another. The harvest fleet is able to move and fish these different areas. Both Bay and Neuse rivers had low numbers of trips per year.

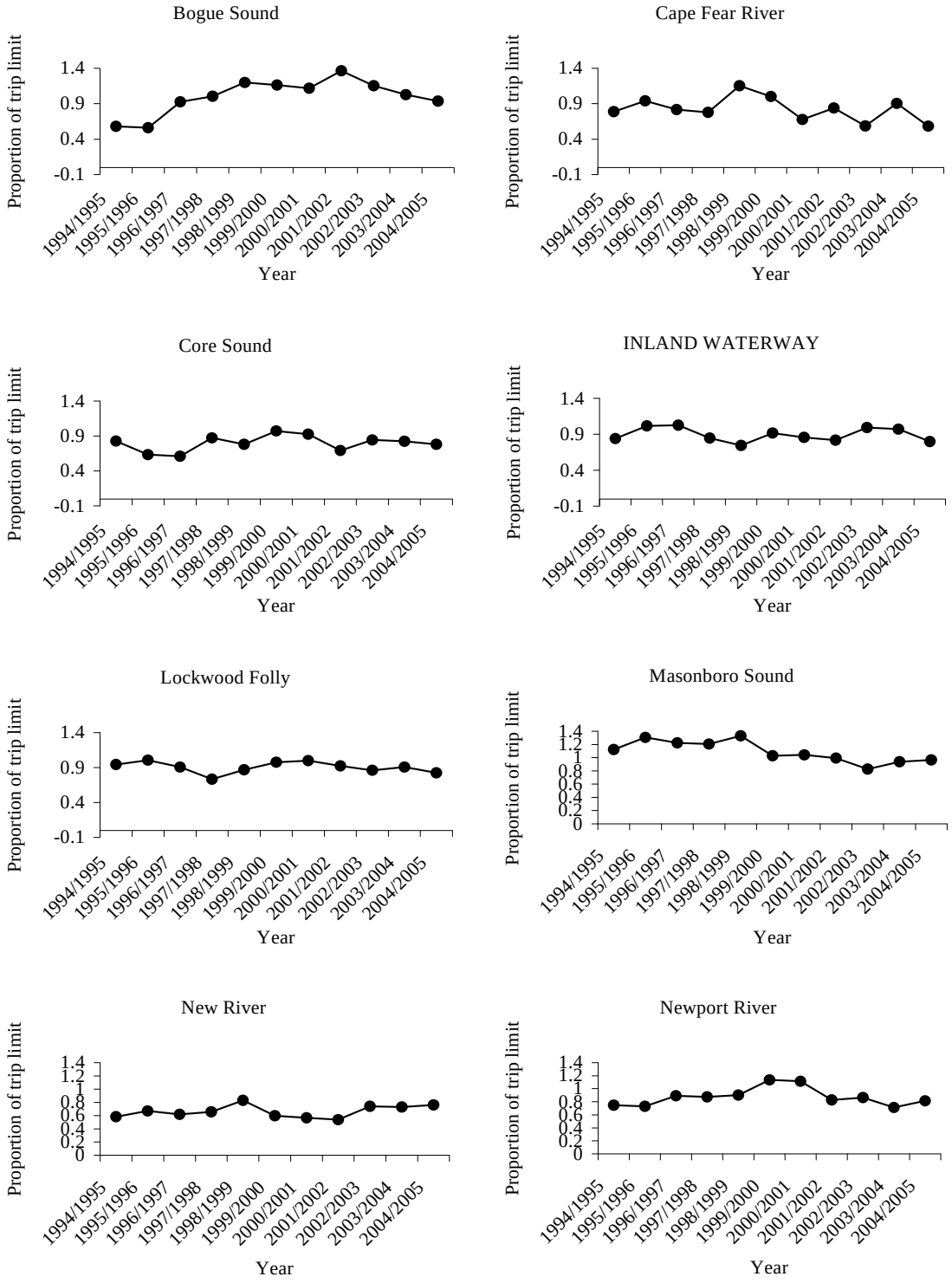

Figure 6.6. Proportion of oyster hand harvest trip limits by water body, (1994/1995-2004/2005).

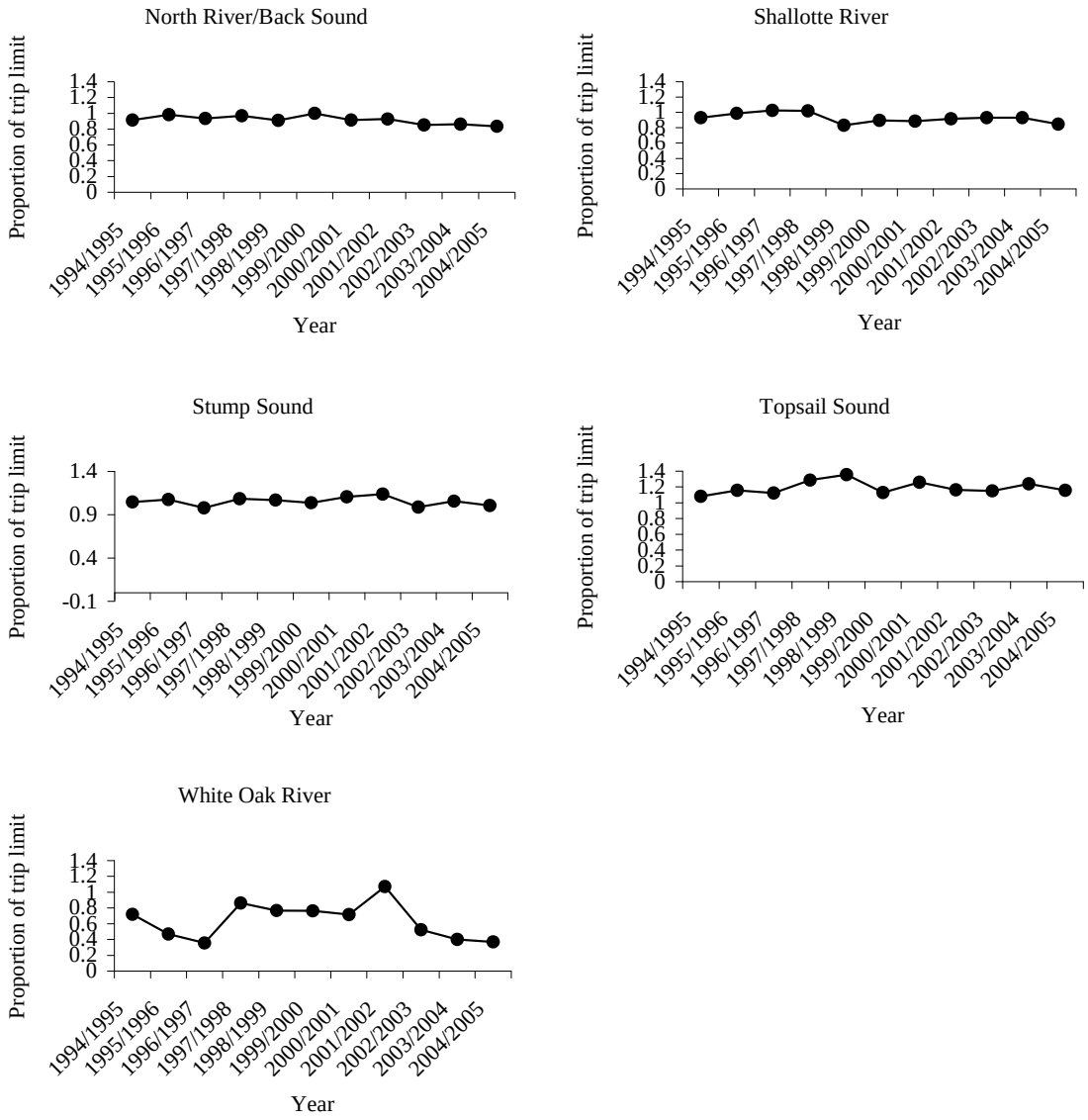

Figure 6.6. Continued.

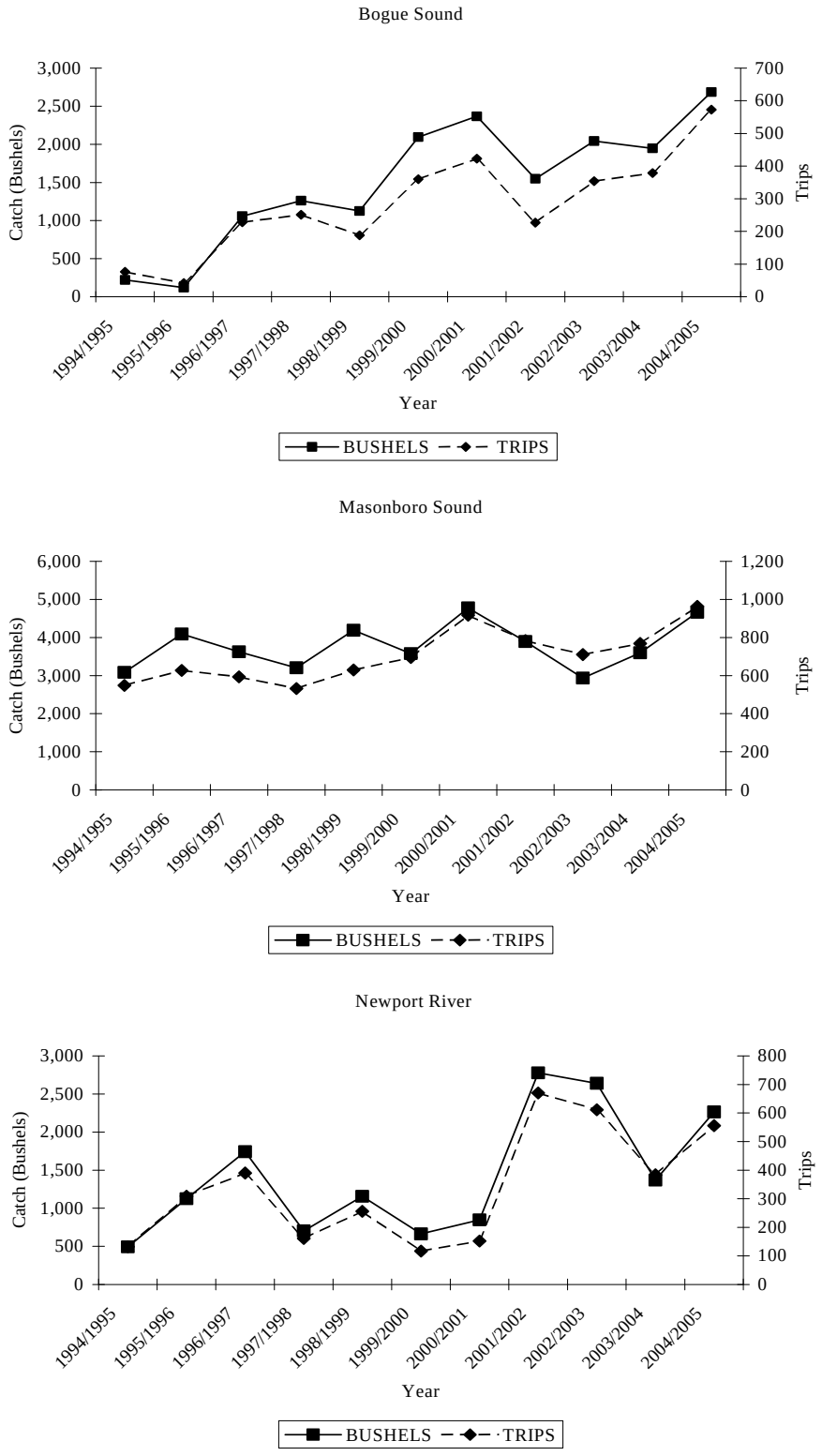

Figure 6.7. Commercial annual oyster hand harvest (bushels) and trips for Bogue Sound, Masonboro Sound, and Newport River, (1994/1995-2004/2005).

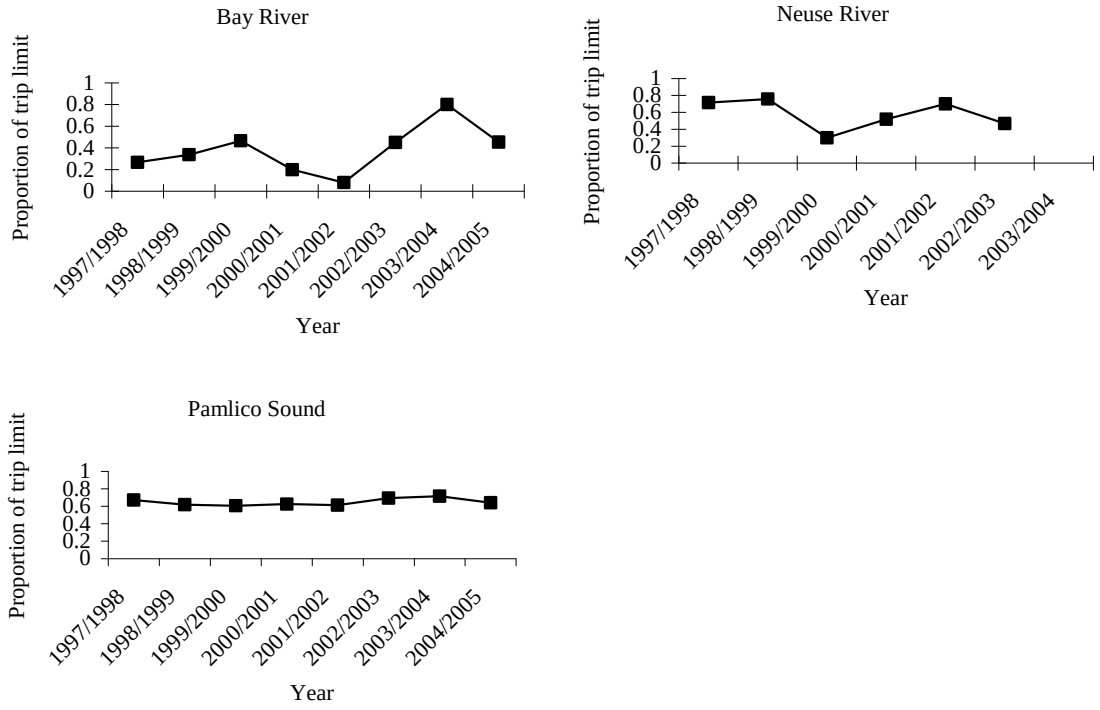

Figure 6.8. Proportion of oyster mechanical harvest by trip limits (percent) for Bay River, Neuse River, and Pamlico Sound (1997/1998-2004/2005).

6.2.2 STOCK ASSESSMENT RECOMMENDATIONS

Since more data collection is necessary, every effort should be made to recognize the costs and benefits associated with available data collection methods and choose one that will best serve the management obligations recognized in this plan. Because the biological program chosen to collect population data on oysters needs to be in place for several years, a thoughtful approach should be taken in selecting the appropriate methodology. Every effort should be made to utilize peer reviewed, standardized monitoring metrics and methodologies for oyster restoration and stock status assessments so that data can be readily compared to other regional efforts. Table 6.1 summarizes the advantages, disadvantages, and data requirements for several approaches that could be used to estimate sustainable oyster harvest. Although age-based analysis is commonly used in finfish stock assessments, this method is probably inappropriate until oyster ageing is validated. Biomass-based analysis should be considered as a possible assessment method for oysters since the necessary data could be collected fairly easily. A noteworthy disadvantage to this approach (that is not unique to oysters) is that estimating sustainable harvest benchmarks is often difficult unless the data include periods when the stock was overfished and periods when the stock was underfished. For both age-based and biomass-based approaches, several years of data must be collected before analysis can begin. A standing stock survey, or density estimate, is consistent with mollusk assessments conducted by NMFS and several other states and could give results that are both immediately useful and easy to understand (MAFMC 1998; Mann and Evans 1998). Standing

stock surveys could be modified to function as fishery independent surveys for more complex stock assessment models. Given the clear deficiencies with the available fishery dependent indices, standardized methodology for a shellfish survey should be pursued.

Table 6.1. Oyster stock assessment options and corresponding advantages, disadvantages, and data demands.

	Advantages	Disadvantages	Data Demands
Age-Based Analysis	Provides detailed information about population structure	Age data cannot be collected from oysters	Catch-at-age matrix
	Is the preferred modeling method for finfish species	Several years before data can be used to estimate sustainable harvest	Natural mortality estimates
		New biological program will need to be initiated	Fishery independent survey would be preferred
Biomass-Based Analysis	Simplicity	Sufficient contrast often lacking if stock has not been both overfished and underfished	Total catch and effort
		Several years before data can be used to estimate sustainable harvest	Fishery index (preferrably fishery independent)
		New biological program will need to be initiated	
Standing Stock Survey	Intuitively understandable results	Shellfish mapping will need to be completed	Oyster density estimates for fished and underfished areas
	Results may be immediately useful for estimating sustainable harvest	Monitoring of oyster densities in all areas must be initiated	

Integration of GIS technology into the management of oysters in North Carolina should be examined since it would allow coordination of population monitoring with habitat management and shellfish sanitation harvest closures. GIS data are currently being gathered through the ongoing Shellfish Mapping Project.

Because extensive numbers of oysters exist in permanently closed areas, a reserve of the total spawning stock is essentially protected from fishing pressure. The contribution of oysters in unfished areas to overall oyster production is currently unknown. Mapping and survey data will address this question by indicating the proportion of the total adult biomass that is protected.

Regardless of how oyster data are collected and analyzed, an important issue that should be settled is that of stock identification. A stock, for assessment purposes, consists of a population (of a single species) for which population processes (i.e.: recruitment, survival) are independent of processes of other populations. If, for example, recruitment and survival patterns for oysters in Pamlico Sound are independent of patterns in Stump Sound, they are probably discreet unit stocks and each should be analyzed and managed separately. If the existence of multiple unit stocks is ignored, and stocks are managed on a statewide assessment, the risk of over- or under-harvesting will exist in regions where conditions differ from the

statewide trend. It is quite probable that multiple oyster stocks exist in North Carolina waters and, therefore, responsible management should include their identification. GIS technology may also be helpful in determining hydrodynamic processes and larval transport that would be necessary to determine the unit stocks. Polymerase Chain Reaction methods for oyster disease assessments should also be acquired to more quickly and efficiently process samples and test for multiple diseases since natural mortality rates are necessary to assess oyster populations.

6.2.3 OYSTER DISEASE

The oyster parasite *Perkinsus marinus*, also known as Dermo disease, has been responsible for major oyster mortalities in North Carolina in recent years. Chestnut (1955a) may have been the first to report that it occurred in this state. However, no extensive assessments were attempted until large-scale oyster mortalities during the fall of 1988 prompted investigations. Oyster samples from various locations were sent to the Virginia Institute of Marine Science (VIMS) and the Cooperative Oxford Laboratory. Results showed that while both MSX (*Haplosporidium nelsoni*) and Dermo were found, Dermo was the major cause of mortalities. During 1988, only eleven sites were sampled for oyster parasites. Dermo was found at nine of the sites, and MSX was found at the other two. Mortalities were reported primarily from New River south to the South Carolina border during this time period (Figure 6.2).

In 1989 DMF began operating a small laboratory to diagnose Dermo infections. Results of DMF Dermo sampling are shown in Figure 6.9. All diagnoses were made using the rectal thioglycolate method described by Ray (1952). New categories of infection intensity were applied to all existing Dermo samples in this analysis based on recommendations from oyster disease experts at the Virginia Institute of Marine Sciences (VIMS)(E.M. Burreson, VIMS, pers. comm. 2007). Categories of infection intensity are established using weighted incidence values based on Mackin (1962) except only three breakdowns are used: uninfected = no infected oysters in sample; 0.1-1.5 = low; 1.51-2.5 = moderate; and >2.5 = high. Low, moderate and high refer to the expected mortality rates at the respective infection intensities. Weighted incidence values range from 0 to 5. Samples with moderate and high categories of infection intensity are expected to have mortality rates that significantly affect harvest if existing environmental conditions persist.

During the first year of sampling, Topsail Sound and Core Sound areas had the greatest numbers of heavy Dermo infections. The heaviest mortalities during 1990 were found in Pamlico County and northern Carteret County (Figure 6.2). Earlier sampling in 1990 also revealed some intensive overwintering infections. Mortalities in Pamlico County were found to begin in June that year, probably due to the mild winter weather (Sherman et al. 1991). Personal communication with Dr. Gene Burreson of VIMS (1993) and Dr. Michael Crosby of the Baruch Marine Institute (South Carolina) (1993) indicated that in Virginia, Dermo infections could not be detected during the winter months, while South Carolina experienced infections on a year-round basis. North Carolina appears to have some overwintering infections during mild years, although few samples have been taken during winter months.

All 113 sites sampled during 1991 showed some level of infection. Infection levels were much higher than previous years. Hyde County was impacted by disease mortalities for the first time

since sampling began. High infection levels continued in most areas, and mortality of a smaller size class of oysters was observed (DMF Resource Enhancement Section). Dermo infections continued to be widespread in 1992. Infection intensity decreased at some sites and one location near Hatteras Inlet changed from a light infection in 1991 to no infection during 1992 (DMF Resource Enhancement Section). However, while some areas improved, the overall infection intensity remained high in 1992 (Figure 6.9).

Infection intensity dropped significantly during 1993 and infection levels capable of causing significant impacts on harvest were lowest in 1996, 1998, 2003 and 2004. However, the prevalence of the parasite remained near 100% (nearly 100 % of samples contained at least one oyster infected with *P. marinus*) from 1993 to 2006 indicating that a return to the very high oyster mortalities of 1991 and 1992 could be expected if extended periods of salinities greater than 20 ppt and water temperatures greater than 20ºC (optimum conditions for parasite growth) occur.

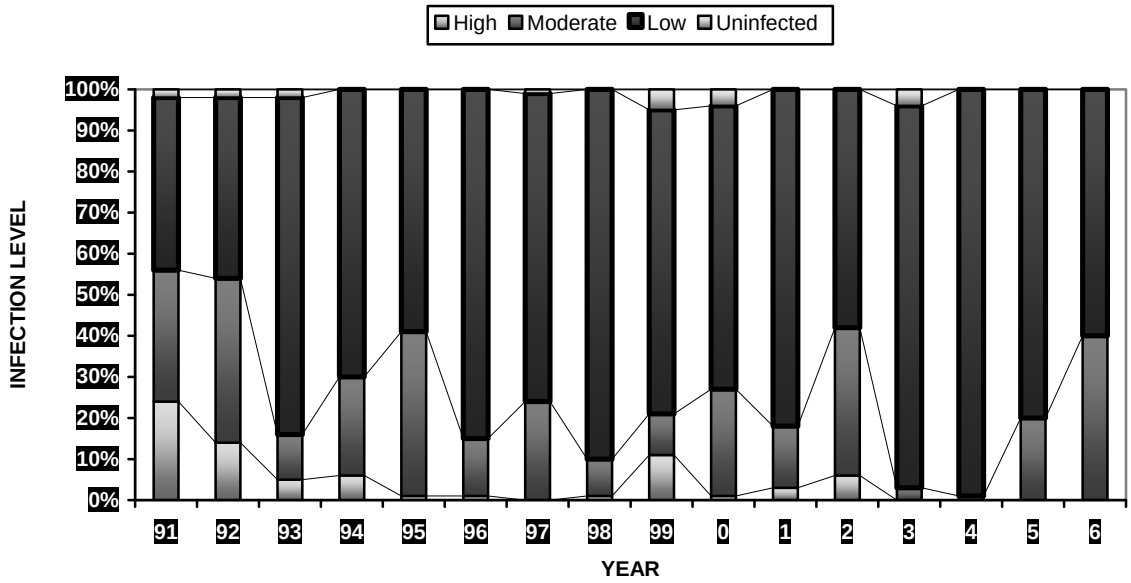

Figure 6.9. Infection categories for *Perkinsus marinus* infections in North Carolina 1991-2006 (DMF Resource Enhancement Section).

It became apparent, when staff observed that late summer, moderate and high level Dermo infection levels did not reduce oyster catches in the affected areas, that oysters in the smaller, more saline southern estuaries were maintaining higher survival rates at infection intensities similar to Pamlico Sound stocks. This situation is evident in commercial landings from 1991 to 2002 where hand harvest landings did not decline in the same manner as mechanical harvest landings during the period (Figure 6.10). Mechanical harvest is practiced almost exclusively in Pamlico Sound while hand harvest is the only harvest method allowed in the southern estuaries. It is suspected that the small, high salinity estuaries may inhibit mortality by flushing out parasites at a higher rate or by exceeding the salinity tolerance of the Dermo parasite. The

link between low DO, increased availability of iron and increased parasite activity (Leffler et al. 1998) may also be a factor in the different mortality rates as the smaller, high salinity estuaries are less prone to low dissolved oxygen (DO) events than the Pamlico Sound area.

Dermo infection intensity levels in 2004 were the lowest since extensive sampling began in 1989. Overall infection intensity increased in 2005 but high level infections were not recorded. Oyster landings responded with a 20,000 bushel increase despite a shortened harvest season in 2004 and landings increased further in 2005 and 2006.

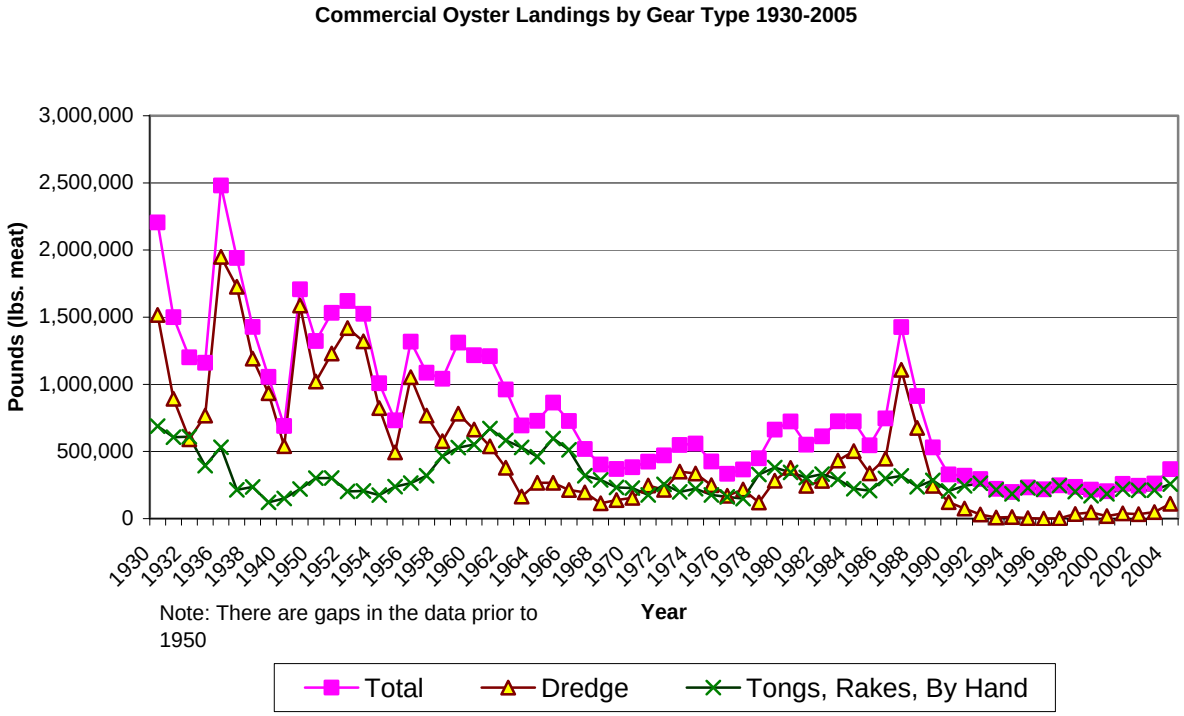

Figure 6.10. Oyster landings by gear type 1930-2005 (DMF Trip Ticket Program).

Haplosporidium nelsoni, the causative agent of MSX, was found at two of the eleven sites examined in 1988. The two sites, Crab Slough in Dare County and Wysocking Bay in Hyde County (Figure 6.2), had high infection levels during 1988 but showed little or no infection in 1989. A total of 11 of the 36 sites sampled in 1989 were positive for MSX. Only two sites, Middle Ground and Great Island, showed infections at levels causing mortality (Figure 6.2) (Morrison et al. 1989). Sampling conducted by the North Carolina State University (NCSU) College of Veterinary Medicine during 1990-1992 indicated no high intensity MSX infections (unpublished data). Analyses from 1989 to 1992 were conducted using hemolymph analysis (Burreson et al. 1988).

MSX does not survive if salinities fall below 10 ppt for a period of at least two weeks. Heavy rainfall from the intense hurricane activity experienced in North Carolina since 1996 has

reduced Pamlico Sound salinities periodically so that sampling has not been necessary. Occasional sampling during 1993-1995 did not indicate any infections.

6.2.4 RECRUITMENT

Long term data on oyster recruitment (spatfall) is only available from Newport River north. Regular surveys of oyster spatfall were initiated in the southern area during 2005. Spatfall is monitored on Shellfish Rehabilitation Program cultch planting sites annually. Spat are counted and measured from 30 randomly selected pieces of cultch material at each cultch planting site and sampling is conducted in the winter months. Data are recorded as spat per piece of cultch regardless of cultch size. The values for spatfall in Figure 6.11 are calculated by dividing the total number of spat collected by the total number of cultch pieces sampled for the respective areas.

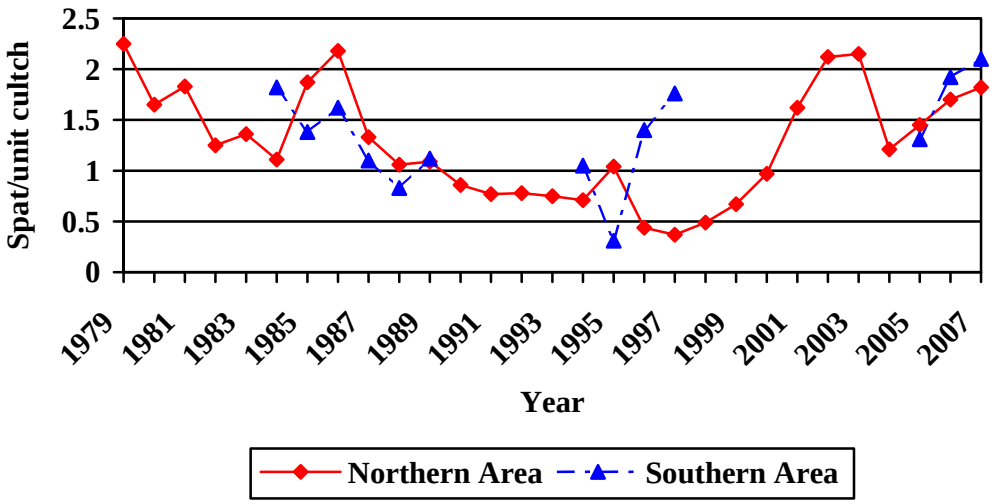

Figure 6.11. Spatfall data from the Shellfish Rehabilitation Program 1979-2007 (DMF Resource Enhancement Section).

There was a great deal of concern about oyster recruitment levels during the development of the 2001 Oyster FMP. In the Pamlico Sound area, average spatfall for 1990 through 1999 was less than half the value for 1979 through 1989 creating concern that northern area oyster populations may become unable to sustain themselves (Figure 6.11**)**. Spatfall levels began increasing in 2000 and by 2002 the recruitment level was equivalent to1980s levels. Spatfall in the intertidal southern estuaries was similar in magnitude and showed some similar trends to the northern area data (Figure 6.11). While it is common for seasonal and local variability in recruitment of oysters to be high (Kennedy 1996), some researchers suspected that oysters were becoming spawner limited. The limitation of spawners may be due to a decline in gamete production and fecundity caused by stress from Dermo infections (Choi et al. 1994; Dittman 1993). High Dermo infection prevalence and intensity also can remove an extremely high percentage of the larger, typically more fecund oysters from Pamlico Sound populations reducing spawning potential (see Section 6.2.3). It is interesting to note the very low

occurrence of high-level Dermo infections during the recovery of oyster recruitment during 2000-2006 (Figure 6.9)

7.0 STATUS OF THE FISHERIES

7.1 COMMERCIAL FISHERY

7.1.1 HISTORICAL PUBLIC BOTTOM FISHERY

The early North Carolina oyster fishery was legally conducted using hand methods only, and oysters were prohibited from being sold out of state until 1872 (Thorsen 1982). Prior to 1880, New Bern and Wilmington were the state's major oyster markets. Beaufort and Washington were also sites for significant oyster trade. Between 1872 and 1889, oysters were not shipped from North Carolina to the large eastern cities, even though the law allowed, because the abundance of oysters in Long Island Sound, Delaware Bay and Chesapeake Bay supplied their needs (Figure 6.2) (Chestnut 1951).

Winslow (1889) reported that 170,000 bushels of oysters were landed in 1880, and that fishermen interviewed in the Pamlico Sound area reported heavy mortality and poor condition of oysters. The season ran from September through April, and oyster dredging had not yet been allowed on public bottom. It should be noted, however, that dredging was allowed on private gardens as early as 1855 and there was no marine law enforcement agency to enforce these laws (Thorsen 1982). It is generally accepted that the landings in 1880 and the 382,000 and 367,000 bushels landed in 1887 and 1888, respectively, were landed primarily by hand harvest methods and from relatively shallow water. It was not until 1889 when, after depleting their own resources, fishermen from northern states entered North Carolina with dredges and efficient mechanical tongs and North Carolina's deep-water Pamlico Sound oyster resource was fully exploited (Chestnut 1951).

A loophole in an 1887 law, which allowed dredging only in waters greater than eight feet deep in Pamlico and Roanoke sounds, pertained only to residents, while there were no restrictions to prevent out-of-state fishermen from dredging anywhere in North Carolina waters. This situation led to a conflict known as the "Oyster Wars," when dredgers from northern states caught large amounts of oysters from virgin stocks in Pamlico Sound. Residents relied heavily on tonging and were not familiar with dredging methods. Finally, after many attempts, a law prohibiting any harvesting by non-residents was passed and enforced in 1891. Consequently, over 300 out-of-state oyster boats left North Carolina waters at one time. Attempts to return to hand-harvest-only management from 1892-1895 and limited dredging in 1896 resulted in huge declines in oyster production and closing of many of the oyster canneries opened during the "Oyster Wars." In 1897 the dredging law was amended, allowing limited dredging, a longer dredging season, and more law enforcement, resulting in a great increase in landings and reopening of the canneries. From 1897 to the present, landings reached their highest level in 1902 at 1,833,000 bushels and exceeded one million bushels only one other time on record (1,003,000 bushels in 1923) (Table 7.1). All of the early oyster landings were accomplished using hand methods and sail-powered oyster dredge boats.

Table 7.1. North Carolina oyster landings in pounds of meat and bushels, 1880-2006.

YEAR	LB.	BU. (x 1,000)	YEAR	LB.	BU. (x 1,000)
1880	938,400	305	1966	726,209	138
1887	1,175,650	382	1967	518,514	100
1888	1,129,960	367	1968	402,959	84
1889	5,528,942	1,795	1969	369,928	81
1890	4,456,075	1,447	1970	381,978	78
1897	4,740,675	1,539	1971	423,675	83
1902	5,645,928	1,833	1972	470,112	93
1908	4,159,320	1,350	1973	548,351	101
1910	1,834,058	595	1974	558,821	105
1918	1,197,630	389	1975	424,831	79
1923	3,089,146	1,003	1976	333,315	66
1927	2,397,750	779	1977	365,714	70
1928	2,286,610	743	1978	449,544	97
1929	2,828,420	918	1979	665,439	168
1930	2,205,674	716	1980	723,099	123
1931	1,500,571	487	1981	550,502	97
1932	1,201,356	390	1982	611,998	112
1934	1,160,700	377	1983	724,509	117
1936	2,480,500	805	1984	724,557	115
1937	1,940,900	630	1985	545,439	94
1938	1,426,900	463	1986	745,548	129
1939	1,055,600	343	1987	1,425,584	225
1940	690,400	224	1988	913,100	138
1945	1,707,100	554	1989	529,858	90
1950	1,322,100	225	1990	328,850	58
1951	1,531,900	247	1991	319,040	61
1952	1,620,900	331	1992	293,956	57
1953	1,525,300	310	1993	223,199	43
1954	1,008,400	223	1994	197,905	37
1955	731,000	150	1995	232,498	44
1956	1,318,000	285	1996	219,411	41
1957	1,086,500	239	1997	249,007	47
1958	1,041,500	228	1998	236,043	45
1959	1,311,000	287	1999	216,329	41
1960	1,216,200	289	2000	203427	38
1961	1,209,100	233	2001	258,086	49
1962	961,400	192	2002	243,775	46
1963	694,000	133	2003	260,966	49
1964	727,700	153	2004	367,660	69
1965	863,700	166	2005	378,062	71
			2006	447,452	85

While the series of events around the turn of the century readily shows the relationship between harvesting with dredges and its pronounced effect on the volume of oyster landings, management measures taken after the decline in landings beginning in the early 1900s appear to have had little long-term effect. There appear to be several contributing factors which allowed for the continuing decline. Coon oysters (long, slender oysters shaped like a raccoon footprint; typically found in intertidal areas) were exempt from size limits until 1971. There was also no definition of a coon oyster, and enforcement was apparently at the discretion of individual officers. Taking oysters for personal consumption was also allowed year-round until 1966. These harvest factors were extremely harsh on oyster resources in the southern estuaries (A. F. Chestnut, UNC- Institute for Marine Sciences, pers. comm. 1991). Also, adequate enforcement seemed to be lacking, allowing for harvest of undersize oysters for sale and for planting on private oyster beds in Chesapeake and Delaware bays (Thorsen 1982; Chestnut 1951). The lack of harvest limits and lack of restrictions on oyster dredge weight until 1947 probably had a pronounced effect on oyster habitat, as well.

Even though oyster dredging was blamed for overharvesting and depletion of oyster resources in Delaware Bay and Chesapeake Bay, North Carolina fishermen adopted the practice and laws were passed allowing its use (Figure 6.2). Early attempts at regulating this fishery limited the dredging areas to open sound waters in depths over certain limits. The 1887 law allowed oyster dredging only in Pamlico and Roanoke sounds in waters 8 feet deep or greater (Thorsen 1982). This law was abolished in 1891 due primarily to the non-resident dredgers. Dredging was reinstated in 1895 after oyster landings dropped drastically, but only from February 1 through May 1 in Pamlico Sound waters ten feet in depth or greater (Thorsen 1982). A heavy tax was also placed on dredge boats, discouraging re-entry into the fishery, and oyster landings were again very low the following season (Thorsen 1982). In 1897 the season was lengthened by two months and landings rose to 1,539,000 bushels.

In 1903, 1905, and 1909, changes were made in the statutes that better defined the area where oyster dredging was allowed. The new laws dropped the depth restriction and reduced the open area. By 1909, only the open waters of Pamlico Sound outside the mouth of all tributaries, offshore of the shoal area behind the Outer Banks, outside of Carteret County, and southwest of Bluff Shoal were available for dredging (Figure 7.1). Oyster landings during this period also fell, reaching a low of 389,000 bushels during 1918.

Available rulebooks indicate that by 1927, the Fisheries Commission had reopened Pamlico Sound north of Bluff Shoal, West Bay (then known as Cedar Island Bay), East Bluff Bay, West Bluff Bay, Juniper Bay, Neuse River, Pungo River, and Swan Quarter Narrows to oyster dredging (Figure 7.2). Only sail powered boats were allowed. The Fisheries Commission was given rule-making authority in 1915. It is not known exactly when between 1915 and 1927 the change in areas available for taking oysters with dredges occurred. These rules were in conflict with the statutes until 1950 when the statutes were repealed. It is felt that the rules were made available to the fishermen and that the rules were used for enforcement purposes.

The areas where oyster dredging was allowed by sail power remained relatively unchanged except for openings and closings of a few Hyde County and Pamlico County bays until 1952. The distinction between power and sailboat dredging disappeared by 1955.

Figure 7.1. Open oyster dredging area 1909 (hatched), sail power only (Marshall 1995).

Figure 7.2. Open oyster dredging area 1927 (hatched), sail power only (Marshall 1995).

While power boats had been around since before World War I, they were not allowed for dredging oysters until 1931, when Pamlico Sound north of Long Shoal, Wysocking Bay, Cunning Harbor, West Bluff Bay, Great Island Narrows, Rose Bay, Juniper Bay, and Swan Quarter Bay were exempted from the general rule of sail power only for dredging (Figure 7.3). These powerboats were restricted to a length of 30 feet and hand dredges only (no power winches allowed for raising dredges). Pamlico Sound north of Long Shoal and Wysocking Bay remained open, but several Hyde and Pamlico county bays opened and closed to power boat dredging between 1931 and 1944. In 1944 power boats 32 feet long

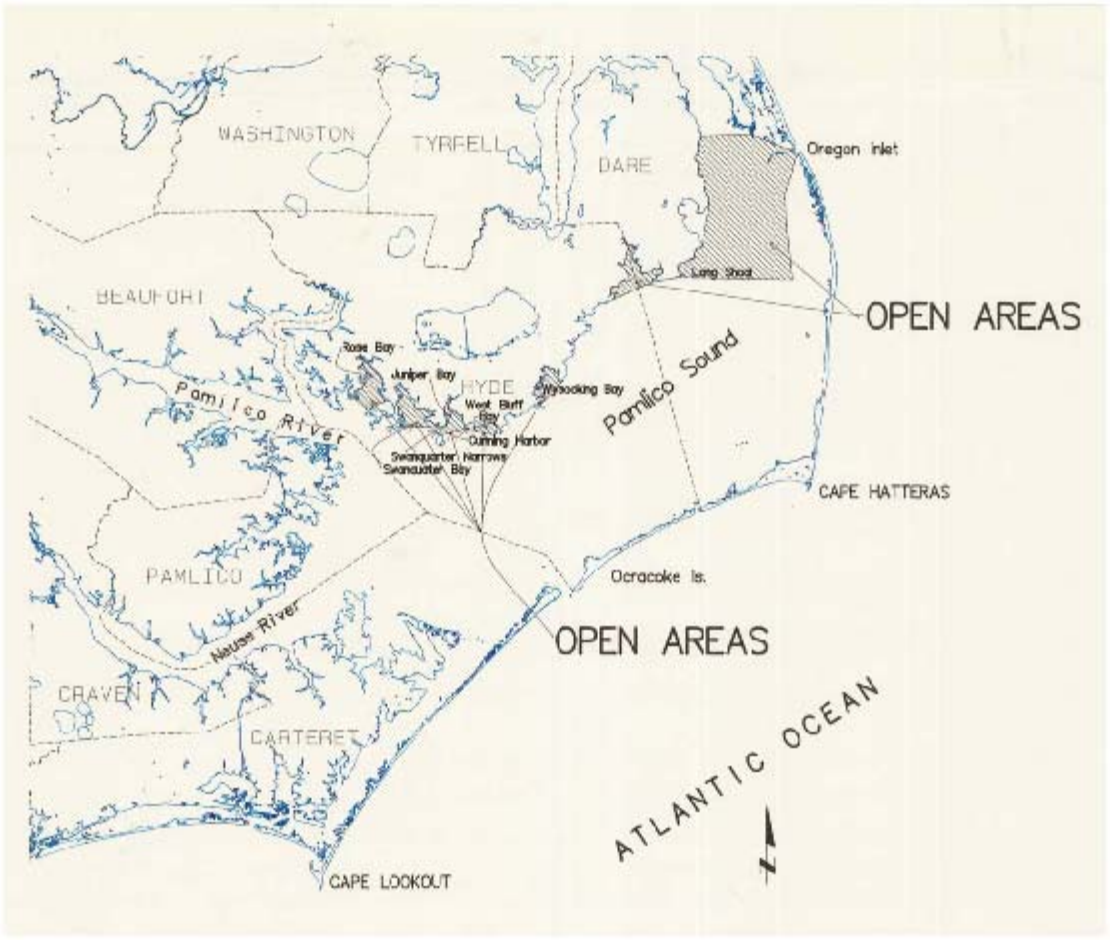

Figure 7.3. Open oyster dredging area for powerboats (hatched), 1931 (Marshall 1995).

and under were allowed to pull hand dredges in Pamlico Sound, Pamlico River, Neuse River, Wysocking Bay, East Bluff Bay, West Bluff Bay, Juniper Bay, Great Island, Swan Quarter Bay, Rose Bay, Deep Bay, Mouse Harbor, Middle Bay, Jones Bay, Bay River, Turnagain Bay, Long Bay, Point of Marsh, and Cedar Island Bay (now known as West Bay) (Figure 7.4). This change represented a significant expansion, probably caused by World War II and resultant increases in price and demand for oysters. In 1946, the hand dredge restriction was dropped, and in 1948 the boat size restriction was also deleted.

The North Carolina General Assembly also made changes in oyster laws during this time period. Beginning in 1947, powerboats were limited to pulling one dredge weighing no more

than 100 pounds and a daily take of no more than 75 bushels of oysters. Sailboats were allowed to pull two dredges of any weight with the same daily harvest limit.

Figure 7.4. Open dredging area for powerboats (hatched), 1944 (Marshall 1995).

Another significant change in the rules had occurred by 1955, which reversed the approach to wording the restriction on dredging areas. The 1955 rulebook described the areas that were closed to oyster dredging instead of describing the open areas. The only closed areas were

the reef area behind Ocracoke Inlet and Portsmouth Island down to the Swash and several Carteret County areas, including Core Sound, Back Sound, Bogue Sound, Straits, North River, Newport River, and Back Bay (Figure 7.5).

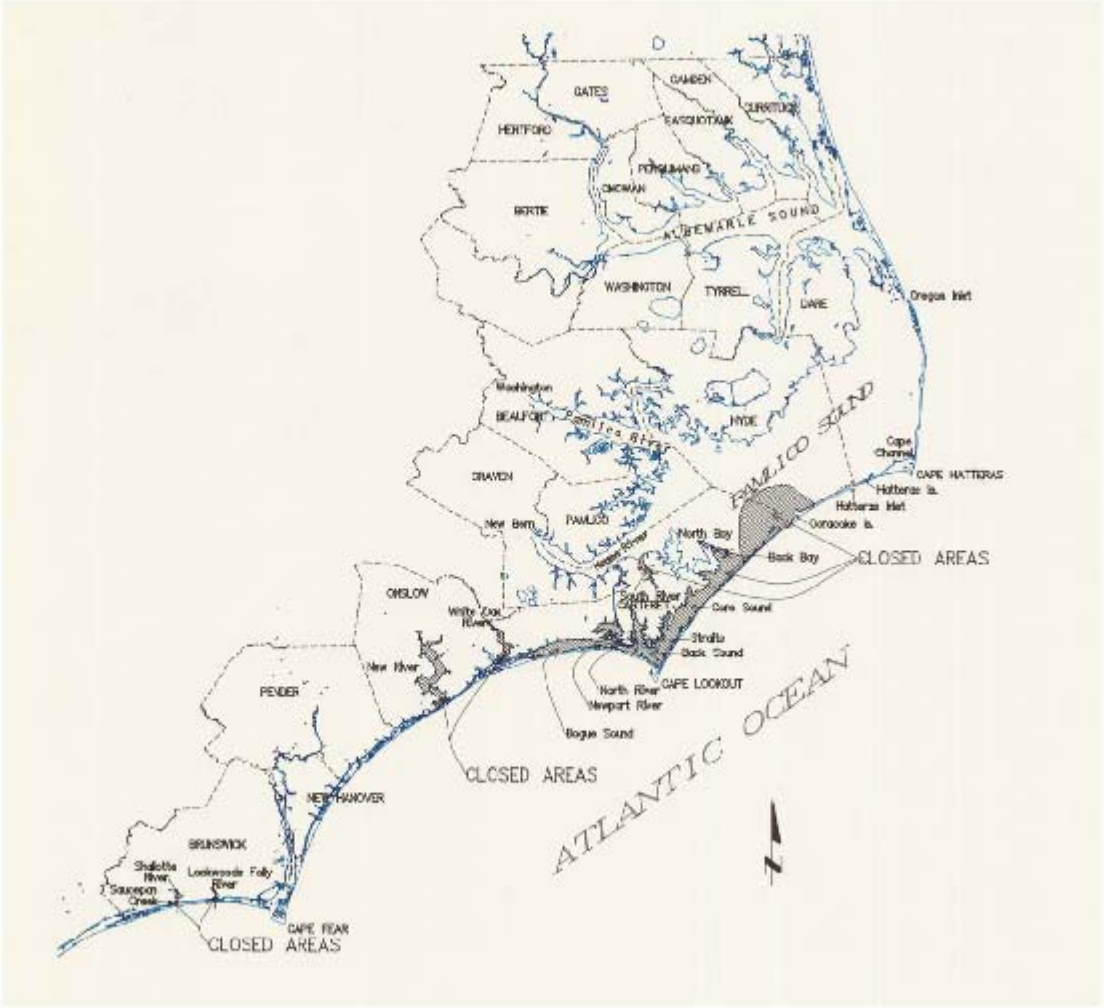

Figure 7.5. Closed oyster dredging area (hatched), 1955 (Marshall 1995).

During the 1960s several areas were added to the list that prohibited oyster dredging, including New River, Shallotte River, Lockwoods Folly River, South River, White Oak River, Saucepan Creek, and Currituck County (Figure 7.6). North Bay was added in 1974, and South River was reopened to dredging in 1975. The formally designated primary nursery areas were added to the list of prohibited dredging territories in 1977.

Figure 7.6. Closed oyster dredging area (hatched), 1960-1975 (Marshall 1995).

In 1981, proclamation authority was established that allowed the reef area (waters generally inside the six foot depth contour) behind Ocracoke Island and Hatteras Island from Hatteras Inlet up to Cape Channel to be closed to dredging. These areas were closed by proclamation

annually until 1988 when dredging was prohibited by rule for this area. The remainder of the reef area up to Oregon Inlet was closed to oyster dredging by rule in 1991 (Figure 7.7).

Figure 7.7. Area closed to oyster dredging 1991- 2004 (hatched) and Primary Nursery Areas (black). Areas restricted to hand harvest of oysters by proclamation are not shown (Marshall 1995, DMF GIS database).

Based on recommendations and criteria in the 2001 Oyster Fishery Management Plan, portions of bays generally less than 6 feet deep were closed to oyster dredging in Dare, Hyde, Beaufort, Pamlico, and Carteret counties in October 2004 (Figure 7.8). The total area closed to dredging was approximately 30,000 acres.

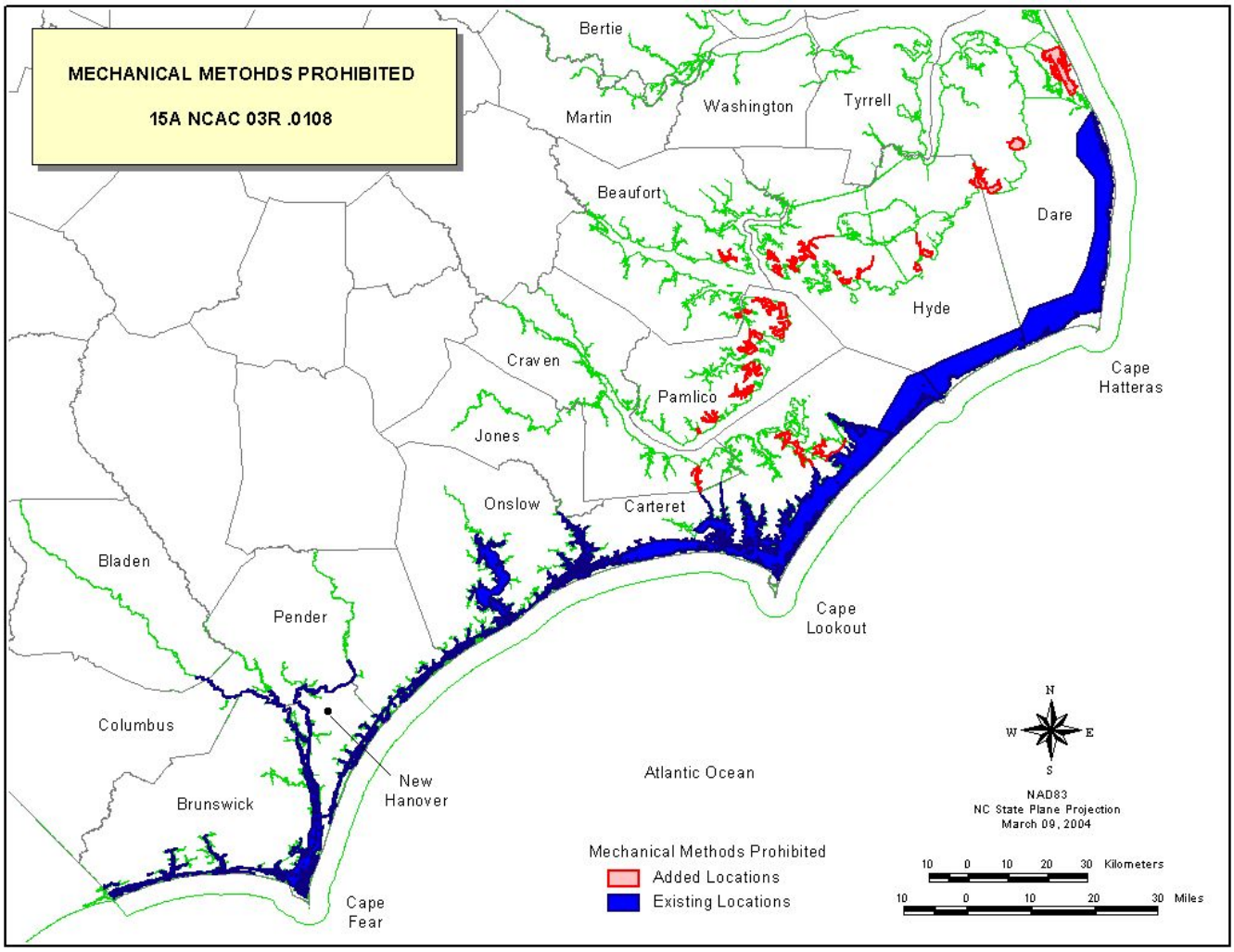

Figure 7.8. Current area closed to mechanical harvest of oysters showing additional area added in October, 2004 (DMF GIS database).

The hand dredge only provision resurfaced in 1967 for the waters of Roanoke Sound. That provision was dropped in 1976, again allowing dredges weighing up to 100 pounds.

The one dredge per boat law was apparently abolished in the early 1970s when that section of the session laws was changed. Since then the use of more than one dredge was allowed from time to time, depending on Division policy. During 1988, the provision for one dredge per boat was adopted by rule. The 75 bushel per day harvest limit existed either in statute or rule

from 1947 until 1984. Since 1985 the limit has been set below 75 bushels, and currently the maximum limit allowed by rule is 50 bushels. Proclamation authority allows the Fisheries Director to establish the limit up to 50 bushels by area or by gear.

Except for seasons, some local laws, and size limits on non-coon oysters, the hand harvest fishery was virtually unrestricted until 1947 when, presumably, the 75 bushel per boat limit was applied. This limit probably had little effect. The first meaningful attempt at regulating the hand harvest fishery occurred in 1989 when a harvest limit of seven bushels per person was established. The early view of hand harvesting of oysters was that it could never affect the stock or habitat. Furthermore, the intertidal oysters of the southern part of the state were seen as inferior and no size limit was adopted until 1971 when a 2 1/2-inch limit was imposed. In contrast, a 2 1/2-inch cull law was initiated on subtidal oysters in 1893 and a further increase to three inches was made between 1931 and 1934. The three-inch cull law was not applied to all oysters until 1980.

The gear for hand harvest of oysters (hand tongs, hand rakes, and by hand) has also been largely unregulated. Early laws refer to the use of regular oyster tongs but have no definition. An old Newport River rule prohibited the use of pitchforks and a local New River rule limited tongs to no more than six teeth. The threat of destruction of oyster rocks by fishermen with bull rakes from northern states prompted the adoption of limitations on rakes for taking oysters in 1981. Originally a ten-pound weight restriction, it was later modified to the current limit of rakes no more than 12 inches wide nor weighing more than six pounds. Hand harvest methods currently include hand tongs, hand rakes, and by hand. Hand tongs are generally used in shallow subtidal areas. Hand rakes and actual picking up by hand are normally used in intertidal areas. Some specialized uses of rakes and modified tongs occur in subtidal areas. Hand methods are allowed in all approved waters during the open season.

The hand harvest fishery has at many times enjoyed a longer harvest season and no management restrictions on open harvest areas. The two major factors affecting the hand harvest fishery appear to be loss of harvest area due to pollution closures and the loss of habitat from clam harvesting.

The culling tolerance that applies to oysters harvested by hand or mechanical means has been incorporated in rule at least since 1927. During the early years it was set at 5%. The culling tolerance changed to 10% around the same time as the change in size limit from 2 1/2 to 3 inches, between 1931 and 1934. Except for a brief four-year period between 1971 and 1975, when the culling tolerance for the 2 1/2 inch coon oysters was 15%, the culling tolerance has remained at 10%. Prior to 1971 there was no size limit and therefore no culling tolerance on coon oysters.

The number of days available to harvest oysters has varied considerably over the years. The first oyster season was set at 32 weeks between the dates of September 1 and April 1, 1872-73. Prior to 1872, oyster harvest was allowed year-round. The next change occurred in 1891, when the season was shortened to 28 weeks by limiting oyster harvest to October 1 through April 1 (Thorsen 1982).

The management action of restricting oyster dredging to a shorter season than hand harvest methods began in 1895 (Thorsen 1982). This concept was in use in regions of the main portion of Pamlico Sound and for other local areas until significant rule changes took place around 1950. Differential openings and closings of regions of the coastal area to oyster harvest by proclamation authority beginning in 1966 had virtually the same effect due to regional harvest restrictions. Between 1988 and 1996, the hand methods harvest season was opened two weeks prior to the mechanical gear season by rule. The differentiation in harvest opening dates continued after 1996 at fishermen's request even though the rules allowed both types of gear to be used beginning October 15.

Based on available rule records, the oyster season has varied between 20 and 28 weeks. Since proclamation authority was established in 1966, records are not available to determine the exact number of weeks harvest was allowed. However, the trend since 1966 has been to lengthen the oyster season. Between 1946 and 1965, the season was set at 20 weeks between October 1 and March 1. Between 1966 and 1972, the oyster season was set between the dates of October 1 and March 15 or 22 weeks. From 1973 to 1987, the season was lengthened to twenty-four weeks by adding the last two weeks in March.

While the length of the season may give some indication of the harvest pressure on oyster resources, data from the National Marine Fisheries Service Boat-And-Shore Survey show that the operating units or numbers of types of fishing gear for oyster harvest gear generally follows oyster landings (Figure 7.9). This information indicates that opportunistic fishermen are able to enter the fishery to take advantage of productive years, but they move to other fisheries during periods of low harvest. However, between 1977 and 1987, the operating units climbed to very high levels relative to the landings, particularly for dredges.

Data on landings by gear indicate that prior to 1960, most of the oysters were taken by dredge when compared to all hand methods (Figure 7.9). Chestnut (1955a) reported that ninety percent of the oysters landed in North Carolina came from Pamlico Sound. The previous discussion on dredging areas shows that the harvest in the Pamlico Sound area is largely dependent on dredging. The resurgence of the dredge landings in 1987 was due, in part, to increased oyster populations and in part to increased effort, as displaced mechanical harvest clammers turned to oyster dredging due to closure of southern clamming areas by a red tide. Hand harvest landings failed to reach their potential that same year due to the fact that a majority of the hand-harvest-only area was also closed because of the red tide and a large crop of oysters in that area was not harvested (Figure 7.10). The red tide was a dinoflagellate bloom that caused closure of over 361,000 acres of public bottoms to shellfish harvest from November 1987 to May 1988. The dinoflagellate (*Karenia brevis*) produced a neurotoxin, which was concentrated in shellfish, making them unfit for consumption.

Hand harvest landings contributed significantly and exceeded the dredge landings at times between 1955 and 1965. It is interesting to note that following the adoption of size limits on coon oysters in 1971 and 1980, landings declined for hand harvest.

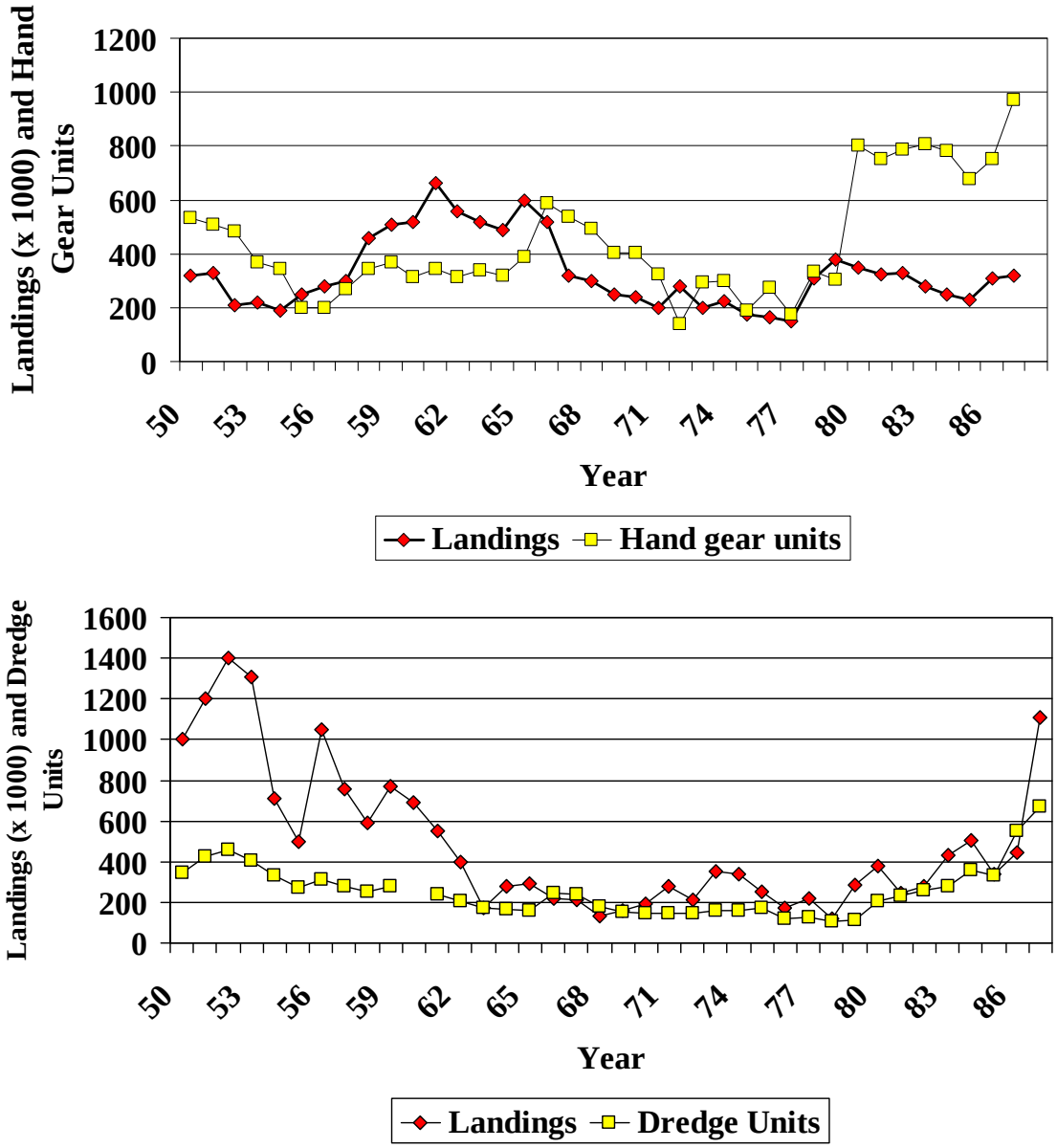

Figure 7.9. Operating units of oyster harvesting gear compared to oyster landings by gear in pounds of meat (Chestnut and Davis 1975; National Marine Fisheries Service unpublished data; DMF unpublished data).

Economic upheavals, world wars, and severe weather events have also affected the commercial oyster fishery by reducing the market, reducing the labor force, or by affecting the fishery or the habitat. During the course of this review, the following occurrences were noted as having a marked effect on the fishery (Figure 7.10).

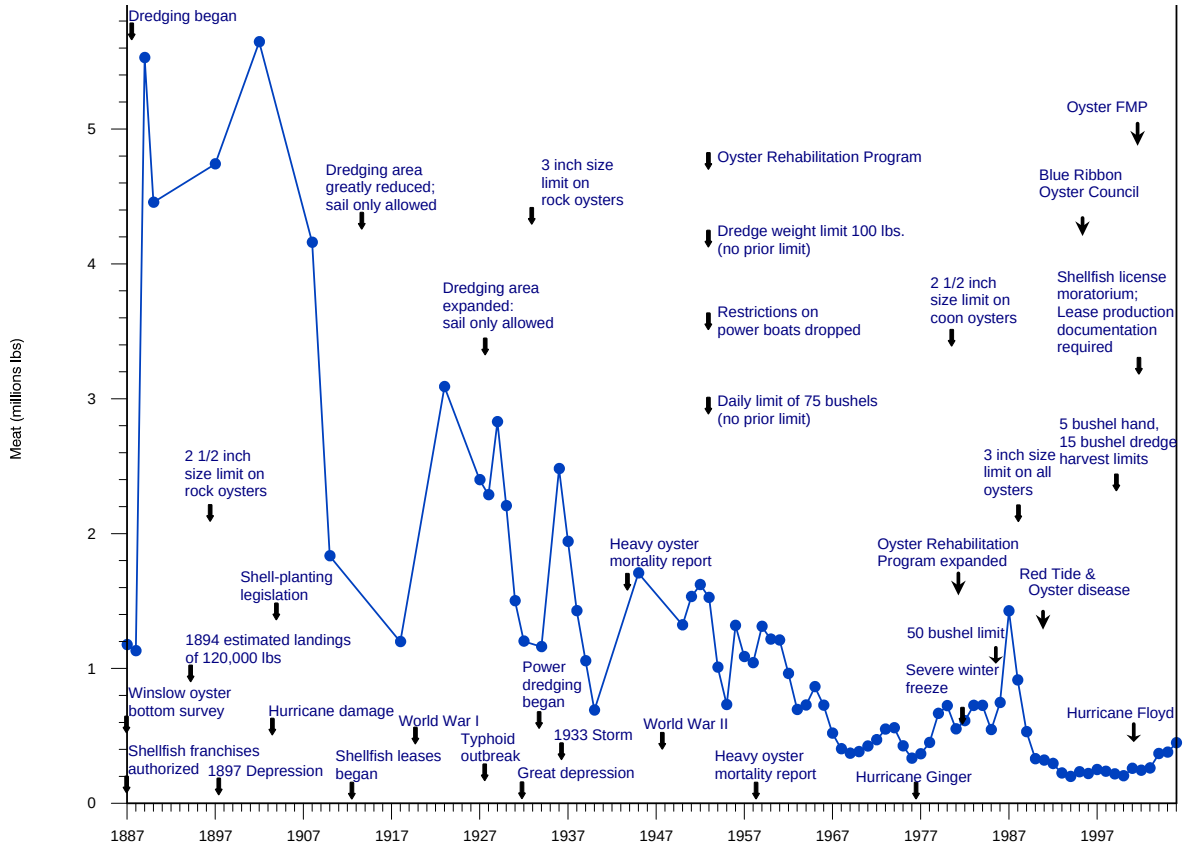

Figure 7.10. Factors affecting the North Carolina oyster fishery, 1887-2006 (DMF Trip Ticket Program). Not shown: 1855 – first private oyster culture license; 1872 – first oyster season established.

1893	An economic depression severely reduced the market for oysters.
1899	Hurricanes in August and October killed many oysters due to excessive rainfall.
1917-18	A severe December and January freeze curtailed harvest; manpower was lost due to World War I.
1924	A typhoid outbreak was traced to east coast oysters reducing markets. The Shellfish Sanitation Program began, and polluted areas were closed to harvest.
1929	The Great Depression caused oyster markets to fall off dramatically.
1933	The 1933 storm destroyed oyster beds around Ocracoke and Portsmouth which had been the most productive in the state since the mid 1800s.
1940	An unexplained heavy mortality of oysters was reported.
1942-46	Production increased due to high prices caused by World War II.

1949	Heavy rains in June, 1949 caused severe oyster mortalities in Hyde and Dare counties which affected landings through 1951.
1953-55	Oyster resources were damaged due to hurricanes Hazel, Connie, Diane, and Ione.
1972	Hurricane Ginger caused an estimated 33% mortality of oysters in Pamlico Sound.
1976-77	A severe freeze curtailed the winter oyster harvest.
1987-88	Oyster harvest from Core Sound south to the South Carolina border was severely curtailed due to a red tide outbreak.
1988-2002	Significant oyster mortalities were caused by the oyster parasite *Perkinsus marinus* (Dermo).

In contrast, some efforts to rehabilitate the oyster fishery were cited for large increases in landings:

1921-24	Approximately 1.5 million bushels of seed oysters and shells were planted and given credit for the great increase in landings around 1923.
1934	Plantings of 825,000 bushels of seed and 78,567 bushels of shell in 1934 were closed until 1936, when landings rose to around 800,000 bushels.

7.1.2 PRESENT PUBLIC BOTTOM FISHERY

The harvest of oysters from public bottoms has been managed in the same manner since approximately 1988. Hand harvest oyster season opens on or about October 15th each year and mechanical harvest opens near mid November. The few changes made in the season involved early closures due to input from fishermen and dealers that most of the harvestable oysters had been taken. A rule change occurred in 1996 that allowed the oyster season to remain open for an additional six week period between March 31 and May 15 to allow for the harvest of Dermo infested oysters. To date the extended season provision has not been utilized due to an inability to identify disease threatened oyster stocks at that time of year.

The areas designated for mechanical harvest of oysters changed in 1991 when an area along the Outer Banks in Pamlico Sound was closed. Three bays and several Shellfish Rehabilitation Program sites in Pamlico Sound were also closed to mechanical harvesting by proclamation annually from 1991 until 2004 when new management strategies implemented in the 2001 FMP were implemented. Effort and landings were at such low levels during this period that the reduction in harvest area probably had little effect. There were no landings from mechanical harvest gears recorded for the 1995/96 and 1996/97 fishing seasons because of impacts from Dermo and major hurricanes in 1996 (Figure 7.11). The additional 30,000 acres closed to oyster dredging in October 2004 has not been in effect long enough to assess its impact however, landings by dredges from Pamlico Sound increased by 10,000 bushels during 2004 primarily due to low Dermo infections and total landings have continued to increase to

85,000 bushels in 2006, the highest landings since elevated Dermo infections began to reduce harvests in 1989.

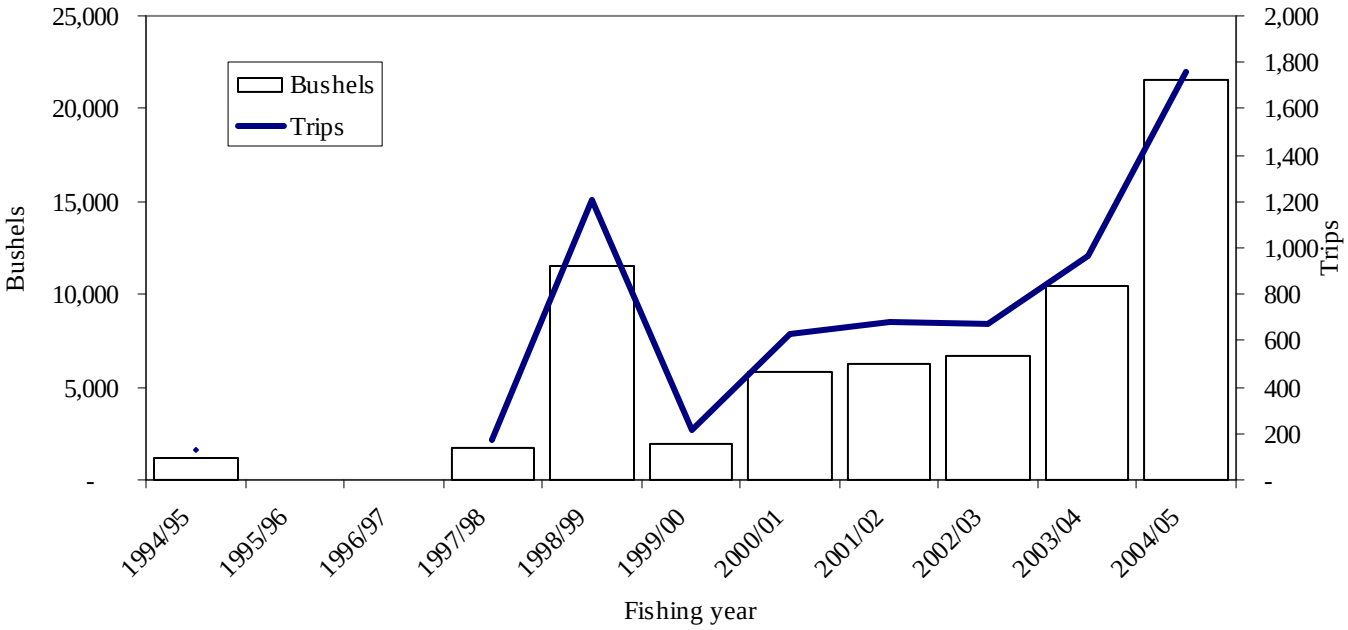

Figure 7.11. Commercial mechanical harvest oyster landings (bushels) and trips from public bottom by fishing year, 1994/95 to 2004/05 (DMF Trip Ticket Program).

The harvest limits for both the mechanical and hand harvest fisheries did not change between the 1992/93 and 2006/07 oyster seasons when hand harvest was limited to 5 bushels per person not to exceed 10 bushels per boat and mechanical harvesters were limited to 15 bushels per fishing operation. Both of these limits are considered to be the minimum that will support commercial activity given the prevailing market conditions and operating costs. One exception allowed the harvest limit for mechanical harvesters to increase to 20 bushels per boat for the 2004/05 oyster season. As noted earlier, hand harvesters have supported the bulk of the public bottom landings in recent years taking 82% of the harvest for the period 1994 through 2005.

The number of shellfish licenses and shellfish and crab licenses issued decreased from 6,610 in 1995 to 3,507 in 1999. Beginning July 1, 1999, the shellfish license was made available to any North Carolina resident for $25.00 while SCFLs were made available only to those fishers with endorsements to sell. The wide availability of the Shellfish License is to enable those subsistence fishers who harvest only shellfish to continue to do so with a low-priced license. A free shellfish endorsement was also made available to SCFL holders that are state residents. A total of 7,545 shellfish licenses and shellfish endorsements were sold in fiscal year 2000. Out of 5,775 standard commercial fishing licenses sold, 5,456 have shellfish endorsements (95%), while only 2,098 shellfish licenses were sold. The number of licensees holding shellfish endorsements and licenses decreased steadily during 2000-2006. Shellfish endorsement holders decreased from 6,481 in 2000 to 5,751 in 2006 while shellfish license holders dropped

from 2,098 in 2000 to 1,592 in 2006. The only sector having an increase in shellfish licensing during 2000-2006 was shellfish endorsement holders with Retired Standard Commercial Fishing Licenses which rose to 771 from 480 during the period. A complete discussion of license trends is presented in Section 10.1.1.

The number of fishermen actually selling shellfish as documented in trip ticket data was much lower than the license data would indicate. Only 521 fishermen filed trip tickets with oyster catches in 1999 but participation gradually increased and reached 726 harvesters reporting oyster landings in 2005.

7.1.3 HISTORICAL PRIVATE CULTURE FISHERY

Although North Carolina law did not formally prescribe the methods for obtaining private oyster 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.

Joseph Hyde Pratt, State Geologist for North Carolina, evaluated the success of this initiative in oyster culture and found that, by 1900, practically all of the beds had been abandoned, except for a few acres being cultivated for private use (Pratt 1911). He found that those purchasing the grants were not familiar with oyster cultivation, that these owners chose poor bottoms, or that they were unwilling to put forth the necessary efforts. Others bought oyster grounds simply for speculation. On the other hand, experienced oyster growers found that not only were the laws inadequate to protect them, but their bottomlands could be taken from them if any two witnesses swore that the area was a natural oyster rock (Pratt 1911).

Grave (1904) provided the information on which Pratt based his report to the General Assembly. While Grave found that he could not find a single private bed anywhere in North Carolina, that was being cultivated or was yielding a return for the investment, he conducted oyster culture experiments on public bottom that showed oyster culture could be productive. Other investigations followed which further demonstrated the productive potential of Pamlico Sound (Pratt 1911).

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. The acreage of shellfish leases was limited to ten acres in the bays and smaller sounds. An individual lease area could be up to fifty acres in size 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.

Chestnut (1951) reviewed the shellfish lease system that had operated under this basic legislation until 1949. At the time there were 264 leased areas totaling 3,232 acres. Chestnut (1951) stated "Except for a relatively few grounds under lease, the majority are being used primarily for the same purpose as fifty years ago, merely to keep a small amount of oysters to supply the family needs." This poor showing occurred despite the fact that the state had operated an Oyster Demonstration Farm in North River, Carteret County, during the late 1930s and early 1940s.

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 the 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.

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. Acting on recommendations from the State Auditor, lease fees were further increased in 2004 to $200.00 for lease applications, $100.00 for lease renewals and lease rental rates were increased from $5.00 per acre per year to $10.00 per acre per year. The increases were intended to make the shellfish lease program self-supporting. The increase in rental rates can only be applied to new leases and at time of renewal for existing leases.

The legislation authorizing the MFC to adopt production requirements also made provisions for periods of low oyster productivity. The statute provided that if a leaseholder made a

diligent effort the lease could not be terminated and acts of God were also reason to excuse lack of production.

During the period 1982-1986, 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 1982-1986. Furthermore, by policy, DMF 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 meet neither of the 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. Oyster cultivation efforts and harvest from leased and franchise areas are shown in Table 7.2.

A generalized analysis for the present similar to past analyses of Winslow (1889), Pratt (1911), and Chestnut (1951) would state that the majority of the shellfish leases today are used by commercial fishermen to supplement their income from public area harvests and to provide opportunities for holding shellfish for better meat condition or better market. Beginning in the early 1980s, there has been a move to fully utilize shellfish lease potential by full-time shellfish culturists, but due to market and available technology, they have largely cultured clams. A few oyster culturists with niche markets are growing and marketing hatchery reared oysters raised using contained growout methods.

Other states have been more successful than North Carolina at establishing an oyster industry based on private cultivation. Virginia, Delaware, Louisiana and Connecticut all have had success with oyster cultivation by private interests. These states all made available large resources of seed oysters to private bottom holders. Some of the areas are naturally occurring and some are augmented substantially by the expenditure of state or federal funds to plant cultch for spat attachment that is then allowed to be moved to private cultivation sites. Oyster cultivation by artificial spawning and rearing of larvae similar to clam culture has been effective on the West Coast with the Pacific oyster but has not been very effective in the Mid-Atlantic region.

Available rules and statutes indicate that early private oyster growers may have had access to the same type of large seed resources as those in other states. Private bottom holders were allowed to take oysters of any size from the public grounds of the state during a period immediately following the close of oyster season. However, Dr. A. F. Chestnut (UNC-Institute for Marine Sciences, pers. comm. 1991) stated that, although the rules appeared to give great latitude, the actual practice was to restrict the areas to coon oysters and stunted growth areas. By the late 1960s oyster transplants could be obtained only from polluted areas and three relatively small seed oyster management areas - two in Dare County and one in Pender County. The number of available polluted sites has increased over the years, and three seed oyster management areas were added - one in White Oak River in 1972, one in Virginia Creek in 1982 and one in Bay River in 1997. While all these transplanting sites comprise a relatively large area, without cultch planting and management the oyster resources in these areas have been slow to recover from depletion by transplanting activities. The period for

transplanting polluted oysters has been set at a six week period following the closure of oyster season (North Carolina Fisheries Rules for Coastal Waters 15A NCAC 03K .0104). Seed oysters can be moved to private cultivation sites from April 1 through September 30 (North Carolina General Statute 113-203).

Table 7.2. Reported oyster planting and harvesting activity on North Carolina shellfish leases, 1979-2005. (DMF Resource Enhancement Section)

Year	Number of Leases	Lease Acreage	Oyster Planting (Bu.)	Cultch Planting (Bu.)	Harvest (Bu.)	Percent of State Landings
1979	246	2,185	9,929	15,622	28,165	20
1980	260	2,233	24,257	27,667	58,792	48
1981	262	2,257	20,126	21,248	17,535	18
1982	262	2,257	34,122	20,386	17,155	15
1983	265	2,286	24,130	27,685	12,457	11
1984	269	2,291	18,263	16,184	11,382	10
1985	272	2,304	20,968	17,693	11,384	12
1986	282	2,380	19,240	17,108	12,734	10
1987	279	2,354	16,746	15,010	6,041	3
1988	285	2,330	20,092	19,402	13,962	10
1989	276	2,232	4,799	28,794	9,555	11
1990	276	2,214	17,036	32,218	13,425	23
1991	281	2,435	21,402	25,355	9,930	16
1992	280	2,191	22,508	34,057	9,668	17
1993	300	2,441	21,680	46,252	7,669	18
1994	285	2,280	21,421	62,219	4,231	11
1995	279	2,216	18,112	27,409	4,348	10
1996	295	2,193	18,070	33,790	4,633	11
1997	295	2,196	24,120	24,932	5,263	11
1998	282	1,933	18,714	22,302	5,601	12
1999	284	2,121	21,130	35,242	5,914	14
2000	285	2,112	21,090	40,628	3,575	9
2001	288	2,142	17,645	21,725	5,948	12
2002	276	2,004	18,085	20,445	6,227	13
2003	273	1,937	19,984	30,957	6,694	14
2004	287	2,050	22,801	21,716	10,113	15
2005	277	1,972	31,027	26,227	10,767	15

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 because they met established legal requirements following a review of all submerged land claims that began in the 1970s. All the claims of ownership of shellfish franchise rights have now been resolved and there are 48 of these recognized shellfish franchises in North Carolina totaling 502 acres. Those that were

recognized as valid claims to public bottomlands were required beginning January 1, 1991, to meet the requirements for surveys, management plans, and commercial shellfish production set for shellfish leases. Production data from these franchises began showing up in the 1991 statistics but is not differentiated from the shellfish lease landings. Franchises that were not recognized may be subject to special leasing provisions.

In 1989 legislation was enacted to allow the use of the water column above existing shellfish leases. At this time, only five water column amendments covering a total of 13 acres exists. Since the first water column amendments were issued in 1991, the highest total in number and acreage occurred in 1998 with seven areas leased and total of 16 acres. The high rental fee of $500 per acre per year probably excluded many leaseholders. However, even though the water column lease fee was reduced in 2004 to $100 per acre per year, this culture opportunity receives little use. A summary of the opportunities for obtaining space in coastal waters to grow shellfish is shown in Table 7.3.

Table 7.3. Comparison of shellfish lease and amendment types currently authorized by NC General Statutes 113-202, 113-202.1 and 113-202.2 for shellfish cultivation.

	Bottom Lease	Water Column	Demonstration Project
Application Fee	$200	$100	$0
Renewal Fee	$100	$100	$0
Survey Requirement	yes	yes [1]	variable
Rental Fee	$10/acre/yr.	$100/acre/yr.[2]	$0[3]
Term	10 yrs.	5 yrs.	2yrs.
Renewals	indefinite	indefinite	one
Production Requirements	10 bu./acre and	40 bu./acre or	none
Planting Requirements	50 bu./acre cultch or 25 bu./acre seed	100 bu./acre cultch or seed	none

1 - Unless area is identical to bottom lease

2 - Fees are additive

3 - Unless commercial production occurs

7.1.4 PRESENT PRIVATE CULTURE FISHERY

Despite the addition of water column use on approved lease sites, increased Sea Grant involvement, and funds provided by the Fisheries Resource Grant Program, interest in utilizing hatchery-reared seed and modern aquaculture techniques to culture oysters is minimal. Aquaculture techniques can circumvent the effects of Dermo parasites in some areas but disease losses are still a concern. The major impediment to increasing aquaculture production

of oysters is locating markets willing to pay the higher prices necessary to offset increased labor, rental, and materials costs. Another obstacle is that the few shellfish hatcheries in North Carolina are unable to produce sufficient number of seed to meet the demands of shellfish growers. Therefore growers typically utilize out-of-state sources for shellfish 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 the 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 DMF policy is to follow the guidelines set forth in the ASMFC Cooperative Agreement. DMF 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 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 DMF 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 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 for 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.

Most leaseholders utilize cultch planting and relaying techniques that have been in use for over 100 years. Although, production of oysters from leases dropped about 75% with the onset of Dermo, leaseholders have maintained production of approximately 14% of the State's oyster harvest in recent years although many leaseholders do not meet the minimum production or planting requirements. The production requirements may be met by producing oysters, clams, scallops or mussels and many leaseholders choose to culture hard clams. There are currently no data to determine the amount of oysters produced per acre on shellfish leases targeting oyster production.

Since 1994, 14% (1994-2005 combined estimate) of the total commercial oyster harvest was from private bottoms in North Carolina. Oyster harvest from private bottom has increased slightly since the higher production requirements were initiated in 2004, but it will require several more years to determine an accurate trend (Figure 7.12). The three top waterbodies, which accounted for 85% of the oyster landings from private bottom included: Topsail Sound, Stump Sound, and Newport River.

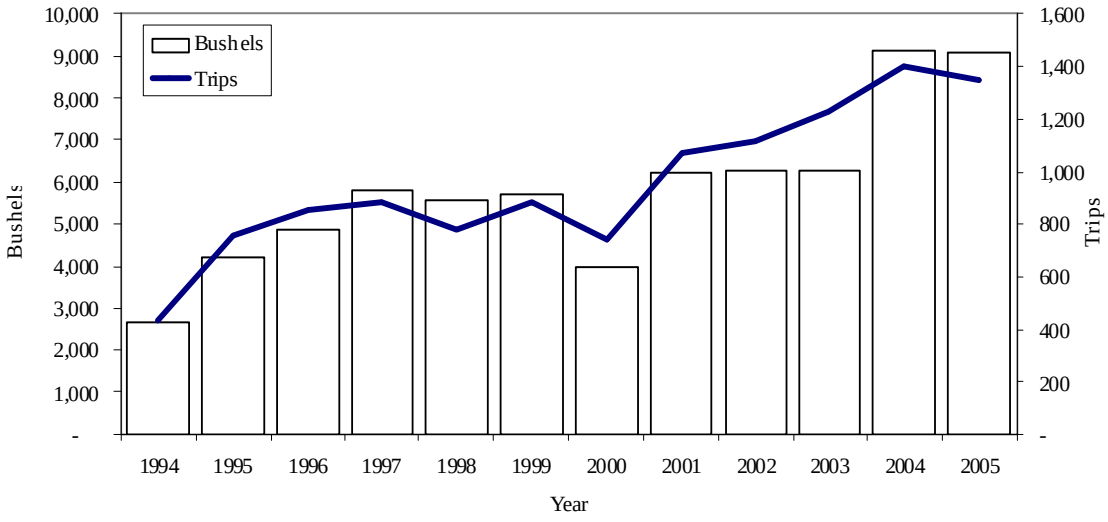

Figure 7.12. Annual commercial oyster landings (bushels) from private bottoms, 1994-2005 (DMF Trip Ticket Program).

Oysters may be harvested from lease sites by hand or mechanical gear depending on the environmental characteristics of the site and determination of conflicts with Primary Nursery Area designations. Since 1994, 95% (1994-2005 combined estimate) of the commercial landings from private bottoms are harvested by hand. If mechanical harvesting on the lease site does not pose a threat to critical habitats or nearby resources, leaseholders may use mechanical methods to harvest oysters even if public bottom mechanical harvest is prohibited in the general area. An average of 35 leaseholders took advantage of the mechanical harvesting permit annually between 1987 and 2005. Leaseholders may also harvest oysters during the closed oyster season and harvest during this period is increasing although it was less than 1800 bushels in 2005. A form certifying the oysters were harvested from a shellfish lease or franchise is required to be delivered to the purchaser during the closed season. Lease and franchise holders are also exempt from size limit restrictions during the regular closed oyster season.

Relaying of oysters from polluted areas to leases for depuration occurs during a six week period after the close of the regular oyster season each year. Transplanting of oysters from seed oyster management areas occurs during the regular closed oyster season from April 1 through September 30. Relaying and transplanting continue to be significant components of oyster culture efforts despite diminished returns in recent years. Between 1991 and 2005 private bottom holder's reports showed that relaying and transplanting totals ranged between 17,645 and 31,027 bushels for oysters (Table 7.2). However, the number of private bottom holders participating was generally less than half of the total bottom holders. The highest total of relayed and transplanted oysters occurred in 2005. Leaseholders using aquaculture techniques have also been active in recent years planting 4,750,000 seed oysters during 2003-2005. Cultch planting also remains popular as an oyster culture technique despite decreasing supplies and increasing costs for cultch materials (Table 7.2).

7.2 RECREATIONAL FISHERY

In North Carolina, one bushel of oysters per person, not to exceed two bushels per boat, may be taken per day during the regular oyster season for recreational purposes with no licenses (North Carolina Fisheries Rules for Coastal Waters 15A NCAC 03K .0105). The quantity of oysters harvested for recreational purposes is unknown. However, in traditional fishing communities it is a customary practice and southern area Marine Patrol officers report that in many areas the recreational harvest is substantial. According to the 1991 Addendum to the 1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, (USFWS 1991), 129,973 shellfishermen aged 16+ expended 1,009,000 days shellfishing in North Carolina in 1985. Shellfishing included both molluscs (oysters, clams, scallops) and crustaceans (shrimp, crabs). North Carolina ranked twelfth and eleventh nationally in those two categories, respectively.

During 1991, the telephone survey portion of the North Carolina Marine Recreational Fishery Statistics Survey included a question on the number of recreational shellfishing trips taken. Results indicate there were more than one million trips to harvest shellfish in North Carolina in 1991. No data on shellfish harvest was given.

Kimel (2004) conducted field interviews of recreational oyster fishermen in portions of Pender and New Hanover counties during the 2003-2004 oyster season. Estimates from his data indicate that the recreational harvest of oysters would increase total county landings by 4.3% for New Hanover County and 9.8% for Pender County during the 2003-2004 oyster season.

There are no other known data on recreational shellfishing in North Carolina and no data on oyster harvest by recreational fishermen. Taking oysters for personal consumption was allowed year round in North Carolina until 1966. Since 1966, it has been allowed only during the open season, including Sundays. Available records indicate both hand and mechanical gear have been allowed in the respective open areas for taking shellfish for home consumption.

7.3 STATE OYSTER RESOURCE ENHANCEMENT PROGRAMS

The State of North Carolina has a long history of conducting activities to enhance the oyster resource. Cultch planting to increase oyster production by creating new spat settlement sites began in 1915 and continues today in the Shellfish Rehabilitation Program (Marshall et al. 1999). Oyster sanctuaries were first constructed in 1996 using State funds and more recently environmental organizations such as the North Carolina Coastal Federation and the Nature Conservancy have partnered with DMF to construct additional sites and conduct research on their success (see Section 10.4.1). The NC General Assembly has recently funded additional programs to aid in the restoration of the oyster resource.

7.3.1 SHELLFISH HATCHERY PROGRAM

In recognition of the eastern oyster's role as a keystone species in the estuarine environment, the Governor and General Assembly supported several initiatives in 2005 and 2006 that would make significant progress toward protecting and restoring native oysters and their habitat. In response to introduced legislation (Senate Bill 550) and budget appropriations starting in FY05-06, the North Carolina Aquariums Division created the North Carolina Oyster Hatchery Program (NCOHP) and appointed the interagency Oyster Hatchery Planning Advisory Team. Representatives from the Aquariums, DMF, North Carolina Sea Grant, UNC-CH Institute of Marine Sciences/Carolina Environmental Program, UNC Coastal Studies Institute, UNCW Center for Marine Science, Carteret Community College, and the North Carolina Coastal Federation met throughout 2005-2006, conducted public meetings and visited existing hatcheries in Virginia and Maryland to develop the program recommendations outlined.

The NCOHP scope: 1) Construct production-scale hatchery facilities to produce *Crassostrea virginica* seed for existing DMF and other restoration and sanctuary programs; 2) establish an extension component to educate, train and engage growers; 3) develop an education program to promote and link existing educational efforts by multiple agencies and involve the public in oyster restoration efforts; and 4) support research initiatives along with a broodstock development program at the hatcheries.

Because the challenges facing oyster restoration are different in each region of the state, the proposed program includes educational, training, and research components that will

complement and enhance production goals. The program recommends a flexible and integrated system of three hatcheries with two remote setting sites in support.

Hatchery site recommendations include: Roanoke Island demonstration and training hatchery, Morris Landing production hatchery, and UNCW research hatchery. A DMF remote setting support site is already established at the South River facility, and a second remote setting support site is recommended at Swan Quarter. When the NCOHP is fully functional, it will produce 5 billion oyster larvae and 225,000 bushels of seeded shell per year for DMF restoration efforts. Additional information and the NCOHP final report recommendations are available at www.ncoysters.net (NCOHP 2007).

Oyster hatcheries could provide disease free spat for restoration and sanctuary efforts, but also for shellfish aquaculture. Additionally, sanctuaries could provide protected bottom for the stocking of disease free spat from hatcheries so they could be monitored for production. Increased education and extension opportunities are important to increase public understanding, support and involvement in restoration and related issues. The shellfish aquaculture industry would receive additional support and encouragement from shellfish hatcheries. Research initiatives (disease resistant stocks, genetics) would be supported by hatcheries.

Because the focus of the NCOHP is restoration of the native eastern oyster, the Advisory Team recommended culture of only one species of oyster (*Crassostrea virginica).* However, the Advisory Team also recommended that consideration be given to culture of other shellfish species such as bay scallops and hard clams when oysters are not in production. Therefore, flexibility in hatchery design to accommodate other shellfish species was incorporated into program design. The Bay Scallop Fishery Management Plan also supports this recommendation.

Other states, such as Maryland and Virginia have active state supported hatcheries that effectively work with commercial hatcheries and state agencies. Maryland recently completed the construction of the Horn Point Laboratory at the University of Maryland, Cambridge. This $25 million facility supports finfish and shellfish aquaculture efforts. Mandates for the Horn Point researchers include growing “cultch-less” oysters and determining if the Chesapeake Bay could sustain a fishery based on hatcheries like the west coast does. The state of Maryland also supports hatchery-based-restoration (HBR) efforts in the Chesapeake Bay. In 2006, 350 million hatchery-raised oysters were released into the Bay, which doubled the production from 2005. Virginia has several large hatcheries, including the Virginia Institute of Marine Sciences (VIMS) at Gloucester Point. This hatchery maintains broodstock lines to support local commercial hatcheries. Virginia also supports HBR efforts in the Chesapeake Bay and allocated $2.1 million in 2007 with most of the funds supporting “spat-on-shell” oyster replenishment. The current restoration plan also offers incentive money to commercial hatcheries to produce larvae and build the infrastructure to meet the increased demand for spat.

7.3.2 Oyster Shell Recycling Program

The N.C. Oyster Shell Recycling Program was established in the fall of 2003. The purpose of the oyster shell-recycling program is to recover post consumer oyster shells that are being lost to driveways, landscaping, construction, and landfills and utilize them to create or enhance oyster habitat in cultch planting, hatcheries, and sanctuaries. A complete discussion of the Oyster Sanctuary Program can be found in section 10.4.1. DMF also collects other calcium-based shells for rebuilding oyster habitat such as clam, scallop, mussel, and conch shells.

Convenient drop-off sites with containers and bins at recycling centers are provided for individuals who may have 20 bushels or less from small oyster roasts. Collections of oyster shells from larger oyster roasts (i.e., church, community, civic organizations, and festivals) require the utilization of trailers or dump trucks. Volunteers, solid waste companies, DMF, and county employees cooperate to monitor, collect and transport these shells to a nearby stockpile site.

Partnering with restaurants, oyster bars, oyster shucking houses, solid waste companies, county solid waste and health departments requires a committed volunteer network to help service these businesses and counties where DMF staff is not available. Volunteers are also needed to transport recycled shell to stockpile sites provided by DMF. Another phase of this program is public education. Public awareness and involvement is essential for the success of this program. Assisting with restoration projects promotes a public sense of conservation in their local waters.

Increasing value of waterfront property and limited funding make it difficult to acquire stockpile sites that are accessible by DMF shell planting vessels. DMF currently has 10 stockpile sites located in seven coastal counties. There are also six stockpile sites located in inland counties. Shells are periodically picked up from recycling sites and taken to one of these stockpile facilities for later deployment. In order to provide access that is convenient to recycling participants as well as to DMF, stockpile sites are needed in every coastal county.

In 2003 and 2004, the DMF collected 711 and 1,053 bushels of oyster shells, respectively (Table 7.4). During 2004, the DMF constructed five public recycling sites in three coastal counties and shell donations increased to 11,092 bushels in 2005. The increase in donations can be attributed to the additional public recycling sites, restaurant participation, and oyster roast/festivals and a shucking house that donated their shells instead of selling them to DMF as they have in the past. Between the fall of 2003 and the end of 2006, the program had collected a total of 29,951 bushels from 15 counties. The program currently has 65 public recycling sites, 37 participating restaurants with 11 pending, and one shucking house. Volunteers estimate that the majority of donated oyster shell came from restaurants (Table 7.5). The number of participants and public recycling sites has grown considerably since the program began due to increased public awareness, education, volunteer assistance, and support of the NC General Assembly.

Restaurant and volunteer participation together with support from county and private waste companies are essential to the success of the oyster-recycling program. Education and awareness of the public is key and staff and equipment to support the program is a must. The

goal is to increase the number of oyster shells donated in order to continue expanding the number of bushels of cultch material being deployed in our state's waters. A successful oyster

Table 7.4. Number of bushels of oyster shells donated to DMF from 2003 to 2006 by county and year.

County	2003	2004	2005	2006
Beaufort	35	68	7,750	5,861
Brunswick	300	250	188	813
Carteret		125	372	1,797
Columbus				375
Craven		8	21.5	185
Dare				3,892
Edgecombe			150	217
Lenior				780
New Hanover		466	2,212	1,424
Onslow	20	50	70	97.5
Pamlico		59	174	496
Pender			21	120
Pitt	350		75	1,013
Washington				26
Wilson	6	28	60	
Totals	711	1,054	11,094	17,098

Table 7.5. Percentage of contribution of shells from 2003 to 2006 based on donation source.

Year	Festivals	Public	Restaurants	Shucking House
2003	50.8%		49.2%	
2004	52.6%	30.1%	17.3%	
2005	2.9%	15.2%	12%	69.9%
2006	4.5%	15.7%	28.9%	30.4%

shell recycling program will provide additional cultch material for oyster habitat restoration projects, reduce solid waste in landfills, and increase public awareness of the importance of a healthy oyster population to the state's marine and estuarine resources.

In addition to providing funds for the Oyster Shell Recycling Program, the North Carolina General Assembly has taken the following actions to increase the supply of oyster shells for restoring the oyster resource.

General Statute 105-130.48 (2006): A taxpayer who donates oyster shells to the Division of Marine Fisheries is eligible for a state tax credit of one dollar ($1.00) per bushel of oyster shells donated. This act will remain in effect until tax year 2011.
General Statute 130A-309.10(f)(2007): No person shall knowingly dispose of oyster shells in solid waste landfills.
General Statute 136-123(b): No landscaping or highway beautification project undertaken by the Department or any other unit of government may use oyster shells as a ground cover. The Department or any other unit of government that comes into possession of oyster shells shall make them available to the Department of Environment and Natural Resources, Division of Marine Fisheries, for use in any oyster bed revitalization programs or any other program that may use the shells.

8.0 SOCIOECONOMIC STATUS OF THE OYSTER FISHERY

8.1 ECONOMIC ASPECTS OF THE FISHERY

8.1.1 EX-VESSEL VALUE AND PRICE

The oyster fishery in North Carolina has a long and convoluted history. As far back as the late 1800s, the vast areas of shallow saltwater protected by the barrier islands recognized as a resource that could match or eclipse the oyster production of the northern states if proper seeding of beds could be organized. In the century that was to follow, North Carolina's production waxed and waned, but oysters harvested in the state remained primarily a locally consumed seafood, unlike species such as blue crabs and various finfish. Currently, oysters represent about 2.5% of the value of landed species in this state, about half that of clams. As a species available primarily during the winter months, oysters provide income to commercial fishermen at a time when other species are not present in harvestable amounts.

The value of oyster landings in the state peaked in 1987 at just short of $2.9 million and dropped off shortly thereafter, reaching a low point ten years ago; however, landings have risen again in the past few years, and are now (in real dollar terms) at roughly the same level as throughout much of the early 1980s and 1990s (Figure 8.1) .[1]

Roughly 70,000 bushels of oysters were pulled from North Carolina waters for commercial use in each of the past two years, which is almost double the number from a decade ago and closest

[1] The consumer prices index (CPI) is a standard tool of adjusting value to account for inflation over time. Ex-vessel value of landings are inflation-adjusted to 1972 because that is the first year that DMF began to have data for all state-managed species. "Real" dollars are inflation-adjusted, "nominal" dollars are not.

to the production levels of the late 1970s. Prices (in real, inflation-adjusted terms) have remained remarkably constant for the past twenty years, and the prices per bushel oyster harvesters get today are the equivalent of what they were getting in the mid-90s and about 20% to 40% more than they received throughout the 1970s and early 1980s (Table 8.1, Figure 8.2).

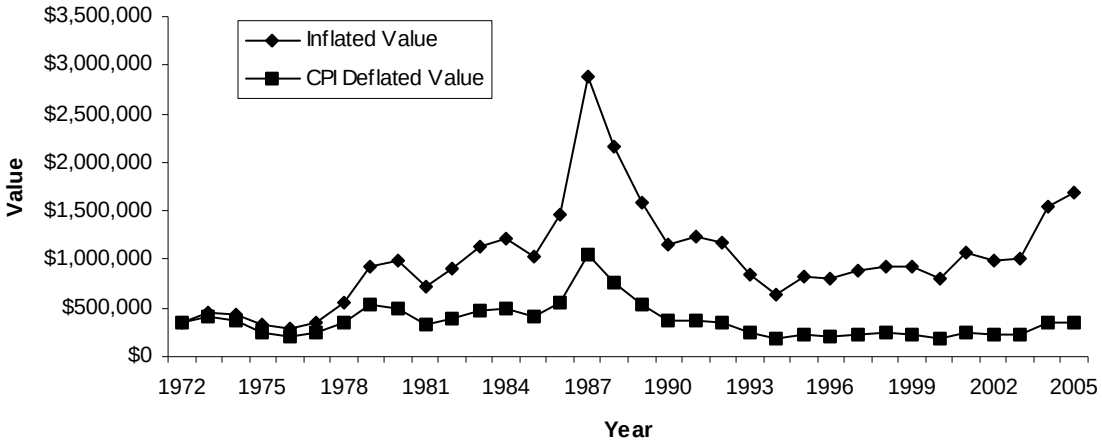

Figure 8.1. Value of oyster landings in North Carolina, 1972-2005 (DMF Trip Ticket Program).

As production fell off sharply following the 1980s boom, price per bushel increased to the highest levels recorded by the DMF in the state. In real dollar terms, a bushel harvested in the post-peak crash of 1990 (when production was less than a quarter of what it had been three years previously) fetched 50% more than at the peak. This indicates that the oyster market in the state was relatively fixed for much of this period, with low supply stimulating higher prices. The higher production of the past two years has not coincided with a decrease in price, indicating that local markets for NC oysters sold in the shell are once again growing. This analysis has been confirmed through recent interviews with oyster dealers (see Section 8.1.5).

8.1.2 PARTICIPANTS AND TRIPS

The Division of Marine Fisheries rigorously keeps track of the commercial catch levels of all fishermen in the state. Information is captured at the point at which catch is sold to the commercial dealer for every trip. This information can be broken down and categorized for a closer look at the patterns of behavior of fishermen in any particular fishery.

Table 8.2 shows the number of oyster harvesters participating in the fishery since 1999, broken down by the number of individual trips taken in each year. The percentages of fishermen in each category is relatively constant, with roughly 60% taking ten or fewer trips in any particular year. The fleet has increased by almost 50% in the past six years, probably due to the relative stability (and actually slightly increasing) price of this product.

Table 8.1. Detail values of pounds landed, total value, deflate value, price per bushel, and percent change from year to year for oysters landed in North Carolina, 1972—2005 (DMF Trip Ticket Program).

Year	Bushels Landed	% Change Bushels	Inflated Value	CPI Deflated Value	% Change Value	Inflated Price per Bushel	CPI Price per Bushel	% Change per Pound
1972	93,000	---	$344,217	$344,217	---	$3.70	$3.70	---
1973	101,000	9%	$446,485	$420,339	22%	$4.42	$4.16	12%
1974	105,000	4%	$435,804	$369,505	-12%	$4.15	$3.52	-15%
1975	79,000	-25%	$329,794	$256,234	-31%	$4.17	$3.24	-8%
1976	66,000	-16%	$292,058	$214,552	-16%	$4.43	$3.25	0%
1977	70,000	6%	$353,581	$243,889	14%	$5.05	$3.48	7%
1978	97,000	39%	$547,783	$351,186	44%	$5.65	$3.62	4%
1979	168,000	73%	$925,964	$533,131	52%	$5.51	$3.17	-12%
1980	123,000	-27%	$987,958	$501,173	-6%	$8.03	$4.07	28%
1981	97,000	-21%	$730,293	$335,822	-33%	$7.53	$3.46	-15%
1982	112,000	15%	$908,676	$393,603	17%	$8.11	$3.51	2%
1983	117,000	4%	$1,124,147	$471,781	20%	$9.61	$4.03	15%
1984	115,000	-2%	$1,207,277	$485,700	3%	$10.50	$4.22	5%
1985	94,000	-18%	$1,037,153	$402,909	-17%	$11.03	$4.29	1%
1986	129,000	37%	$1,452,056	$553,795	37%	$11.26	$4.29	0%
1987	225,000	74%	$2,875,406	$1,058,028	91%	$12.78	$4.70	10%
1988	138,000	-39%	$2,162,931	$764,248	-28%	$15.67	$5.54	18%
1989	90,000	-35%	$1,575,634	$531,141	-31%	$17.51	$5.90	7%
1990	52,000	-42%	$1,160,171	$371,042	-30%	$22.31	$7.14	21%
1991	61,000	17%	$1,229,293	$377,272	2%	$20.15	$6.18	-13%
1992	57,000	-7%	$1,172,397	$349,296	-7%	$20.57	$6.13	-1%
1993	42,000	-26%	$843,617	$244,036	-30%	$20.09	$5.81	-5%
1994	35,000	-17%	$632,561	$178,415	-27%	$18.07	$5.10	-12%
1995	42,000	20%	$815,070	$223,556	25%	$19.41	$5.32	4%
1996	40,000	-5%	$793,123	$211,297	-5%	$19.83	$5.28	-1%
1997	41,000	3%	$888,963	$231,518	10%	$21.68	$5.65	7%
1998	42,000	2%	$925,559	$237,352	3%	$22.04	$5.65	0%
1999	41,000	-2%	$922,910	$231,558	-2%	$22.51	$5.65	0%
2000	38,000	-7%	$804,212	$195,215	-16%	$21.16	$5.14	-9%
2001	49,000	29%	$1,068,352	$252,158	29%	$21.80	$5.15	0%
2002	46,000	-6%	$991,004	$230,261	-9%	$21.54	$5.01	-3%
2003	49,000	7%	$1,017,464	$231,141	0%	$20.76	$4.72	-6%
2004	70,000	43%	$1,551,022	$343,212	48%	$22.16	$4.90	4%
2005	71,000	1%	$1,682,857	$360,181	5%	$23.70	$5.07	3%

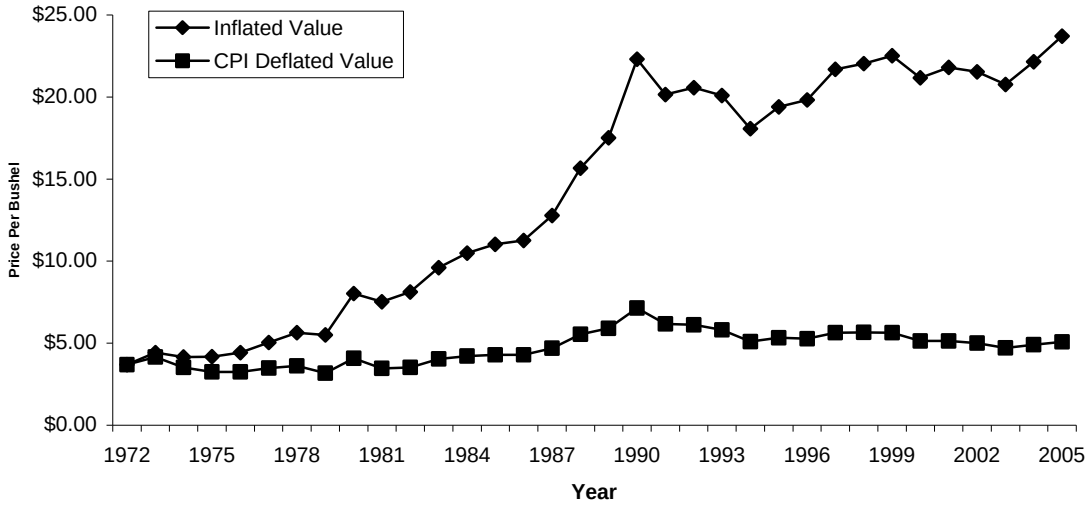

Figure 8.2. Average price per bushel of oyster landings in North Carolina, 1972-2005 (DMF Trip Ticket Program).

Table 8.2. Number of participants and the number of trips taken that landed oysters in North Carolina, 1999—2005 (DMF Trip Ticket Program).

	Year						
	1999	2000	2001	2002	2003	2004	2005
1 Trip	94	97	86	127	95	94	99
% within Year	18%	17%	13%	20%	15%	13%	14%
2 - 10 Trips	212	226	289	260	274	318	297
% within Year	41%	41%	44%	40%	43%	44%	41%
11 - 20 Trips	74	79	113	90	96	95	120
% within Year	14%	14%	17%	14%	15%	13%	17%
21 - 50 Trips	88	106	103	110	107	128	121
% within Year	17%	19%	16%	17%	17%	18%	17%
51 - 100 Trips	43	36	43	47	51	62	71
% within Year	8%	6%	7%	7%	8%	9%	10%
More than 100 Trips	10	14	17	10	13	26	18
% within Year	2%	3%	3%	2%	2%	4%	2%
Total	521	558	651	644	636	723	726

Table 8.3 breaks down participants in this fishery by annual income from oyster harvesting. Few people make their living solely from harvesting oysters, with between 40% and 50% of all commercial harvesters' catches fetching $500 or less in any given year. Fewer than 35 people have made over $10,000 annually from oysters in the most recent years. There is a substantial disparity between the average income from oyster harvesting ($2,445 in 2005) and what the median harvester brings in ($942 in 2005), indicating this is a top-heavy fishery, with most of the income generated by the top oystermen.

Table 8.3. Number of participants in the oyster fishery by value of landings and year in North Carolina, 1999—2005 (DMF Trip Ticket Program).

	Year						
	1999	2000	2001	2002	2003	2004	2005
$1 - $500	249	269	313	316	295	294	279
% within YEAR	48%	48%	48%	49%	46%	41%	38%
$501 - $1,000	62	74	83	91	92	98	91
% within Year	12%	13%	13%	14%	14%	14%	13%
$1,001 - $2,000	71	76	99	93	89	115	106
% within YEAR	14%	14%	15%	14%	14%	16%	15%
$2,001 - $5,000	75	89	95	91	100	115	144
% within YEAR	14%	16%	15%	14%	16%	16%	20%
$5,001 - $10,000	45	41	44	35	44	70	72
% within YEAR	9%	7%	7%	5%	7%	10%	10%
> $10,000	19	9	17	18	16	31	34
% within YEAR	4%	2%	3%	3%	3%	4%	5%
Total	521	558	651	644	636	723	726

As with any fishery in the state, oyster harvesters may only sell their catch to licensed dealers. Most of the dealers are spread out from Carteret County to the South Carolina border. The number of dealers who deal in oysters has remained stable for the past decade, hovering between 120 and 140 dealers in any single year (Figure 8.3).

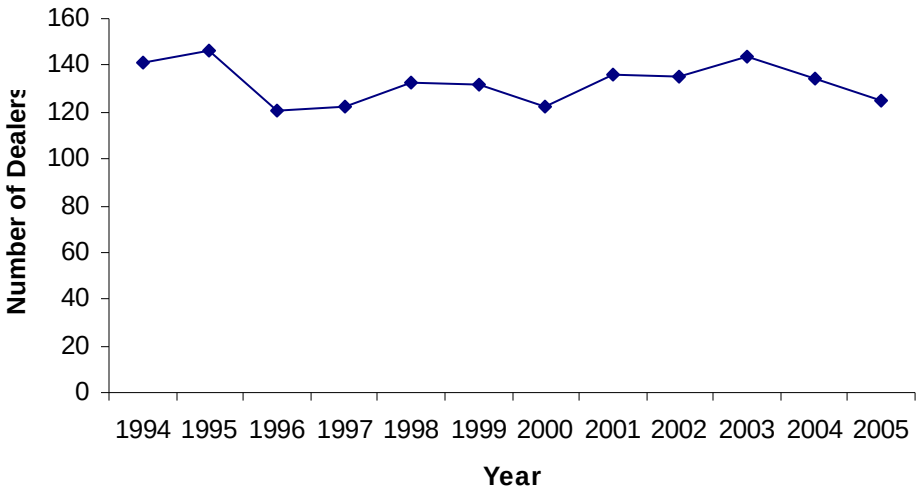

Figure 8.3. Number of dealers who purchased oysters from 1994—2005 (DMF Trip Ticket Program).

8.1.3 PROCESSING, MARKETING, AND DISTRIBUTION

The DMF does not keep track of the oyster markets, either in-state or nationally. However, in a series of interviews in Onslow County in January 2006, the consensus view among oyster

dealers confirms the impression of stability presented here; in the words of one dealer, "the market is the same as it ever was, maybe getting a little more per bushel than we used to [get]." None of these dealers dealt exclusively in oysters, but handled it as a seasonal crop for the winter season when other fishing is slow. None exported oysters out of state or had difficulty keeping up with demand. Two dealers had imported oysters in small quantities (from Texas) exclusively during the off-season in North Carolina (one described the oysters as of poor quality and not an experience he would care to repeat).

8.1.4 ECONOMIC IMPACT OF THE COMMERCIAL FISHERY

Table 8.4 shows the economic impact of the oyster harvest to North Carolina's economy over the past half decade. These impacts were calculated using IMPLAN, an economic modeling software. Trip ticket data include crew sizes (on average between 1.3 and 1.4 for oyster harvesting trips), so the number of fishermen actually involved is slightly larger than the "participants" number DMF uses to indicate licensed commercial fishermen who sell shellfish to dealers. As the fishermen spend their earnings, these models project that additional economic impact until it leaves the state's borders, although the full impact is underestimated since there is no specific data available to track the flow of dollars between different commercial fishing business, nor a way to track the economic impact of business taxes for a particular species harvested.

Table 8.4. Economic impact of the commercial oyster fishery in North Carolina, 2000—2005 (DMF Trip Ticket Program, IMPLAN).

Year	Ex-Vessel Value	Fishermen (w/crew)	Total Statewide Impact	Additional Jobs Created
2000	$804,212	728	$1,344,937	6.9
2001	$1,068,352	852	$1,786,626	9.2
2002	$991,004	847	$1,657,493	8.6
2003	$1,017,464	865	$1,701,439	8.8
2004	$1,551,022	1010	$2,755,472	11.9
2005	$1,682,857	1017	$2,990,588	12.9

8.1.5 RECREATIONAL ECONOMICS

The DMF collects data about recreational fishing in conjunction with the federal government's Marine Recreational Fisheries Statistics Survey (MRFSS). However, MRFSS collects information about finfish only. Beginning in 2007, the state requires a Coastal Recreational Fishing License (CRFL) for recreational saltwater finfishing in state waters, but specifically exempts recreational shellfish gathering from this requirement. Currently, then, the DMF has almost no data about recreational oyster harvesting, including the number of participants and the effect of their economic activity.

8.2 SOCIAL IMPORTANCE OF THE FISHERY

8.2.1 COMMERCIAL FISHERMEN

The socioeconomic program at the DMF has been conducting a series of in-depth interview-style surveys with commercial fishermen along the coast since 2001. Data from these interviews are added to a growing database and used for fishery management plans, among other uses. In the current database, 112 of the fishermen reported commercially harvesting oysters. This group is used to provide a snapshot of the North Carolina oyster fishermen in this section.

8.2.1.1 DEMOGRAPHIC CHARACTERISTICS OF COMMERCIAL FISHERMEN

Table 8.5 shows the demographic characteristics of the 112 oyster harvesters surveyed by the Socioeconomic Program over the past five years. Nearly all were white males, with an average age of 46 and almost 26 years of commercial fishing experience. Almost 60% had a high school diploma and 15% had at least some college education. About 75% had $30,000 or less in household income when surveyed, with 10% bringing in $50,000 or more.[2] Over 20% had less than $15,000 in annual household income.

Table 8.5. Demographic characteristics of oyster harvesters (DMF Socioeconomic Program).

Variable	n = 112	Average or %
Years Fishing		25.5
Age		46.0
Gender		
	Male	96.4%
	Female	3.6%
Race		
	White	96.4%
	Black	2.7%
	other	0.9%
Education Level		
	Less than HS	40.2%
	HS Grad	44.6%
	Some College	11.6%
	College Graduate	3.6%
Marital Status		
	Married	59.8%
	Divorced	10.7%
	Widowed	6.3%
	Never Married	3.6%
	Separated	19.6%
Total Household Income		
	Less than $15,000	20.5%
	$15,001 - $30,000	53.4%
	$30,001 - $50,000	15.9%
	$50,001 - $75,000	9.1%
	More than $75,000	1.1%

[2] The refusal rate on the household income question was 21.4%.

Fishing accounted for 63% of the household income from these fishermen, and 38% reported fishing as the sole source of income. Almost 17% supplemented their income with social security or pensions. Only 64% said they fished all year long, and the months that they fished least were in the fall (October and November). A tenth reported holding a shellfish lease. The average number of commercial boats was 1.19, and almost everyone had at least one—only 15 of 112 did not have a registered commercial fishing vessel.

8.2.1.2 HISTORICAL IMPORTANCE

A historical overview of the oyster fishery can be found in section 6.0 Status of the Fisheries. The socioeconomic interviewers asked harvesters how important commercial fishing has historically been in their communities, and almost all of them felt it had been vital, giving it a 9.1 on a 10-point scale. Perceptions of current community support were somewhat lower, at 7.1 on the same scale, with 30% of the respondents choosing a number on the bottom half of the scale. The statement "fishing is important economically in my community" generated an average response of 8.6.

8.2.1.3 COMMUNITY RELIANCE ON THE COMMERCIAL FISHERY

Fulltime fishermen are increasingly rare on the North Carolina coast, and exclusive oyster gatherers are almost non-existent. Out of a survey of over 500 holders of commercial fishing licenses in the area from Core Sound south, only 21% reported they harvested oysters, and most of those also targeted other species, most often clams but also shrimp, flounder, spot, crabs, and various other finfish (Table 8.6). Only a tenth of the fishermen reported that oysters represented the overwhelming majority (90% or more) of their harvest; on average, oysters represent 36% of the fishing income from those who gather in the southern half of the state; data from the northern half of the state is not yet available but it likely higher. This is not to downplay the importance of gathering oysters, since most oyster gathering occurs in the winter months, when other fisheries are less productive. Approximately 10% of these oyster fishermen reported that they currently had a shellfish lease.

Table 8.6. Prevalent species targeted by oyster harvesters (DMF Socioeconomic Program).

Species	% who land	% Income
Oysters	100.0%	36.5%
Clams	80.4%	42.7%
Shrimp	28.6%	36.7%
Flounder	22.4%	30.8%
Spot	19.6%	18.7%
Striped Mullet	13.7%	33.5%
Blue crabs	9.8%	42.7%
Scallops	3.9%	11.3%
Atlantic Croaker	2.0%	10.0%
Weakfish	2.0%	3.5%

8.2.1.4 PERCEIVED CONFLICTS

Oyster harvesters were also asked about conflicts they had with other resource users and with regulations. They were not specifically asked whether the conflicts were involved with shellfish or finfish harvesting, but conflicts with other resource users are certainly not unusual when dealing with a stationary animal populating mostly public waterways. Nonetheless, 70% of commercial oyster harvesters did not report a single conflict with other commercial fishermen in the previous year (Figure 8.4).

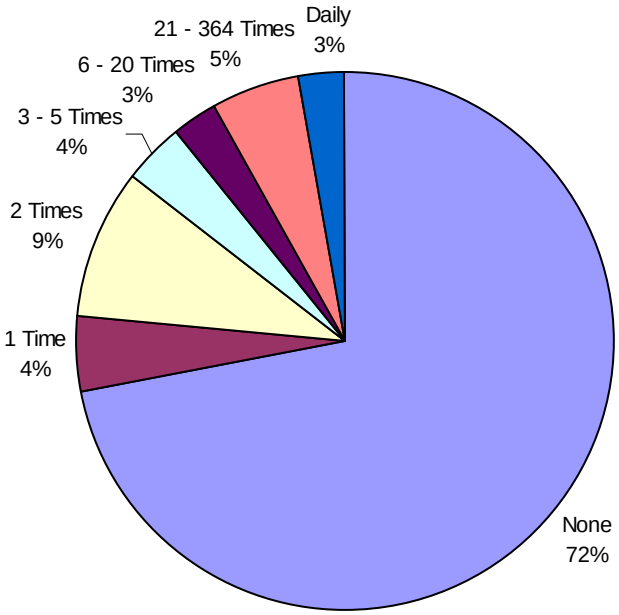

Figure 8.4. Frequency of conflict experiences with other commercial fishermen in the past year (DMF Socioeconomic Program).

Somewhat larger percentages reported having had conflicts with recreational fishermen, but again, the numbers are relatively low, with 58% reporting no conflict in the previous year, and another 10% only having conflicts once or twice (Figure 8.5).

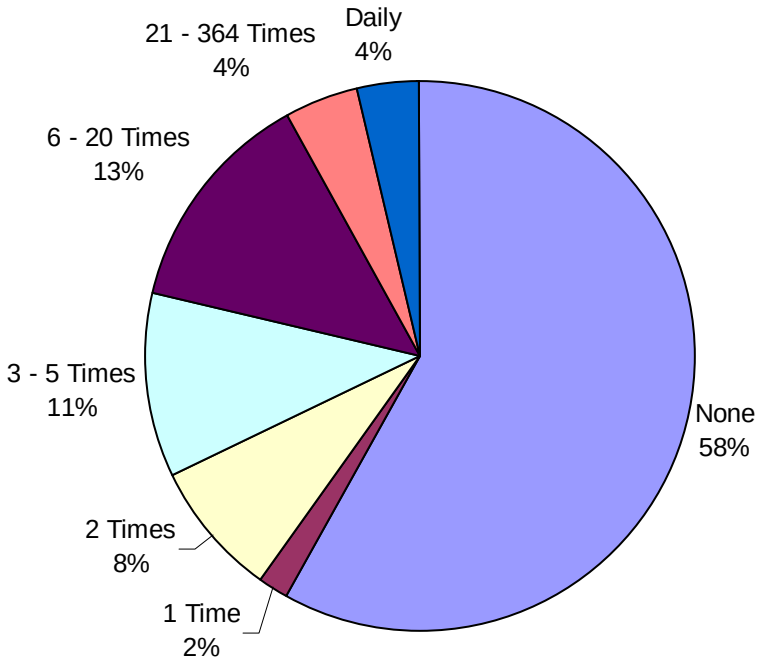

Figure 8.5. Frequency of conflict experiences with recreational fishermen in the past year (DMF Socioeconomic Program).

Perceptions of conflicts with federal regulations were nearly non-existent, unsurprising since authority and management of oysters is vested in the state. These numbers are substantially lower than have been found with other commercial fishermen, and the complaints found here are by fishermen and not by species, so the focus of their ire may well be regulations for other species they fish such as flounder. These numbers are illustrated in Figure 8.6. Reported conflicts with state regulations are quite different (Figure 8.7). Shellfish water quality is monitored by the Division of Environmental Health, and shellfish harvesting is closed when established levels of indicator bacteria are found.

8.2.1.5 PERCEPTION OF IMPORTANT ISSUES

Oystermen were also asked to rate the seriousness of a number of issues facing themselves and their businesses. The issue that they ranked higher than any other was overfishing. This is not the norm for the larger group of fishermen DMF has surveyed, who generally rank regulation and prices as the most important issues facing them. Keeping up with rules and regulations was the second-rated concern, an issue that is vital for a species that lives in areas that are sometimes closed because of water quality issues (an issue that itself ranked fourth on the list) (Table 8.7).

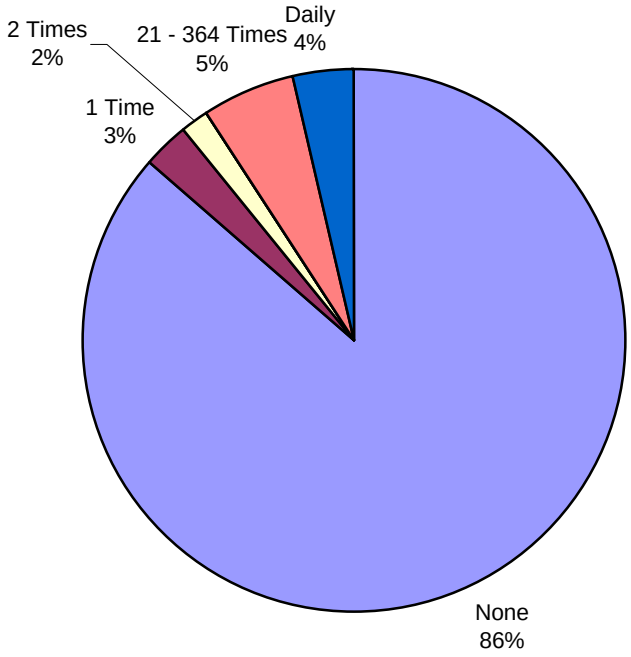

Figure 8.6. Frequency of conflict experiences with federal regulations in the past year (DMF Socioeconomic Program).

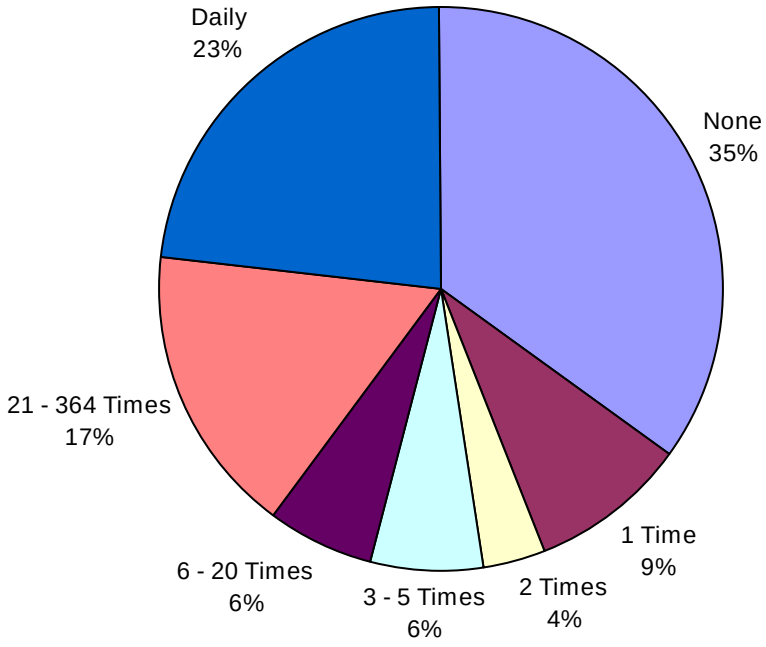

Figure 8.7. Frequency of conflict experiences with state regulations in the past year (DMF Socioeconomic Program).

Table 8.7. Fishing related issues considered most important to oyster harvesters (DMF Socioeconomic Program).

Ranking	Issue
1	Overfishing
2	Keeping up with rules and regulations
3	Local competition
4	Areas off limits
5	Low prices for seafood
6	Imported seafood
7	Outside competition
8	Costs of doing business

8.3 RECREATIONAL FISHERY

As mentioned previously, the DMF has no information about recreational shellfish harvesters, or the issues that they find most important, though presumably keeping up with proclamations and area closures would be important to them as well.

8.4 RESEARCH RECOMMENDATIONS

The most pressing socioeconomic research issue is the complete lack of data in recreational shellfish harvesting. Ideally, the Socioeconomic Program would be able to identify and survey recreational oyster harvesters for demographic and spending data. This issue is covered in more depth in Section 10.3.1 No Data on Recreational Harvest of Shellfish.

8.5 DEFINITIONS AND ACRONYMS

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

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

Inflated (Ex-vessel) price and value - The total landed dollar amount of a given species (or species landing condition and market category). Example: 10 bushels at a PRICE of $25 per bushel will have a VALUE of $250. These values represent the amounts paid to a fisherman by a seafood dealer.

9.0 ENVIRONMENTAL FACTORS

The fundamental requirement of the eastern oyster is the mixture of salt water from the oceans with fresh water from upland drainage that occurs in estuarine systems. Oysters have established themselves as one of the true estuarine species and, given their other requirements for clean, hard substrate necessary for oyster larvae settlement, they survive the often harsh and constantly changing conditions found in the sounds and rivers of North Carolina.

Although harvest records suggest a major decline in North Carolina's oyster-producing habitat, oyster rocks are still formed today on sites where no oysters existed previously. Therefore, oyster habitat should include the potentially productive areas where substrate, water flow, salinity patterns, and sedimentation will allow their development. Identifying oyster habitat is thus crucial for rebuilding the stock.

Oysters are the primary component of shell bottom habitat described in detail in the Coastal Habitat Protection Plan, or CHPP (Street et al. 2005). The CHPP provides information on many aspects of shell bottom habitat. Shell bottom is defined in the CHPP as "estuarine intertidal and subtidal bottom composed of surface shell concentrations of living or dead oysters (*Crassostrea virginica*), hard clams (*Mercenaria mercenaria*), and other shellfish." As such, the primary reference for this section is Street et al. (2005) unless otherwise noted. The CHPP also includes management recommendations that will be reiterated and expanded upon in this section. While the interdependency of all habitats is important to oysters, some habitats are of particular importance because they are actually inhabited by oysters. Those habitats include water column, estuarine bottoms that support the oyster's growing or accumulative community weight (Jenkins et al. 1997), and wetlands. Threats to these habitats are discussed in the following sections.

Threats to oyster bottom habitat include mobile bottom disturbing fishing gear, hand harvest methods, water-dependent development, mining, dredge material disposal, and introduced or nuisance species. Water quality threats include excess turbidity/sedimentation, nutrient enrichment, toxic chemicals/organisms, and microbial contamination. This section will focus primarily on threats within the jurisdiction of the Marine Fisheries Commission. Those threats include fishing activities, associated turbidity/sedimentation, microbial contamination (shellfish harvest area closure) and introduced or nuisance species. For information on the other threats, consult Street et al. 2005.

9.1 HABITAT DESCRIPTION AND DISTRIBUTION

Other than shell bottom, oysters are associated with two other "bottom" habitats: wetlands and soft bottom (unconsolidated muds, muddy sands, sands, and peat sediments). Coastal wetlands are attractive to intertidal oysters, and soft bottom areas are included for their potential in shell bottom restoration.

The CHPP defines shell bottom as "estuarine intertidal or subtidal bottom composed of surface shell concentrations of living or dead oysters (*Crassostrea virginica*), hard clams (*Merceneria merceneria*), and other shellfish" (Street et al. 2005). Consequently, this definition does not

include subsurface clam beds (see Clam FMP environmental factors section). Because eastern oysters are the primary biological component of shell bottom habitat, oysters are the only fishery species that is also a habitat. As such, the discussion and recommendations must consider the relationship of shell bottom and other fishery species.

In order to identify the threats to oyster habitat, the current distribution and quality of oysters and shell bottom must be documented. The DMF shellfish habitat and abundance mapping program has been ongoing since 1988. The maps are being compiled using standardized surveys from the South Carolina border north through Core Sound, along the perimeter of Pamlico, and in Croatan/Roanoke sounds (Figure 9.1). The program delineates all bottom habitats, including shell bottom, and samples the density of oysters, clams, and bay scallops in these habitats. This program has differentiated 24 different bottom types based on combinations of depth, bottom firmness, vegetation density, and density of surface shells. This program defines shell habitat (shell bottom) as significant cover (>30% of bottom) of living or dead shells. The program also maps salt marsh, submerged aquatic vegetation, and soft bottom. A stratified random sampling design is used to provide statistically sound shellfish density estimates by area and habitat.

As of January 2007, mapping has been completed from Carolina Beach north through Core Sound, west to Clubfoot Creek on the lower Neuse River, and north to Pungo River (Figure 9.2). The following specific areas have also been mapped: Shallowbag Bay, portions of Pamlico Sound in the vicinity of Oregon Inlet, and parts of eastern and northern Pamlico Sound (Figure 9.1). This area represents approximately 70% (409,130 acres) of the total area (584,153 acres) intended for mapping (Figure 9.1). The areas mapped and intended for mapping do not include military restricted areas and lease areas. Of the entire area mapped by January 2007, approximately 3.5% (14,600 acres) of the bottom was classified as shell bottom (Table 9.1). The southern estuaries have the greatest relative area of shell bottom (17% - mostly intertidal) among the areas mapped to date. Cape Fear had the greatest relative area of subtidal shell bottom (12%). However, only 40% of the near shore Pamlico Sound area has been mapped (Table 9.1). Based on the coverage of shell bottom in each management unit, the extrapolated total area of shell bottom in North Carolina is 18,462 acres. Not all shell bottom is inhabited by living oysters, so the figure is an indication of potential habitat where salinities are suitable for larval settlement. The estimate also does not account for oyster beds in deep water outside of shellfish mapping areas.

Private shellfish leases were delineated but not included in these estimates. As of January 2007 mapping, there were 160 shellfish lease areas in mapped coastal North Carolina waters occupying 880 acres, which comprises less than 1% of the shellfish mapping study area[3]. However, according to lease records for 2007, there are 1,935 acres reserved as shellfish leases. For more information on shellfish leases, consult the "Present Private Culture Fishery" section.

[3] However, the contribution of shellfish leases to overall shell bottom is unknown because they contain areas that do not meet the definition of shell bottom. So the estimates for overall shell bottom coverage are probably underestimated.

Table 9.1. Shell bottom habitat mapped within Coastal Habitat Protection Management Units by the North Carolina Division of Marine Fisheries' Shellfish Habitat and Abundance Mapping Program (January 2007).

Management unit	Mapping area	Total area mapped		Shell bottom (intertidal)		Shell bottom (subtidal)		Total shell bottom	
		Acres	% complete	Acres	% of mapped	Acres	% of mapped	Acres	% of mapped
Albemarle	61,408	49,354	80	43	0	276	1	319	1
Cape Fear	17,251	6,218	36	16	0	769	12	785	13
Coastal Ocean	264	246	93	0	0	2	1	2	1
Core/Bogue	152,235	152,235	100	1,949	1	5,584	4	7,533	5
Neuse	20,594	20,594	100	0	0	43	0	43	0
New/White Oak	34,511	34,511	100	346	1	333	1	679	2
Pamlico	223,587	90,039	40	32	0	626	1	658	1
Southern estuaries	30,820	25,896	84	2,592	10	1,795	7	4,387	17
Tar/Pamlico	43,482	30,036	69	0	0	194	1	194	1
Total	584,152	409,129	70	4,978	1	9,622	2	14,600	4

9.2 ECOSYSTEM ENHANCEMENT

9.2.1 WATER QUALITY ENHANCEMENT

The direct and indirect ecosystem services of the oyster reef, such as filtering capacity, transfer of production between bottom and water column, nutrient dynamics and sediment stabilization, have been largely ignored or underestimated (Coen and Luckenbach 1998). Shell bottom also indirectly benefits the fisheries by providing water filtration. Kennedy (1991) suggested that the filtering activities of the massive concentrations of oysters historically present in the Chesapeake Bay might have resulted in different assemblages of plankton, with fewer sea nettles, microplankton and bacterioplankton. Before the end of the 19th century, oysters in the Chesapeake Bay could theoretically filter the entire volume of the bay in a little more than three days (Newell 1988). Newell's estimate of the filtering capacity of Chesapeake Bay oyster populations in 1988 was 325 days. Other researchers agree that the loss of oyster populations removes one potentially important means of controlling nuisance phytoplankton blooms and other negative impacts of nutrient enrichment and coastal eutrophication (Officer et al. 1982; Dame et al. 1984; Lenihan and Peterson 1998; Coen et al. 1999; Jackson et al. 2001). Jackson et al. (2001) attributed much of the decline in water quality in Pamlico Sound and Chesapeake Bay to loss of bio-filtration capacity attributable to the drastic decline (>90%) in oyster harvest and presumable biomass**.**

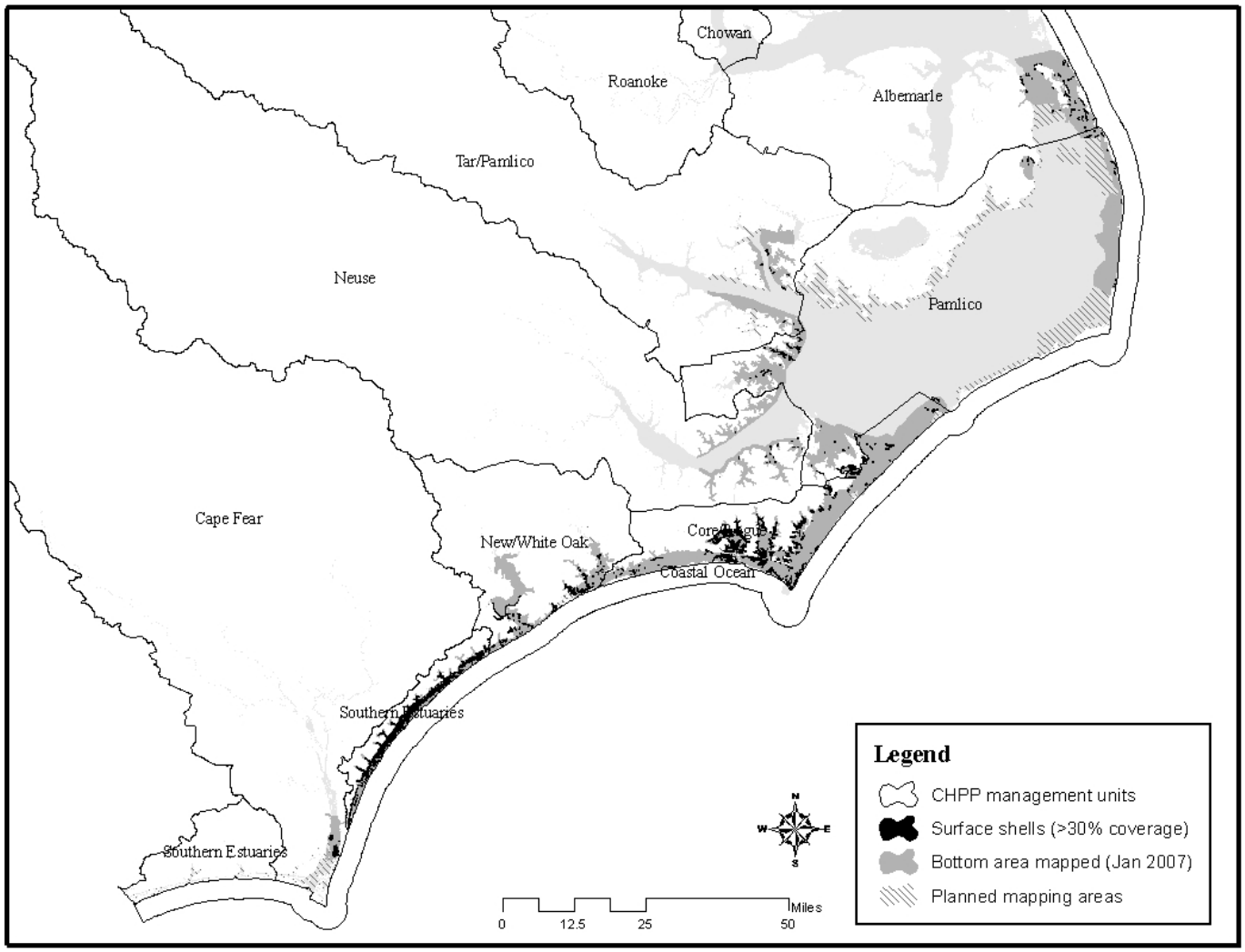

Figure 9.1. Distribution of mapped shell bottom based on DMF bottom mapping, January 2007.

Shell bottom enhances water quality by transferring phytoplankton production to benthic production through filter feeding (Officer et al. 1982; Cloern 2001; DMF 2001; Newell et al. 2002). Increased shell bottom and oyster biomass reduce the impacts of eutrophication. After being recycled by oysters, nutrients are deposited around the base of oyster beds where nitrogen is removed (Newell et al. 2002). The organic deposits from oyster filtering can be released by erosion, sediment reworking by animals, or resuspension with possible uptake by adjacent SAV (Peterson and Peterson 1979). With more nutrients denitrified or stored in the sediment, the frequency of hypoxia (<2 mg/L of dissolved oxygen) and anoxia (no dissolved oxygen) events in the water column should decrease. The oyster shells themselves also store carbon in the form of calcium carbonate (Hargis and Haven 1999). The sequestered carbon is thus taken out of atmospheric circulation, serving as one means to partially offset the observed trend of increasing concentrations of COB_{2B}, an important greenhouse gas associated with global warming.

9.2.2 HABITAT MODIFICATION

The oyster's structural modification of habitat is important to the estuarine system. As shell bottom increases, wave energy decreases, stabilizing sediment and decreasing erosion (Lowery and Paynter 2002). High-relief shell bottom alters currents and water flows, influencing patterns of fish settlement, predation and predator feeding success (Breitburg et al. 1995; Coen et al. 1999). On the down-current side of the reef, flow velocity is reduced and larval fish species can maintain their positions during the high-flow portions of the tidal cycle (Breitburg et al. 1995). Oyster reefs can also constrict tidal flow to certain areas, resulting in island formation (Bahr and Lanier 1981). By reducing wave energy along the shoreline, shell bottom aids in stabilizing creek banks and reducing salt marsh erosion (Bahr and Lanier 1981; Dame and Patten 1981; Marshall 1995; Breitburg et al. 2000).

The presence of shell bottom reduces turbidity by filtering water and physically trapping and stabilizing large quantities of suspended sediment and organic matter with the shell structure (Haven and Morales-Alamo 1970; Dame et al. 1989; Coen et al. 1999; Grabowski et al. 2000). This, in turn, improves water clarity, which increases productivity of the water column and SAV. The reduction in turbidity has a positive effect on SAV by increasing light penetration to the plants, creating more suitable conditions for SAV growth, survival, and expansion (Meyer and Townsend 2000). As an example, prior to large-scale losses of shell bottom in the Chesapeake Bay, the waters were reported to be much less turbid than current conditions, which allowed submerged aquatic vegetation to thrive (Coen et al. 1999; Jackson et al. 2001). Because of these ecosystem benefits provided by oysters to other habitats, Lenihan and Peterson (1998) proposed that oysters might now be more economically valuable as a habitat than a fishery.

9.2.3 FISH UTILIZATION

Shell bottom provides critical fisheries habitat not only for oysters, but also for recreationally and commercially important finfish, other mollusks, and crustaceans. The ecological functions of oyster reefs related to oyster production are well known and accepted (Coen et al. 1999). These functions include aggregation of spawning stock, chemical cues for

successful spat settlement, and refuge from predators and siltation. Oysters have also been described as "ecosystem engineers that create biogenic reef habitat important to estuarine biodiversity, benthic-pelagic coupling, and fishery production"T[4]T (Lenihan and Peterson 1998).

Data quantifying fish use of habitats vary from presence/absence and numerical abundance, to actual fish production value. In North Carolina, 18 fishery species have been documented utilizing both natural and restored oyster reefs in Pamlico Sound, including Atlantic croaker (*Micropogonias undulatus*), southern flounder (*Paralichthys lethostigma*), Spanish mackerel *Scomberomorus maculatus*), spotted seatrout (*Cynoscion nebulosus*), weakfish (*Cynoscion regalis*), American eel (*Anguilla rostrata*), and black sea bass (*Centropristis striata*) (Lenihan et al. 2001). Numerical abundance and production compared to other habitats provides additional information on the importance of habitat for fish. The species found most abundantly on oyster reefs compared to adjacent soft bottom were silver perch (*Bairdiella chrysoura*), sheepshead (*Archosargus probocephalu*s), pigfish (*Orthopristis chrysoptera*), pinfish (*Lagodon rhomboides*), toadfish (*Opsanus* spp.), and Atlantic croaker. Southern flounder was collected on both oyster reefs and adjacent soft bottom areas, while bluefish (*Pomatomus saltatrix*) and Atlantic menhaden (*Brevoortia tyrannus*) were not collected near oyster reefs (Lenihan et al. 2001).

Several studies have found higher abundance and diversity of fish on shell bottom than adjacent soft bottom, particularly pinfish, blue crabs (*Callinectes sapidus*), and grass shrimp (*Palaemonetes* spp.) (Harding and Mann 1999; Posey et al. 1999; Lenihan et al. 2001). A study in Back Sound also found that crabs were more abundant on shell bottom than restored SAV beds (Elis et al. 1996). Breitburg (1998) concluded that the importance of shell bottom to highly mobile species is very likely underestimated, partially due to the difficulty in sampling oyster beds.

Peterson et al. (2003) estimated the amount of fish production that shell bottom provides in addition to adjacent soft bottom habitats. Using results from numerous studies, they compared the density of fish at different life stages on oyster reefs and adjacent soft bottom habitats. The published growth rates of species were then used to determine the amount of production gained from shell bottom. The species were separated into recruitment-enhanced, growth-enhanced, and not enhanced groups. Recruitment-enhanced species are those having early life stages showing almost exclusive association with shell bottom. For other species with higher abundance in shell bottom, diet and life history studies were used to determine the fraction of their production associated with the consumption of shell bottom-enhanced species. Species consuming relatively more shell bottom-enhanced species were classified as growth-enhanced. Analysis of the studies revealed that every $10m^2$ of newly constructed oyster reef in the southeast United States is expected to yield a benefit of an additional 2.6 kg of fish production per year for the lifetime of the reef (Peterson et al. 2003).[5]

[4] Benthic-pelagic coupling refers to the transfer of production from the oyster beds to the mobile species foraging on the beds, benefiting both estuarine and ocean fisheries. It also refers to the transfer of phytoplankton production and other fine particulates to the bottom (Lenihan and Peterson 1998).

[5] For individual species, the amount of additional production ranged from 0.08 (spottail pinfish *Diplodus holbroki*) - 158.80 (bay anchovy *anchoa mitchilli*) fish/$10m^2$. Of the 53 species of fish and shellfish for which data were available, ten were recruitment-enhanced and ten were growth-enhanced. About half of the 20 shell

Fish that utilize shell bottom can be classified into three categories: resident, transient, and facultative (Coen et al. 1999; Lowery and Paynter 2002). Resident species live on shell bottom and depend on it as their primary habitat. Transient species are wide-ranging species that use shell bottom for refuge and forage along with other habitats. Facultative species depend on shell bottom for food, but utilize other habitats with vertical relief or shelter sites.

At least seven fish species have been identified as resident species—naked goby (*Bobiosoma bosc*), striped blenny (*Chasmodes bosquianus*), feather blenny (*Hypsoblennius bentz*), freckled blenny (*Hypsoblennius ionthius*), skilletfish (*Gobiesox strumosus*), and oyster toadfish (*Opsanus tau*) (Coen et al. 1999, Lowery and Paynter 2002). These species were also considered recruitment-enhanced by Peterson et al. (2003). Resident fish are important prey for transient and facultative predator species (Coen et al. 1999). For example, Breitburg (1998) found high densities of juvenile striped bass (Morone saxatilis) (15.4 individuals/m^2 of reef surface) aggregating near the reef surface feeding on naked goby larvae congregated on the down-current side of the reef. Other common predator species sampled on oyster reefs in North Carolina are red (*Sciaenops ocellatus*) and black drum (*Pogonias cromis*), Atlantic croaker, sheepshead, weakfish, spotted seatrout, summer (*Paralichthys dentatus*) and southern flounder, blue crab, and oyster toadfish. Of these species, however, only sheepshead, southern flounder, and oyster toadfish were considered shell bottom-enhanced by Peterson et al. (2003). Production of black drum, Atlantic croaker, blue crab, and summer flounder were classified as not enhanced by shell bottom. Oyster reefs in higher salinity waters are critical habitat for predators such as juvenile gag (*Mycteroperca microlepis*), snappers (*Lutjanus* spp.) and stone crab (*Menippe mercenaria*) (Wenner et al. 1996; Peterson et al. 2003).

There is some variation in fish use among salinity gradients as well. Oyster reefs in higher salinity waters tend to support a greater number of associated species than reefs in lower salinity waters (Sandifer et al. 1980). Studies summarized by Coen et al. (1999), which included work in North Carolina, identified 72 facultative, resident and transient fish species in close proximity to oyster reefs. The ASMFC-managed species categorized as transient and also important to North Carolina's coastal fisheries are American eel, Atlantic croaker, Atlantic menhaden, black sea bass, bluefish, red drum, spot, striped bass, summer flounder, tautog, and weakfish. Only black sea bass and tautog were considered shell-bottom enhanced by Peterson et al. (2003). A partial list of macrofaunal species observed in collections from oyster habitat is provided in Table 9.2. Those species that use shell bottom as spawning and/or nursery areas are identified, as are those species that forage on shell bottom habitat and/or use it as a refuge (SAFMC 1998; Lenihan et al. 1998; Coen et al. 1999; Grabowski et al. 2000). More than 30 species are listed in Table 9.2, emphasizing the importance of shell bottom as fisheries habitat.

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bottom-enhanced species were fishery species (sheepshead, black sea bass, gray snapper *Lutjanus griseus*, white perch *Morone americanus*, gag, pigfish, southern flounder, and tautog *Tautoga onitis*). The recruitment-enhanced species included stone crabs, sheepshead, blennies/gobies (Gobidae), skilletfish, gray snapper, gag, toadfish, and tautog. Growth enhanced species included bay anchovy, black sea bass, sheepshead minnow *Cyprinidon variegatus*, spottail pinfish, silversides (Atherinidae), white perch, pigfish, and southern flounder.

Table 9.2. Partial listing of finfish and shellfish species observed in collections from shell bottom in North Carolina, and ecological functions provided by the habitat.

Species*	Shell Bottom Functions [1]					Fishery [2]	Stock Status [3]
	Refuge	Spawning	Nursery	Foraging	Corridor		
ANADROMOUS & CATADROMOUS FISH							
American eel	X		X	X	X	X	U
Striped bass			**X**	**X**		**X**	**V- Albemarle Sound, Atlantic Ocean, O- Central/Southern**
ESTUARINE AND INLET SPAWNING AND NURSERY							
Anchovies (striped, bay)		**X**	**X**	**X**			
Blennies	**X**	**X**	**X**	**X**			
Black drum				**X**		**X**	
Blue crab	**X**	**X**	**X**	**X**	**X**	**X**	**C**
Oyster	**X**	**X**	**X**	**X**		**X**	**C**
Gobies	**X**	**X**	**X**	**X**			
Grass shrimp	**X**	**X**	**X**	**X**			
Hard clam	**X**	**X**	**X**	**X**		**X**	**U**
Mummichog	X	X			X		
Oyster toadfish	**X**	**X**	**X**	**X**		**X**	
Red drum	**X**		**X**	**X**	**X**	**X**	**R**
Sheepshead minnow		**X**		**X**			
Silversides				**X**			
Skilletfish	**X**		**X**	**X**			
Spotted seatrout				**X**		**X**	**V**
Stone crab	**X**		**X**	**X**		**X**	
Weakfish	X		X	X	X	X	C
MARINE SPAWNING , LOW-HIGH SALINITY NURSERY							
Atlantic croaker				X		X	V
Brown shrimp	**X**		**X**	**X**	**X**	**X**	**V**
Southern flounder				**X**		**X**	**O**
Spot	X		X	X	X	X	V
Striped mullet				X		X	V
MARINE SPAWNING , HIGH SALINITY NURSERY							
Atlantic spadefish						X	C [4]
Black sea bass	**X**		**X**	**X**	**X**	**X**	**V- north of Hatteras, O- south of Hatteras**
Gag	**X**		**X**	**X**	**X**	**X**	**V**
Gulf flounder						X	
Pigfish				**X**		**X**	
Pinfish	**X**		**X**	**X**	**X**	**X**	
Pink shrimp	**X**		**X**	**X**	**X**	**X**	**V**
Sheephead	**X**		**X**	**X**	**X**	**X**	**C** [4]
Spanish mackerel						X	V
Summer flounder	X			X	X	X	C

* Names in **bold** font are species whose relative abundances have been reported in the literature as being generally higher in shell bottom than in other habitats. Note that lack of bolding does not imply non-selective use of the habitat, just a lack of information.

[1] Sources: Pattilo et al. 1997; SAFMC 1998; Lenihan et al. 1998, 2001; Coen et al. 1999; Grabowski et al. 2000; Peterson et al. 2003

[2] Existing commercial or recreational fishery. Fishery and non-fishery species are also important as prey

[3] V=viable, R=recovering, C=Concern, O=overfished, U=unknown (DMF 2006).

[4] Status of reef fish complex as a whole. Sheepshead and Atlantic spadefish have not been evaluated in NC.

9.3 PHYSICAL THREATS

9.3.1 MOBILE BOTTOM DISTURBING FISHING GEAR

Of the factors affecting the condition of oyster habitat, oyster harvest is the most obvious. Both Chestnut (1955) and Winslow (1889) reported finding formerly productive areas in Pamlico Sound where intensive oyster harvesting made further harvest and recovery of the oyster rocks impossible. Heavily fished oyster reefs lose vertical profile and are more likely affected by sedimentation and anoxia which can suffocate live oysters and inhibit recruitment (Kennedy and Breisch 1981; Lenihan and Peterson 1998; Lenihan et al. 1999). Marshall (1954) studied oyster reefs in the James River, Virginia and found that half of the loss in vertical profile (6 inches) was due to oyster harvesting. By 1987, an estimated 75% of the oyster reef area in the James River had disappeared due to burial and possibly dredging activity (Selizer and Boggs 1988). Oysters are protected within Mechanical Methods Prohibited Areas (15A NCAC 03R .0108). These areas cover over 280,000 acres (48%) of the 1.4 million acres considered to have salinities suitable for oyster survival (Street et al. 2005). Later in 2005, the MFC closed an additional 30,000 acreas to mechanical harvest. Mechanical harvest of oysters is allowed on deep water reefs during a limited season. An option being recommended by DMF is the encouragement of hand harvest methods over mechanical methods in bays of Pamlico Sound. There is also a research recommendation concerning the biological impact of 100lb dredges (currently allowed) compared to 50lb dredges. Consult Sections 10.1.1 - Mechanical vs. Hand Harvest Trip Limit Differences and 10.1.6 - Increased Dredging Restrictions in Pamlico Sound Bays for more information and development of the recommendations.

Oyster rocks and cultch plantings also provide an excellent habitat for hard clam settlement and growth in areas where salinity regimes and water flow are suitable for clam survival. Hard clam harvesting in oyster rocks involves overturning or sifting through the shells and oysters overlying the hard clams, potentially damaging the oysters. Oyster rocks are protected from mechanical harvest of clams and bull rakes by MFC rules (North Carolina Fisheries Rules for Coastal Waters 15A NCAC 03K .0304 and 03K .0102). However, most harvesting of clams in relation to oysters occurs around the base of oyster beds, where they are most abundant (Noble 1996). But clams are also harvested by mechanical methods using either hydraulic escalator dredge or clam trawl. Clam trawling, or kicking, began in Core Sound with a method involving the scouring of bottom sediment with a prop wash while towing a trawl. Anecdotal accounts indicate that significant negative impacts occurred to oyster rocks prior to closure and marking of areas closed to the mechanical harvest of clams. Current fisheries regulations prohibit the use of mechanical gear in SAV beds and live oyster beds because of the destructive capacity of the gear. Therefore, clam kicking is only allowed in designated harvest areas that do not contain significant SAV or oyster resources. The delineation of harvest areas is based on occasional field examinations. Due to the long-term decline in clam kicking effort, it has also been recommended that mechanical harvest areas be modified to include only actively fished areas. The effects of mechanical clam harvest on fish habitat is discussed further in Section 10.19 - Effects of Mechanical Clam Harvest on Fish Habitat in the draft 2007 NC Hard Clam FMP.

Other fishing gears also impact oyster habitat. Shrimp and crab trawling can result in removing oysters and cultch material from rocks and firm bottom and depositing them on unsuitable bottoms where they will be covered by sediments (Berrigan et al. 1991; Chestnut 1955). However, commercial fishermen generally avoid oysters beds because they damage towed nets. Intentional disturbance of oyster habitat is more probable over scattered oysters. Frequent disturbance could prevent the formation of larger oyster rocks in the future, especially where there are historical losses. Ongoing efforts to identify suitable areas for oyster restoration may include currently trawled areas. The impact of current fishing practices on oyster habitat suitability has not been quantified in North Carolina.

State posted oyster plantings are protected from any type of trawling or seining when designated as a shellfish management area under North Carolina Fisheries Rules for Coastal Waters 15A NCAC 03K .0103. This includes both oyster beds planted for sanctuaries and for periodic harvest. However, the posting of all natural oyster beds has never been attempted because of the large number of areas that would have to be posted and the lack of sufficient resources and enforcement to keep them marked and patrolled. The DMF has designated some areas as Shellfish Management Areas where enhancement activities are conducted (shell is added and/or oysters are transplanted) and oystering and clamming are restricted or prohibited, except by proclamation. As the oysters reach harvestable size, the areas may be opened to oyster harvest first, then opened to clamming afterward. The posted areas are mostly south of New River. The deep water oyster rocks in Pamlico Sound must be located and marked to be effectively managed. The location process has begun with a planned expansion of the Shellfish Habitat and Abundance Mapping Program into deeper water (B. D. Conrad, DMF, pers. comm. 2007). However, restoration and enforcement of these areas will be an additional burden on already limited enforcement capabilities.

9.3.2 HAND HARVEST METHODS

Intensive hand harvest methods can also be destructive to oyster rocks and in 1977 the North Carolina General Assembly enacted legislation to forbid the taking of clams by rakes or tongs on oyster rocks that had been posted by DENR (North Carolina General Statutes 113-207). The harvest of clams or oysters by tonging or raking on intertidal oyster beds causes damage to not only living oysters but also the cohesive shell structure of the reef (Lenihan and Peterson 1998). This destruction has been an issue where oysters and hard clams co-exist, primarily around the inlets in the northern part of the state and on intertidal oyster beds in the south (DMF 2001). Studies by Noble (1996) and Lenihan and Micheli (2000) quantified the effects of oyster and clam harvest on oyster rocks. The former study found that the density of live adult oysters was significantly reduced where clam harvesting occurred. Mortality was attributed to oysters being cracked or punctured and subsequently dying or being eaten by predators, or by being smothered beneath sediments associated with clam digging. Conversely, oyster harvesting had little effect on clam populations. DMF conducted field investigations of the status of oyster rocks in Ward Creek, Carteret County, to assess the destruction of oyster rocks by individuals taking clams by legal hand harvest methods (Noble 1996). The 1995 survey determined that the oyster rocks were impacted

and, subsequently, the affected portion of Ward Creek was designated a Shellfish Management Area (SMA) and was closed to clamming.

In January of 2007, the Director issued a proclamation allowing shellfishing in the Ward Creek SMA in accordance with existing shellfish harvest limits. This allows hand rakes and tongs to be used to take the legal limits of oysters and clams. The proclamation was issued after DMF sampling indicated that legal sized subtidal oysters were present in sufficient quantity to open harvest. The Southern District has a long history of managing SMAs from New River south by allowing oyster harvest on planted rocks first, and then allowing clam harvest. This protects the oyster rocks from being damaged or destroyed by tongs and rakes digging for clams. The one Carteret County SMA in Wards Creek could be managed in this manner by sampling the rocks to determine if there are enough legal-sized, subtidal oysters to support tong and rake effort and opening by proclamation when there are. When the samples reveal few legal oysters, rakes and tongs would be prohibited. The Section regarding this topic (10.5.4 Wards Creek Shellfish Management Area) contains more background, discussion, and development of the recommendations.

9.3.3 INTRODUCED AND NUISANCE SPECIES

Nuisance and non-native aquatic species are becoming more of a problem throughout the United States. North Carolina shell bottom is at risk from the accidental or intentional introduction of these species. Non-native species enter North Carolina waters through river systems, created waterways such as the IWW, ships discharging ballast water of foreign origin, boats entering North Carolina waters from other areas, and the sale of live fish and shellfish for bait or aquaculture (North Carolina Sea Grant 2000). Oysters have already been impacted by the introduction of the parasites Dermo and MSX. It is suspected that the MSX parasite was introduced with Pacific oysters (*Crassostrea gigas*) (DMF 2001a). Intentional introductions of non-native species are covered under state laws and rules of several commissions. Proposals to introduce organisms not native to North Carolina into the coastal waters of North Carolina, or organisms native to North Carolina when the individuals in question originate outside North Carolina, are subject to MFC rule 15A NCAC 03I .0104. An applicant must submit a written application to the Fisheries Director with sufficient information for the Director to "determine that the action will not pose a significant danger to any native marine resource or the environment." The Director can require an applicant to conduct analyses to aid in evaluation of the application, and hold public meetings concerning the proposal to determine whether or not to issue the requested permit.

As North Carolina's oyster populations have declined, interest in establishing a non-native oyster population has grown. While some oyster introductions have revived or expanded oyster fisheries in some parts of the world (especially in Europe), others have failed or caused problems, such as the destruction of native species by exotic diseases (Andrews 1980; DMF 2001). If the native oyster stocks cannot recover naturally, establishment of non-native oyster populations could provide complex structure for fish habitat (if the introduced species were reef-builders - some oysters are not), water filtration functions, and preserve a traditional North Carolina fishery.

The Pacific oyster (*Crassostrea gigas*) and Suminoe oyster (*Crassostrea ariakensis*) are the leading candidates for non-native introductions. Researchers have conducted overboard tests in North Carolina with Pacific oysters and work is underway with the Suminoe oyster (C. H. Peterson, UNC-IMS, pers. comm. 2002). The results of the completed study are provided in Section 10.5.1 Non-native Oyster Introduction Issue. The shells of Pacific oyster were found to be too thin to resist predation by native oyster drills (DeBrosse and Allen 1996). The Suminoe oyster has proven more promising. Laboratory and field studies conducted on *C. ariakensis* in Chesapeake Bay indicate rapid growth and survival under a wide range of coastal and estuarine conditions (Richards and Ticco 2002). *C. ariakensis* also shows greater disease resistance than native oysters.

There is still much debate and uncertainty regarding the introduction of non-native oysters (Richards and Ticco 2002). Concerns include long-term survival of introduced species, competition with native oysters, unknown reef-building attributes, cross-fertilization with native species (reducing viability of spat and decreasing reproductive success), and introduction of non-native pests with the introduced oysters (DMF 2001). A comprehensive study of non-native oyster introductions was completed by the National Research Council of the National Academy of Science in 2003 (NRC 2003). The study identified concerns that should be addressed by decision-makers when the introduction of a non-native oyster is under consideration. The concerns included:
Viability of introduced stocks in Atlantic coast waters,
Co-introduction of new pathogens and parasites,
Economic and social impacts of a non-native oyster introduction, and
Adequacy of regulatory and institutional structure for monitoring and overseeing the interjurisdictional aspects of open water aquaculture.

The study concluded that *C. ariakensis* is probably well suited for growth and reproduction in the Chesapeake Bay and similar estuarine habitats on the Atlantic coast. But to get more definitive answers, the major concerns became the focus of 28 NOAA-funded research projects scheduled for completion by June 2007. A summary of important findings from this work is provided in Section 10.5.1 Non-native Oyster Introduction Issue. The issue paper also describes the current state of non-native oyster introduction in North Carolina.

9.3.4 WATER-DEPENDENT DEVELOPMENT

Water-dependent development includes any permanent, man-made structures that are designed for access to the water (Kelty and Bliven 2003). These include marinas, docks, piers, and bulkheads. Although the construction of water-dependent structures may actually increase substrate for oysters, activities associated with water-dependent development can harm shell bottom. Dredging of channels for navigational purposes can remove, damage, or degrade existing shell bottom. Dredging creates turbidity that can clog oyster gills or cover the oysters completely. Even low levels of siltation affect growth of oyster beds by reducing larval attachment. However, the indirect impact of dredging on oysters has been difficult to quantify (Kelty and Bliven 2003). *Therefore, a CHPP implementation action was included to solicit university proposals to conduct research on the effect of dock siting practices on*

shell bottom and SAV. The research should help in design modification that would minimize impacts

Although there are no major new channels being constructed at this time in North Carolina's estuarine waters, maintenance dredging, construction of new marinas and docking facilities, and new dredging for deep water access continue to be potential problems. Primary Nursery Areas are currently protected from dredging projects for deep-water access. However, there are other areas with shallow oyster beds that are not protected from such dredging.

Current (January 2003) CRC marina siting rules discourage significant degradation of existing shellfish resources [CRC rule 15A NCAC 07H .0208]. To comply with rules, a field survey of shellfish resources is needed to determine if significant loss or degradation would occur. This information is vital to the multi-agency permit review process. *The 2007-2008 CHPP implementation plan includes an action to develop permit application survey protocols for shellfish and SAV habitats for CAMA applicants.* Efficient permit review also requires consistent definitions for shellfish resource in order to ensure consistency among agencies. *Thus, another CHPP implementation action was included to ensure consistency of habitat definitions among agencies and commissions.*

9.4 WATER QUALITY DEGRADATION

9.4.1 TURBIDITY AND SEDIMENTATION

Sediment was the largest cause of water quality degradation in the Albemarle-Pamlico estuarine area (DEM 1989). Sediment was also listed by Division of Water Quality (DWQ) as a problem parameter for 964 miles of North Carolina waterways in 125 water bodies, including 25 water bodies in the Cape Fear River basin, 18 in the Neuse River basin, and 11 in the Tar-Pamlico River basin in 1998-1999 (DWQ 2000a). All of these river basins contain shell bottom habitat. The current DWQ reports are summarized differently and the area of water impaired by sediment is unclear.

In addition to direct physical damage to the shell mound structure, bottom disturbing fishing gear, including hydraulic clam dredges, clam trawls (kickers), and shrimp and crab trawls can impact oyster reefs indirectly by re-suspending sediment. As sediment disperses away from the disturbance and settles to the bottom, it can bury oyster larvae, adults, or shell, deterring successful recruitment of larvae due to lack of an exposed hard substrate (Coen et al. 1999). Excessive sedimentation can also harm shellfish by clogging gills, increasing survival time of pathogenic bacteria, or increasing ingestion of non-food particles (SAFMC 1998). Oyster eggs and larvae are most sensitive to suspended sediment loading (Davis and Hidu 1969). In order to protect sensitive habitats from episodic turbidity generated by bottom disturbing fishing gear, a minimum buffer zone should be defined around the habitat. *Formulating a definition will require both research on the impact of bottom disturbing activities on nearby habitats and on the shifting boundaries of habitat itself.*

Sediment in excessive amounts is also a problem because it transports fecal coliform in stormwater farther downstream and allows the bacteria to persist longer in the water column

than would live in clear waters (Schueler 1999). While fecal coliform bacteria do not affect the viability of oysters, pathogenic bacteria can make oysters unfit for human consumption. The primary sources of microbial contamination in coastal waters are thought to occur within ½ mile of the shoreline (Street et al. 2005).

There are many other sources of human-induced turbidity and sediment pollution. Any activity that involves clearing of vegetation, grading, and ditching of land can potentially increase erosion and sediment loading in stormwater runoff. These activities include, but are not limited to, construction of residential, commercial, or transportation structures; forestry operations; and agricultural activities. There were many thousands of wetland acres lost to agricultural drainage before the "Swampbuster" provisions of the 1985 Farm Bill (Street et al. 2005). Today, large-scale drainage projects on wetlands are prohibited without mitigation. However, existing drainage from agricultural lands, forestry operations, and construction activities continues to deliver sediment to aquatic ecosystems downstream.

Increased sedimentation in headwaters from upland development has caused environmental stress and possibly some mortality to upstream oyster stocks (Ulanowicz and Tuttle 1992; Mallin et al. 1998). There is anecdotal evidence that sedimentation from upstream development (primarily road construction) has silted over numerous oyster beds in trunk estuaries such as the Newport River, where Cross Rock (a large oyster rock) has been buried under 1-2 feet of soft sediment (P. P. Pate, DMF, pers. comm. 2004; C. H. Peterson, UNC-IMS, pers. comm. 2004). Restoring oyster beds in these headwater areas could be more difficult than planting oyster cultch on historical bed foundations downstream. However, restoring shellfish in headwater areas could also provide more water quality benefits. *Improved voluntary and regulatory land use strategies must be considered to reduce non-point source pollution and subsequent habitat degradation in coastal waters. Mitigation should also be required from upstream development projects that result in habitat loss downstream.*

To address land-based, non-point sources of turbidity, vegetated buffers are required along coastal waters and in selected river basins. Although definitions and characteristics of vegetated buffers vary, a buffer is generally a vegetated transitional zone, situated between upland land use and aquatic habitats, that functions as a filter of surface water runoff (Crowell 1998). Vegetated buffers are very effective in trapping sediment as well as other pollutants from stormwater runoff (Williams and Nicks 1988; Lee et al. 1989; Gilliam et al. 1994; Lowrance 1997; DWQ 2000b). Properly constructed vegetated buffers ranging from 5 - 185 m (15 - 600 ft) have been shown to remove as much as 90% of sediment and nitrate and up to 50% of phosphorus from stormwater runoff (Desbonnet et al. 1994). Relative effectiveness is dependent on buffer width, slope, soil type, vegetative cover, quality and flow of the runoff, and size of the drainage area.

The CRC adopted a 30 ft buffer as part of the Coastal Shoreline Area of Environmental Concern (AEC) in August 2000 for all new development in the 20 coastal counties governed by CAMA. This buffer begins at the water's edge, and allows clearing of vegetation as long as no soil disturbance occurs. Although this buffer will certainly have positive environmental benefits throughout the coast, the science suggests that it will be inadequate in

significantly reducing pollutant loading from nonpoint runoff (Lee et al. 1989; Zirschky et al. 1989; Groffman et al. 1991; Desbonnet et al. 1994; Gilliam et al. 1994; Lowrance 1997; Ensign and Mallin 2001). For example, a study of Goshen Swamp, a Coastal Plain blackwater stream that was clearcut, found that the clearcut caused violations of ambient N.C. water quality standards for turbidity, chlorophyll *a*, fecal coliform bacteria and DO compared with a control stream (Ensign and Mallin 2001). Despite a 10 m (33 ft) buffer left along the streambank, these violations occurred over a two-year period following the clearcut. The buffer was less than the state BMP recommending a 50 ft minimum buffer.

In the Neuse, Tar-Pamlico, and Catawba river basins, there is a mandatory buffer of 50 ft from mean high water, with exemptions for managed forests and selective harvesting of high value trees. The Neuse and Tar-Pamlico riparian buffer rules include a zonal design. Zone 1 must be a 30 ft wide forested area, beginning at mean high water (MHW), where the first 10 ft remain completely undisturbed, and the other 20 ft may have limited thinning of trees. Landward of this, Zone 2 must be 20 ft wide and have dense plant cover where no fertilizer use or development are allowed. The rule applies to all perennial and intermittent streams, lakes, ponds, and estuaries. All man-made ditches are exempt from this rule [EMC rule 15A NCAC 02B .0233 (6)]. *Ideally, mandatory buffer zones, of scientifically based and effective widths and configurations that protect habitat and water quality, should be required along all streams draining to coastal fish habitat in North Carolina.*

Shoreline erosion can also be a source of sediment in coastal estuarine systems. This is a natural process except where bulkheads have hardened the shoreline. While bulkheads can retain some upland sediment, such structures can increase erosion at the base of and downstream from the hardened structures, causing chronic increased turbidity in those areas (McDougal et al. 1987). Oyster are indirectly affected where marsh grass substrate is lost in front of the bulkheads that are less suitable as substrate.

9.4.2 MICROBIAL CONTAMINATION

Microbial contamination from fecal matter is important to DMF because it affects the opening and closing of shellfish harvest waters. Fecal coliform bacteria occur in the digestive tract of, and are excreted in the solid waste from, warm-blooded animals including humans, wildlife and domesticated livestock. While these bacteria are not harmful to humans or other animals, their presence in water or in filter-feeding shellfish may indicate the presence of other bacteria that are detrimental to human health (DWQ 2000a). Moreover, elevated levels of fecal coliform bacteria suggest that pollutants, such as nutrients, sediment, or toxins, may also be entering the water. Mallin et al. (2000; 2001), studied water quality in several tidal creeks in New Hanover County, and found a positive correlation between fecal coliform abundance and turbidity, nitrate, and orthophosphate. The significant correlation between bacteria and sediment was most likely because fecal coliform bacteria are associated with suspended particulate matter, and survive longer when in association with sediment particles (Mallin et al. 2000). The positive relationship between coliform bacteria and nutrients was attributed to both pollutants coming from the same sources in some instances. Also, some studies suggest that nutrient loading can stimulate growth and survival of fecal bacteria indicators (Evison 1988). Any steps taken to reduce non-point sources of bacteria

loading will also reduce loading of other pollutants into coastal waters and improve water quality and habitat conditions.

Because consumption of shellfish containing high levels of fecal coliform bacteria and associated pathogens can cause serious illness in humans, shellfish growing waters must be closed to shellfish harvest when fecal coliform counts increase above the standard 14 MPN/100ml [Commission for Health Services rule 15A NCAC 18A .0900], where MPN denotes "most probable number." The DEH recommends closing waters where a high potential for bacterial contamination exists, such as around marinas and point source discharges. Shellfish harvest closures have continued to occur over time (DMF 2001), which has led to a reduction in available shellfish harvest areas. Long term shellfish closures due to bacterial contamination remove available harvest area for oysters and clams and concentrate those activities on remaining resources compounding harvest related impacts on the oyster habitat in those areas. While closures may protect shell bottom habitat from harvesting, water quality degradation associated with high bacterial contamination is generally not advantageous for other aquatic organisms and fish. However, because shellfish filter organisms from the water column, unharvested shellfish may provide an important water quality enhancement function to the water column. *The effect of shellfish filtering capacities on water quality parameters, such as bacteria, nutrients and sediments, should be determined.*

Fecal coliform originates from both point and non-point sources. Point sources for the purposes of shellfish area protection include National Pollution Discharge Elimination System (NPDES) wastewater discharges and other sources with identifiable origins, such as pipes emptying directly into coastal waters. Although the wastewater discharges are treated, closures are required around all NPDES wastewater discharges due to the possibility that mechanical failure could allow inadequately treated sewage to reach shellfish waters. There were five minor and three major municipal NPDES discharges located within 0.5 mi of SA waters (Street et al. 2005). There were also 39 minor and 10 major non-municipal wastewater discharges near SA waters. These include discharges from water treatment plants (regular and reverse-osmosis), fish houses, sand and phosphate mines, and miscellaneous industrial activities.

Current EMC rules discourage creation of new direct discharges into shellfish waters [EMC rule 15A NCAC 2B .0224]. In fact, there has been a trend to remove some direct discharges, such as in the New River, and dispose of treated effluent on land. Most wastewater discharges meet their permit limits. However, when wastewater treatment plants are found to be out of compliance with their permitted discharge limits, waters can become degraded. Facilities that are out of compliance are subject to civil penalties. *Additional funds and process changes are needed to allow local communities to more rapidly address repairs and upgrades to all aspects of the municipal waste systems, including collection and treatment systems.*

Sanitary surveys conducted by DEH (Shellfish Sanitation and Recreational Water Quality Section) indicate non-point stormwater runoff is the primary cause of water quality contamination in more than 90% of the areas sampled (G. H. Gilbert, DEH-SS, pers. comm.

2002). Sources of bacteria and other contaminants carried into coastal waters via stormwater runoff and contributing to shellfish harvest closures identified by DEH and in numerous other studies (DEM 1994; Frankenberg 1995; Reilly and Kirby-Smith 1999; Schueler 1999; DMF 2001) include:
Residential and commercial development activities (urbanization);
Construction of impervious structures (buildings);
Roadways, parking lots, and driveways;
Domestic pet waste;
Unauthorized discharges of sewage effluent;
Failing on-site sewage systems or subsurface flow from drainfields;
Mechanical failure of centralized sewage treatment plants or lift stations;
Marinas;
Animal operations;
Agricultural croplands;
Mechanical forest harvesting;
Hydrologic alteration (e.g., channelization, ditching, bulkheading, canals) from multiple land uses;
Wetland loss and degradation associated with multiple land uses; and
Wildlife.

The primary way in which urban non-point runoff reaches coastal waters is from storm drain outlets, residential lawns, driveways, and streets (Schueler 1999). Bacterial concentrations in stormwater discharging from storm drains is found to be at least an order of magnitude higher than any other individual source in a watershed, indicating that the storm drain system is the most concentrated bacterial source in the watershed (Schueler 1999). Therefore, bacterial contamination tends to come from local, rather than from upstream, sources. Once in the water, bacteria can be transported downstream, but are relatively short-lived. These bacteria die more quickly when exposed to sunlight or high salinity water. Elevated bacterial levels have been positively correlated with high rainfall (low salinity), increased turbidity and suspended solids, and low temperature (Schueler 1999). Bacterial life is extended under low temperature, low salinity, and low light conditions and may be transported with sediment (DEM 1994; White et al. 2000). Fecal coliform bacteria may also be transported to shellfish-growing waters through subsurface flow. Onsite wastewater disposal systems with less than 10 cm distance (about 4 in) between the water table and the drainage trench may contribute to bacterial contamination of the surrounding groundwater and transport to adjacent surface waters (Reilly and Kirby-Smith 1999).

A number of watershed studies have identified specific sources of bacterial contamination in a watershed (Table 9.3). The cause of impairment varies and is often due to a combination of factors. When hydrological alterations (i.e., ditching and draining) occur, many wetland and stream functions are removed, increasing the delivery rate of non-point source runoff, and decreasing the time available for bacteria to be filtered out (DEM 1994; White et al. 2000). The forestry and agricultural BMPs that were in place during these studies did not prevent fecal coliform standards from being exceeded (DEM 1994; Mallin et al. 1998).

Some recommendations from the above referenced bacteria tracking studies for reducing fecal coliform contamination include:
Improve enforcement of existing Forestry Practice Guidelines and BMPs.
Implement more effective BMPs for forestry and agriculture, particularly where extensive hydrological modifications exist.
Require advance notice before any timber harvest in close proximity to coastal waters.
Implement innovative wetland restoration and stormwater retention techniques (bioretention areas, peat and sand filters, and constructed wetlands) to slow, capture, and filter stormwater runoff.
Work with owners of small animal farms to restrict livestock and their waste from direct access to stream waters.
Educate homeowners on how and why to properly dispose of pet waste.

Table 9.3. Primary causes of fecal coliform impairment in localized North Carolina studies.

Waterbody, CHPP MU	Primary causes of impairment	Reference
South River, Neuse MU	Hydrologic modifications for logging, agriculture, and development; animal grazing at stream edge	DEM 1994
Jumping Run Creek, Core-Bogue MU	Channelization, ditching, bulkheading	White et al. 2000
North River, Core-Bogue MU	Hydrologic modifications; pet and wildlife waste	Reilly and Kirby-Smith 1999
Tidal creeks, Southern Estuaries MU	Increasing impervious surfaces and population	Mallin et al. 2001
N.E. Cape Fear River, Cape Fear MU	Swine waste lagoon spills and ruptures	Mallin et al. 1997

The control of fecal coliform bacteria sources before they reach shellfish waters is the simplest and most cost effective measure for restoring water quality (Reilly and Kirby-Smith 1999). However, to effectively reduce bacteria loading, the site-specific sources must be identified. *Collaborative research is underway by NCSU and NOAA to determine accurate and cost effective methods of bacterial source tracking (M. Fulton, NOAA, pers. comm. 2003). DENR should support this research since it is needed for successful restoration of bacteria impaired waters.*

In urban areas, the percentage of impervious surfaces in a watershed has been found to be a strong indicator of fecal coliform abundance (Mallin et al. 2000). Removing vegetated areas reduces the natural filter and groundwater recharge capability of the land and forces water into areas of smaller pervious surfaces. These smaller surfaces are then overwhelmed by high volumes of water, leading to standing water and flooding. As the amount of impervious surface increases, so does the amount of runoff and flooding. Mallin et al. (1998; 2001) examined the effects of land-use practices on water quality in New Hanover County and found a statistically significant relationship between percent impervious surface cover and fecal coliform concentrations among several tidal creek systems ($r^2 = 0.95$) (Figure 9.2).

There has been a continual increase in fecal coliform contamination with increasing human population along the North Carolina coast (Maiolo and Tschetter 1981; Mallin et al. 2001). As of 2002, 263 of 776 estuarine areas (SA waters) were on the 303(d) list because of fecal

coliform contamination. The DWQ 305(b) report listed 28,435 acres (of approximately 2 million acres) of estuarine area impaired by fecal coliform contamination in coastal North Carolina. If the contamination is mostly from stormwater flow and other anthropogenic sources, the location of these impaired waters could indicate other non-point pollutants.

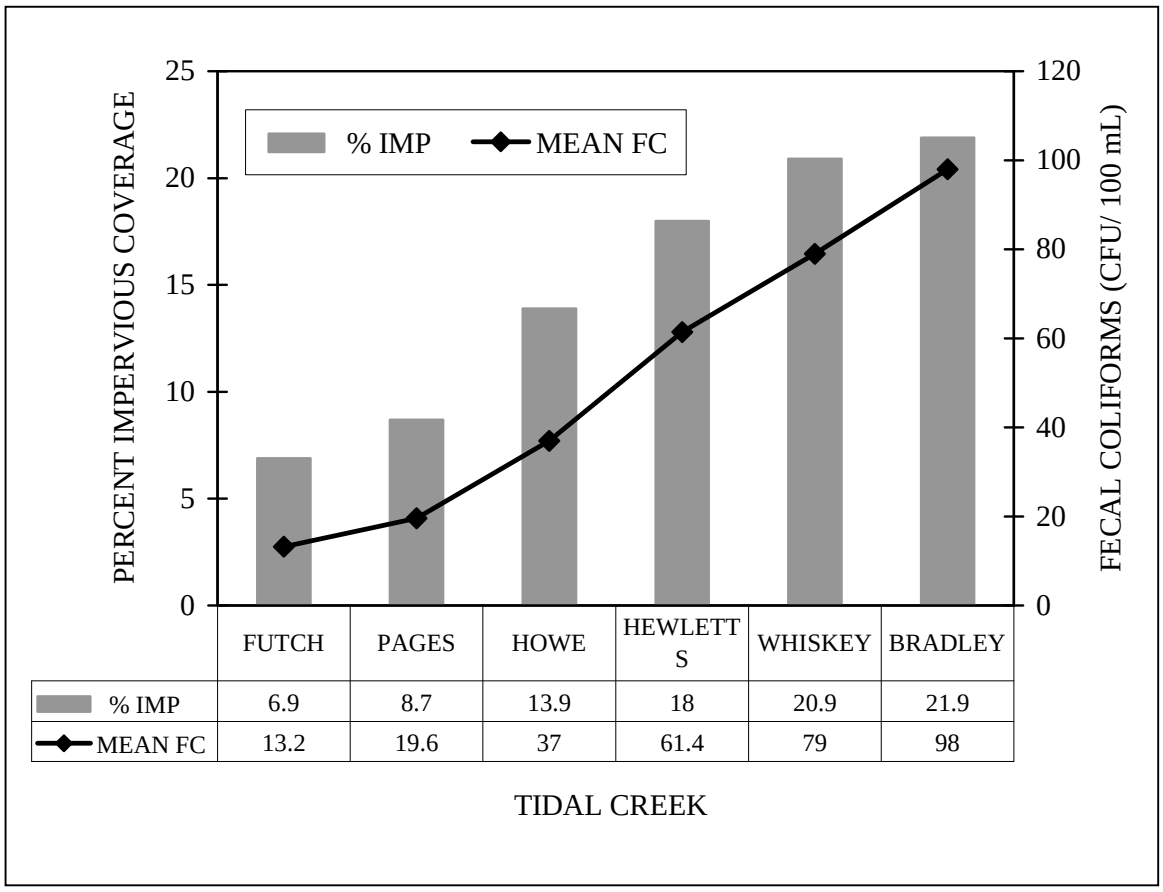


Figure 9.2. Percent watershed impervious surface coverage versus geometric mean fecal coliform bacteria counts for six New Hanover County tidal creeks (Mallin et al. 2001).

Trends in shellfish harvest closures reflect trends in fecal coliform contamination. Over 364,325 ac of coastal (salt and brackish) waters were closed to shellfish harvesting in North Carolina in 2002 due to high levels of fecal coliform or the potential risk of bacterial contamination (immediately around wastewater treatment plant discharges) (DEH, unpublished data). Of this total, approximately 56,446 acres of closed shellfish waters are suitable for shellfish production. These closures have primarily affected the central and southern areas of the coast. In more recent years, additional closures have been made in and around the Pamlico Sound (DMF 2001). Fecal coliform abundance tends to be highest upstream and in shallow creeks and waterbodies; contamination decreases downstream and in larger open waterbodies. The areas prone to high fecal coliforms are also typically areas where shell bottom habitat is concentrated.

Between 1983 and 1985, there was a sharp decline in the acreage of estuarine SA waters that were permanently closed to shellfish harvesting (Figure 9.3). This decline was attributed to increased sampling efforts and refinements in growing area classifications by DEH (i.e., conditionally approved, open or closed), and to reductions in point source discharges in coastal waters. From 1985 through 1995 shellfish closures continued to increase. Between 1995 and 2000, the total acreage of shellfish closures has fluctuated and totals have changed only slightly since 2000.

Figure 9.3. Acreage of North Carolina shellfish waters permanently closed to shellfish harvest during 1982-2002. N.C. Division of Environmental Health, Shellfish Sanitation and Recreational Water Quality Sections.

In addition to the areas that are permanently closed to shellfishing, other areas are temporarily closed during periods of high rainfall. For example, a rainfall of 1.5 inches in a 24-hour period can cause temporary shellfish harvest closures. Closures last from several days to more than a month. Large storms, such as hurricanes, result in harvest closures covering much larger areas, sometimes including all of North Carolina's estuarine waters. The conditionally approved areas are concentrated in the Core-Bogue, New-White Oak, and Southern Estuaries management units. Within these watersheds, permanent closures are most common in the upper reaches of tidal creeks and rivers, with conditionally approved areas occurring downstream of those areas or in the upper portions of less degraded creeks. As temporary closures have increased in frequency and duration, they have become an issue of great concern to the public, particularly in the southern area of the coast. The issue of shellfish closures is discussed further in Section 10.5.2 - Water Quality Degradation by Biological Contamination of Shellfish Growing Waters.

As of January 2007 mapping, there are approximately 3,349 acres of shell bottom that are currently unharvestable most of the time due to outright prohibitions or restrictions based on bacterial concentrations (classified as "prohibited" or "conditionally approved closed") (Table 9.4). An additional 5,663 acres of shellfish waters are closed to harvest for some portion of the year ("conditionally approved open" areas), representing approximately 39% of the mapped shell bottom (14,600 acres). Conditionally approved closed areas are most at-risk to permanent closure because they are considered impaired by DWQ and thus considered available for marina development by the DCM. *Therefore, land-based protection and restoration efforts should target productive shellfish resources in conditionally approved closed areas.* While some recent permit decisions have not allowed marinas in conditionally approved closed areas (S. L. Jenkins, DEH-SS, pers. comm. 2007), there is nothing in rule or policy stopping a marina permit in conditionally approved closed areas. And even approved waters can be threatened by large docking facilities too small to be classifed as marinas. The cumulative impact of multiple docking facilities in approved waters can result in a permanent or temporary closure of shellfishing waters to harvest. *Research is necessary to quantify the relationship between water quality and the cumulative effect of shoreline development (i.e., docks, bulkhead sections, drainage channels).* The core problem is a system that allows new degradation sources in impaired waters that could be restored. But until degradation sources are confirmed, restrictions cannot be applied (T. A. Reeder, DENR-DWQ, pers. comm. 2007). *A designation of Use-Restoration Water should be considered to prioritize impaired waters that could be restored. Tracking degradation sources in these waters should also be a priority.*

Table 9.4. Area of shell bottom mapped by January 2007 in different shellfish harvest water classifications. Resource Enhancement Shellfish Mapping Program and N.C. Division of Environmental Health, Shellfish Sanitation and Recreational Water Quality Sections. Note: 70% of bottom mapping area complete.

	Mapped Shell bottom		Approved		Conditionally Approved - Closed		Conditionally Approved - Open		Prohibited	
Name	Acres	% of mapped	Acres	% of mapped	Acres	% of mapped	Acres	% of mapped	Acres	% of mapped
Albemarle	319	1	270	85	0	0	0	0	45	14
Cape Fear	785	13	0	0	0	0	0	0	785	100
Coastal Ocean	2	1	0	8	0	0	0	0	0	0
Core/Bogue	7,533	5	1,762	23	611	8	3,914	52	962	13
Neuse	43	0	5	13	0	0	33	77	4	10
New/White Oak	679	2	274	40	27	4	280	41	87	13
Pamlico	658	1	629	96	0	0	0	0	20	3
Southern Estuaries	4,387	17	2,101	48	164	4	1,436	33	644	15
Tar/Pamlico	194	1	194	100	0	0	0	0	0	0
Total	14,600	4	5,235	36	802	5	5,663	39	2,547	17

Approximately 1,157 acres of ORW waters have been closed to shellfish since 1990 (Street et al. 2005). These closures are in tributaries of Middle Sound, Stump Sound, and Topsail Sound in the Southern Estuaries MU; western Bogue, Core, and Back sounds in the Core-Bogue MU; and Swan Quarter and Juniper bays in the Pamlico Sound MU. As development activities continue, so will the number of shellfish area closures, unless changes are made to the manner in which land is developed and stormwater runoff is managed. And those changes may be realized with the new stormwater rules being considered by DWQ (see 'Habitat and water quality management' subsection). In the mean time, reclamation of contaminated waters will become more difficult as population pressures and associated infrastructures increase. For more information regarding shellfish closures consult the water quality section (10.5.2) presented later in this document.

9.5 HABITAT AND WATER QUALITY MANAGEMENT

Federal and state laws mandate water quality protection activities through government commissions and agencies. Several divisions within DENR are responsible for providing technical and financial assistance, planning, permitting, certification, monitoring, and regulatory activities that have a direct or indirect impact on coastal water quality and habitat. Various federal and state environmental and resource agencies, including DMF, evaluate proposed projects and provide comments and recommendations on potential water quality and resource impacts. Water quality protection relies on enforcement, the ability of commenting agencies to evaluate impacts, and whether recommendations are incorporated into permitting decisions. Various public agencies (state and federal) and private groups have also established parks, refuges, reserves, sanctuaries, and natural areas that help to protect adjacent public trust estuarine water quality.

9.5.1 MARINE FISHERIES COMMISSION AND DIVISION OF MARINE FISHERIES

Presently, the MFC has authority to manage, restore, develop, cultivate, conserve, protect, and regulate marine and estuarine resources. Marine and estuarine resources are defined as "All fish [including marine mammals, shellfish, and crustaceans], except inland game fish, found in the Atlantic Ocean and in coastal fishing waters; all fisheries based upon such fish; all uncultivated or undomesticated plant and animal life, other than wildlife resources, inhabiting or dependent upon coastal fishing waters; and the entire ecology supporting such fish, fisheries, and plant and animal life." (G.S. 113-129). Although MFC's primary responsibilities are management of fisheries (seasons, size and bag limits, licensing, etc.), the MFC also has authority to comment on State permit applications that may have an effect on marine and estuarine resources or water quality, regulate placement of fishing gear, develop and improve mariculture, and regulate location and utilization of artificial reefs. MFC authority is found at G.S. 143B-289.51 and 289.52.

As discussed previously, the MFC prohibits certain bottom disturbing gears from areas supporting SAV, shell bottom, or juvenile finfish populations to protect these resources. Through designation of Primary Nursery Areas, the MFC restricts use of certain fishing gears in such areas as well as triggering protective actions by other regulatory commissions. In

some cases, these areas overlap shell bottom (Table 9.5). Other protections for shell bottom are actually based on protecting oyster rock– see, "Physical Threats," subsection on, "Mobile bottom disturbing fishing gear," for more information on mechanical methods prohibited areas and shellfish/seed management areas.

In addition to protection from certain fishing gears in Shellfish/Seed Management and Mechanical Methods Prohibited areas, shell bottom is also protected from harvest in military restricted areas. Military restricted areas cover 24,051 acres of the shellfish mapping study area, and all of these areas have been mapped (Table 9.5). Other area designations protecting shell bottom from specific fishing gear impacts include nursery areas, mechanical oyster harvest prohibited areas, trawl net-prohibited areas, and crab spawning sanctuaries. These areas cover more than half of the shellfish bottom mapping area, leaving the largest unrestricted areas in west and northwest Pamlico Sound, the lower Pamlico and Neuse rivers, and around Roanoke Island. A number of cultch planting sites in the Pamlico Sound area are also closed to mechanical harvest by proclamation annually, although none have been designated shellfish management areas (DMF 2001).

Table 9.5. Amount of bottom habitat mapped (acres) by the North Carolina Division of Marine Fisheries Shellfish Habitat and Mapping Program within areas receiving specific North Carolina Marine Fisheries Commission designations that restrict fishing activities (as of January 2003).

Marine Fisheries Commission restricted fishing area designation	Amount within the shellfish bottom mapping area	Currently mapped area	% complete
Crab spawning sanctuaries	17,673	12,831	73%
Mechanical clam harvest areas	39,446	29,878	76%
Mechanical oyster harvest prohibited	289,617	169,925	59%
Military restricted areas	24,051	24,051	100%
Permanent secondary nursery areas	34,825	243	1%
Primary nursery areas	46,941	31,045	66%
Shellfish/seed management areas (SSMA)	628	489	78%
Special secondary nursery areas	30,686	21,889	71%
Taking crabs with dredges	43,318	2,044	1%
Trawl nets prohibited	138,812	37,959	27%

While the MFC has no jurisdiction over land-based activities and shoreline development, the DMF plays an important role in permit decisions regarding major development projects. Projects are reviewed by DMF biologist and recommended for approval or denial based on projected impacts on fishery resources. The task is currently hampered by inadequate staff time to review development plans in a timely fashion. The CHPP implementation plans have been pushing for dedicated permit review staff since the first implementation plan in 2005. This continues to be an action in the current 2007-09 implementation plan.

9.5.2 ENVIRONMENTAL MANAGEMENT COMMISSION

By Environmental Management Commission (EMC) rules, all shellfish waters with significant resources are classified as SA waters and are, by definition, High Quality Waters (HQW). In addition, some waters that are classified SA also carry the Outstanding Resource Waters (ORW) classification based on recreational or environmental special uses. These waters are afforded additional protection from construction and runoff under EMC, CRC and Sedimentation Control Commission rules. The HQW and ORW areas cover 8% and 24% of the shellfish mapping study area, respectively. A total of 142,017 acres out of 362,450 acres of ORW in the CHPP management units are within the DMF shellfish mapping study area. Of the total bottom area mapped by DMF to date (January 2003), 55% (126,583 acres) was classified ORW (Street et al. 2005). However, the percentage will decline as remaining areas are mapped, because they have relatively few ORWs.

The North Carolina Division of Water Quality (DWQ) has established water quality classifications and standards program for "best usage." Water quality classifications and standards have recently been implemented to promote protection of surface water supply watersheds, high quality waters, ecosystem functions, and the protection of unique and special pristine waters with outstanding resource values. Classifications, particularly for HQW, ORW, Nutrient Sensitive Waters (NSW) and Water Supply (WS) waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. Many water quality standards are based on potential impacts in the immediate receiving waters and do not factor in the cumulative and long-term effects to the complex functions that characterize estuarine systems. Standards should be based on the assimilative capacity of, and impacts to, the entire system. The Comprehensive Conservation and Management Plan of the Albemarle-Pamlico Estuarine Study (EPA and NCDEHNR 1994) and other earlier plans for water quality management have recommended strategies that need to be implemented to improve water quality. Some unachieved recommendations from the plan were incorporated into the CHPP. In addition to CHPP, achievement of basinwide water quality management objectives by the DWQ should also improve coastal water quality.

A study of Goshen Swamp, a Coastal Plain blackwater stream that was clearcut, found that the clearcut caused violations of ambient N.C. water quality standards for turbidity, chlorophyll *a*, fecal coliform bacteria and DO compared with a control stream (Ensign and Mallin 2001). Despite a 10 m (33 ft) buffer left along the streambank, these violations occurred over a two-year period following the clearcut. The buffer was less than the state BMP recommending a 50 ft minimum buffer. Desbonnet et al. (1994) summarized studies documenting the different benefits of various buffer widths. Scientific literature suggests that minimum buffers between 26 ft (8m) and 75 ft (23 m) wide are needed to protect water quality and riparian habitat from logging impacts (Desbonnet et al. 1994; Ensign and Mallin 2001). In the Neuse, Tar-Pamlico, and Catawba river basins, there is a mandatory buffer of 50 ft from mean high water, with exemptions for managed forests and selective harvesting of high value trees. *Ideally, mandatory buffer zones, of scientifically based and effective widths and configurations that protect habitat and water quality, should be required along all streams draining to coastal fish habitat in North Carolina.*

Although definitions and characteristics of vegetated buffers vary, a buffer is generally a vegetated transitional zone, situated between upland land use and aquatic habitats, that functions as a filter of surface water runoff (Crowell 1998). Vegetated buffers are very effective in trapping sediment as well as other pollutants from stormwater runoff (Williams and Nicks 1988; Lee et al. 1989; Gilliam et al. 1994; Lowrance 1997; DWQ 2000b). Properly constructed vegetated buffers ranging from 5 - 185 m (15 - 600 ft) have been shown to remove as much as 90% of sediment and nitrate and up to 50% of phosphorus from stormwater runoff (Desbonnet et al. 1994). Relative effectiveness is dependent on buffer width, slope, soil type, vegetative cover, quality and flow of the runoff, and size of the drainage area. *Implementation of mandatory vegetated buffers along all coastal waters should be considered as a strategy for reducing sediment loading, the largest pollutant in N.C. coastal waters. Width and configuration of the buffers should be scientifically based and may need to be larger adjacent to strategic habitat areas.*

In 1998, DCM staff compiled an extensive bibliography on reported pollutant removal effectiveness of various buffer widths and recommended buffer widths for various environmental objectives (Crowell 1998). The widths range from 2 to 178 m, depending on the objective and the desired amount of pollutant removal.

The CRC adopted a 30 ft buffer as part of the Coastal Shoreline AEC in August 2000 for all new development in the 20 coastal counties governed by CAMA. This buffer begins at the water's edge, and allows clearing of vegetation as long as no soil disturbance occurs. Although this buffer will certainly have positive environmental benefits throughout the coast, the science suggests that it will be inadequate in significantly reducing pollutant loading from nonpoint runoff (Lee et al. 1989; Zirschky et al. 1989; Groffman et al. 1991; Desbonnet et al. 1994; Gilliam et al. 1994; Lowrance 1997).

The DWQ has recently reviewed a number of scientific studies (Schueler 1994; Arnolds and Gibbons 1996; Mallin et al. 2000; Barnes et al. 2001) that demonstrate that areas with greater than 10 to 15% impervious surfaces without structural stormwater controls result in some level of water quality degradation. In addition, DWQ has concluded that three coastal stormwater programs adopted in the late 1980s have been ineffective in protecting shellfishing use. The Coastal Stormwater Program, the Shellfishing Waters Programs and the Outstanding Resource Waters Program allow low-density development (with built upon areas of between 25 to 30% impervious surfaces) to be constructed without engineered, or structural, stormwater controls. A review of DWQ's permitting database indicates that since 1988, 72% of impervious surfaces have been built in the 20 Coastal Counties under the low-density provisions of these stormwater programs. Studies conducted in the southern tidal creeks of North Carolina showed that these stormwater rules were ineffective and closures of SA waters will continue unless changes are made in the low density provisions (T. A. Reeder, DENR-DWQ, pers. comm.. 2007).

Based on federal mandates, these findings and an associated review of the scientific literature, DWQ has begun implementation of two new programs. The Phase II Stormwater Rules were passed in July of 2006 and implementation should begin in July of 2007. At present, this federal program affects the southeast counties of Onslow, New Hanover and Brunswick and no other coastal counties. Within these rules, there are two classifications of

waters, SA and Shellfish Resource Waters (SR). The other program is a voluntary program called the Universal Stormwater Management Program (USMP) that went into effect on January 1, 2007 and can be adopted at a local government's discretion. This program removes the high and low density provisions and requires some sort of treatment of all stormwater runoff on a site. The USMP is available to local governments. Section10.5.2 has more information of these programs. *The MFC should support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation.*

9.5.3 COASTAL HABITAT PROTECTION PLAN

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

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

The CHPP recommends that some areas of fish habitat be designated as Strategic Habitat Areas. Strategic Habitat Areas (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 (Street et al. 2005). The process of identifying and designating SHAs was initiated in 2005. The process and data inputs should capture exceptional oyster habitat for both protection and restoration. *The identification of SHAs should also be coordinated with DENR's Strategic Conservation Plan – the land-based component of strategic area protections.*

9.5.4 RESTORATION ACTIVITIES

Restoration efforts are another form of oyster management designed to address the precipitous decline in oyster harvest and associated population size. The oyster Rehabilitation Program, which began in 1947, has contributed to the restoration of depleted oyster grounds through the planting of cultch material and seed oysters (Chestnut 1955; Munden 1975; and Munden 1981). State-sponsored cultch plantings begin in 1915. Over the entire period of cultch planting from 1915-1994, about 15 million bushels of oysters were planted in North Carolina waters (Street et al. 2005). The primary purpose of the DMF cultch-planting program since it began has been oyster fishery enhancement, which provides only temporary habitat value. Recent research showing the important ecological and economic value of oyster reefs has prompted DMF enhancement efforts to broaden their primary focus to ecosystem enhancement[6]. This broadening of focus for the protection/restoration program has occurred since the late 1990s. As of 2001, there were five constructed/artificial reef sanctuaries in North Carolina located in Bogue Sound, West Bay (Tump Island), Deep Cove (Swan Quarter), Croatan Sound, and behind Hatteras Village (DMF 2001). Work is currently underway to enhance several existing restoration sites and create additional sites. Since 2001, five more sanctuaries have been established (H. C. Hardy, DMF, pers. comm. 2007). The building of these sanctuaries follows the recommendation to expand oyster habitat restoration in Street et al. (2005). *The construction and maintenance of additional sanctuaries could be accomplished with conservation leasing made available to non-government organization such as the Nature Conservancy.* Section 10.4.1 - Oyster Sanctuary Development and Construction goes into further detail on the sanctuary program and future planning.

To coordinate other organizations' interests with DMF restoration work, a steering committee was established by the North Carolina Coastal Federation to draft an oyster restoration plan for North Carolina. Many of the protective recommendations (listed in section 9.6) were taken directly from Street et al. (2005) and the subsequent implementation plans. Other recommendations and subsequent actions involving restoration included (See www.nccoast.org/publication/**oyster**plan/**Oyster**Plan_05.pdf for the final plan):

1. Use NCDMF bottom mapping, CHPP Strategic Habitat Areas, and historical Winslow survey maps, and ground truthing to measure gains in restored/created oyster habitat – *Fisheries Resource Grant project completed to digitize and re-evaluate the Winslow Survey maps (Balance 2005).*
2. Conduct research on regionally specific and appropriate reef design and siting for optimal water quality and habitat functions -- *University (UNC-W and UNC-IMS) research on restoration protocols, including on-going reef seeding by NCCF and TNC in conjunction with DMF cultch planting for sanctuaries.*
3. Develop and apply scientifically rigorous methods to evaluate restoration success, including project monitoring, changes in oyster biomass, spatial coverage, spawning

[6] Peterson et al. (2003) estimated the amount of fish production that shell bottom provides in addition to adjacent soft bottom habitats. Using results from numerous studies, they compared the density of fish at different life stages on oyster reefs and adjacent soft bottom habitats. Analysis of the studies revealed that every $10m^2$ of newly constructed oyster reef in the southeast United States is expected to yield a benefit of an additional 2.6 kg of fish production per year for the lifetime of the reef (Peterson et al. 2003).

and recruitment success, survival, biological community development (i.e., expansion of SAV habitat), growth and complexity, use by other economically important species, and enhancement of water quality – *Monitoring protocols proposed (at Charleston Meeting 2004) and testing underway; exceeds NOAA minimum required monitoring.*

Appropriate staff from DMF should continue to participate in collaborative efforts to monitor the biological effectiveness of restoration activities and sanctuary development.

9.6 RECOMMENDED MANAGEMENT STRATEGY

Despite current restoration and protection efforts, large areas of shell bottom habitat are still unprotected from direct physical removal or damage via human-related activities, as well as from indirect damage from water quality degradation (Table 9.5). In order to restore shell bottom habitat, the destruction of oyster beds from fishing practices, channel or marina dredging, and pollutant loading must be reduced and oyster habitat restoration must increase significantly.

9.6.1 HABITAT

Suitable and adequate habitat is a critical element in the ecology and productivity of estuarine systems. Maintenance and improvement of suitable estuarine habitat and water quality is critical to successfully recovering and sustaining oyster stocks. To work toward this goal, the MFC, CRC, and EMC should adopt rules to protect critical habitats for oysters as outlined in the CHPP. The DENR should develop a strategy to fully support CHPP implementation with additional staff and funding. The MFC and DMF should continue to comment on activities that may impact aquatic habitats and work with permitting agencies to minimize impacts and promote restoration and research.

A strategy should be developed and adopted by the MFC and DENR to accomplish the actions outlined below. Most of the actions can be implemented by DMF/MFC as CHPP-related actions. The other actions would need to be implemented through the cooperative efforts of the N.C. General Assembly and/or several divisions within the Department of Environment and Natural Resources. The involvement of federal agencies and increased funding (state and federal) may also be necessary to accomplish these actions. The actions listed below are either covered in the draft 2007-2009 Implementation Plan (IP) or the CHPP research report.

Strategic Habitat Areas

1. Identify and delineate Strategic Habitat Areas that will enhance protection of oysters and oyster habitat.
2. Coordinate SHAs with land-based conservation and restoration activities such as One North Carolina Naturally and DENR's green infrastructure planning.

Shell Bottom

3. Ensure oyster habitat definitions are consistent across regulating agencies.

4. Completely map all oysters and oyster habitat in North Carolina, including the deep subtidal rocks in Pamlico Sound.
5. Remap oysters and oyster habitat to assess changes in distribution and abundance over time.
6. Restore historical distribution and acreage of oysters where possible and coordinate with land-based protection and restoration efforts
7. Balance protection of oyster beds (as habitat) with harvest provisions and expand oyster sanctuary planting.
8. Monitor biological/ecological condition and effectiveness of oyster sanctuaries.
9. Cooperate with University researchers on oyster larvae distribution and oyster recruitment studies to aid in restoration planning.
10. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to oyster habitat.
11. Develop permit application survey protocols for shellfish and SAV habitats for CAMA applicants.
12. Evaluate and adjust as necessary mechanical gear harvest boundaries to protect and enhance oyster habitat.
13. Seek additional resources to enhance enforcement of and compliance with expanded bottom disturbing fishing gear restrictions that protect oyster habitat.
14. Encourage use of hand harvest methods over mechanical harvest where feasible.
15. Due to the long-term decline in clam kicking effort, modify mechanical harvest areas to include only actively fished areas.
16. Evaluate making conservation leasing available to non-government organizations for the purpose of oyster restoration and sanctuary development.

Wetlands

17. Prevent loss of additional riparian wetlands through the permitting process, land acquisition, or land use planning.
18. Restore coastal wetlands to enhance habitat and water quality conditions for oysters.

9.6.2 WATER QUALITY

Suitable water quality is a critical element in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of water quality may have a corresponding impact on habitat. Maintenance and improvement of suitable estuarine water quality and habitat are probably the most important factors in providing a sustainable oyster stock. The MFC has no regulatory authority over water quality impacts other than the effects of fishing practices. The MFC and DMF should highlight problem areas and advise other regulatory agencies (EMC, DWQ, DEH – Shellfish Sanitation, Division of Land Resources, COE, and local governments) on preferred options and potential solutions. The MFC and DMF should continue to comment on activities (state, federal, and local permits) that may impact estuarine water quality and work with permitting agencies to minimize impacts. Additionally, the MFC and DMF should solicit and support Fishery Resource Grant (FRG) projects that may provide information necessary for protection, management, and restoration of water quality. Water quality standards should be based on the assimilative capacity of, and impacts to, the entire system.

Several plans for water quality management have recommended strategies that need to be implemented to improve water quality. The DENR should develop a strategy to fully support CHPP implementation with needed staff and funding. Water quality protection and restoration are essential to accomplish the goal and objectives of this plan. Actions would need to be implemented through the cooperative efforts of the N.C. General Assembly and several divisions within the DENR. The involvement of federal agencies and funding may also be needed to accomplish these actions. Specific water quality recommendations can be found in the 2005-2007 CHPP Implementation Plan. The recommendations from this section are listed below. Most of the recommendations are covered in the draft CHPP Implementation Plan or research report. Only the fifth recommendation is new from this plan.

1. 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 oyster production.
2. Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation; Recommend DWQ designate Use-Restoration waters in conditionally closed waters where moderate contamination and healthy shellfish beds are present and develop strategies to protect and restore those waters.
4. Provide additional funds and process changes to allow local communities to more rapidly address repairs and upgrades to all aspects of the municipal waste systems, including collection and treatment systems.
5. Target productive shellfish resources in conditionally approved closed areas for land-based protection and restoration efforts. This could involve designation as Strategic Habitat Area or Use-Restoration Waters.

9.7. HABITAT AND WATER QUALITY RESEARCH PRIORITIES

- Determine the effect of shellfish filtering capacities on water quality parameters, such as bacteria, nutrients and sediments.
- Support collaborative research to more efficiently track bacterial sources for land-based protection and restoration efforts.
- Quantify the impact of current fishing practices on oyster habitat suitability in North Carolina.
- Determine the impact of docks siting practices and bottom disturbing activities on nearby habitats and on the shifting boundaries of habitat itself so that protective buffer distances can be established.
- Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units (i.e., docks, bulkhead sections)
- Develop peer reviewed, standardized monitoring metrics and methodologies for oyster restoration and stock status assessments.

10.0 PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

10.1 HARVEST ISSUES

10.1.1 EFFECTS OF AN OPEN HARVEST LICENSE ON SHELLFISH FISHERIES

ISSUE

What are the effects of an open harvest license on shellfish fisheries?

BACKGROUND

The North Carolina General Assembly passed a moratorium on the sale of commercial fishing licenses in 1994 because of concerns voiced by the commercial and recreational fishing community. The General Assembly also appointed a moratorium steering committee to oversee the study of North Carolina's fisheries management process and to make recommendations on improving the process. Five subcommittees, including a License Subcommittee, were established to examine coastal fisheries issues. The recommendations of these committees formed the basis of the Fishery Reform Act of 1997.

The License Subcommittee proposed the adoption of a new coastal fisheries licensing system to enable documentation of the numbers of fishermen and to establish a basis to better determine fisheries harvest and effort. The license system in place today is based on recommendations made by this subcommittee. The current commercial license system consists of the standard commercial fishing license (SCFL) with a cap on the number of licenses available. A free shellfish endorsement is available to SCFL holders who are North Carolina residents to allow fishermen the flexibility of participating in shellfish harvest in addition to other fisheries. A $25.00 commercial shellfish license is also available to persons without a SCFL and allows any North Carolina resident to harvest and sell shellfish.

The North Carolina commercial shellfish license has always been restricted to North Carolina residents because shellfish are non-motile and are found in publicly owned submerged lands. Shellfishermen wanted this prohibition on the shellfish license to remain in effect. Therefore the shellfish license and the shellfish endorsement are only allowed to be held by North Carolina residents. In addition, the shellfish license is available to residents at a lower cost than the SCFL so that those impoverished fishermen whose commercial fishing activities are limited to shellfishing on public bottom could continue to afford a license.

Concerns about the shellfish license becoming available to all North Carolina residents was an issue addressed in the 2001 Hard Clam FMP and the 2001 Oyster FMP. Unlike the SCFL,

which has a cap on the number of licenses issued, there is no cap on the shellfish license causing concern about the possibility of a large increase in the number of fishermen harvesting shellfish. Before the new license system was in effect, license data from 1995 to 2000 indicated the number of licenses to harvest shellfish was decreasing. However, because the new license system began shortly before the implementation of the 2001 FMPs, there were no data available to assess the effect of the open shellfish license on the fishery. It was recommended in both plans to revisit this issue when more license data became available.

Recently, an additional issue brought forward by the Shellfish Advisory Committee is the availability of the shellfish license for mechanical harvest of shellfish as well as hand harvest because of similar concerns about increases in the number of fishermen mechanically harvesting shellfish.

CURRENT AUTHORITY

North Carolina General Statutes
113-168.5 License endorsements for Standard Commercial Fishing License
113-169.2 Shellfish license for North Carolina residents without a SCFL

DISCUSSION

North Carolina Division of Marine Fisheries license data indicates that the total number of shellfish licenses issued between 1995 and 1999 decreased. For the 1995 license year, 4,294 shellfish and crab licenses and 2,361 shellfish only licenses were issued. These numbers decreased every year afterward and by the 1999 license year, only 2,109 shellfish and crab licenses and 1,505 shellfish only licenses were issued. When implementation of the new license system began in July of 1999, shellfish license numbers continued to decrease (Table 10.1).

Table 10.1. Total number of shellfish licenses issued for FY2000-FY2006.

Fiscal year*	Total number of shellfish licenses
2000	2,098
2001	2,176
2002	2,304
2003	2,131
2004	1,835
2005	1,623
2006	1,529

* The license fiscal year is from July 1 to June 30 of each year.

The total number of SCFLs has also been decreasing over time along with some decrease in the number of SCFLs with shellfish endorsements. However the number of retired SCFLs (RSCFLs) is increasing but these numbers are low compared to the SCFL (Table 10.2). The decrease in SCFLs is most likely reflecting the high cost of fuel, increased competition with imported seafood and the increased fisheries regulations.

Table 10.2. Total number of standard commercial fishing licenses (SCFL), retired standard commercial fishing licenses (RSCFL) and shellfish endorsements for FY2000-FY2006.

Fiscal year*	Total number of SCFLs	Total number of SCFL shellfish endorsements	Total number of RSCFLs	Total number of RSCFL shellfish endorsements
2000	6,990	6,481	515	480
2001	6,783	6,191	630	601
2002	6,632	6,092	676	656
2003	6,505	5,984	727	704
2004	6,421	5,923	754	733
2005	6,301	5,484	754	742
2006	6,171	5,751	787	771

* The license fiscal year is from July 1 to June 30 of each year.

The majority of fishermen who participate in the mechanical harvest of clams and oysters hold a SCFL or RSCFL with a shellfish endorsement. The number of participants in the mechanical oyster harvest has increased while numbers who participate in mechanical clam harvest have decreased (Table 10.3). There are very few mechanical harvesters that hold a shellfish license (less than 8 since the its implementation) (Table 10.3).

Table 10.3. Total number of mechanical shellfish harvest participants with standard commercial fishing licenses endorsement (SCFL), retired standard commercial fishing license endorsements (RSCFL) and shellfish licenses for FY2000-FY2006.

	Mechanical oyster fishery		Mechanical clam fishery	
Fiscal year*	RSCFL/SCFL endorsement	Shellfish license	RSCFL/SCFL endorsement	Shellfish license
2000	23	0	84	7
2001	58	1	76	6
2002	47	1	86	5
2003	47	4	64	2
2004	44	1	73	3
2005	128	3	61	4
2006	136	2	34	2

* The license fiscal year is from July 1 to June 30 of each year.

Capping the number of shellfish licenses available to North Carolina residents would prevent expansion of the commercial fishery beyond a specified level of participants. The number of shellfish licenses that may be issued could be capped at the number of current, valid shellfish licenses held by licensees on a certain date. This is similar to how the initial cap was established for SCFLs in the Fishery Reform Act of 1997. Limiting shellfish license holders to hand harvest only would limit mechanical effort to SCFL holders with shellfish endorsements and would limit the potential for expansion of the fishery.

The Fisheries Reform Act states that the NC Marine Fisheries Commission (MFC) can recommend that the General Assembly limit participation in a fishery if the MFC determines that sustainable harvest in the fishery cannot otherwise be achieved. Sustainable harvest cannot be determined for oysters or hard clams at this time; therefore capping the number of licenses (a form of limited entry) does not appear to be a viable option.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ License trends indicate decreasing participation
+ No additional regulation on the fishery
- Possible increase in number of fishermen harvesting shellfish

B. License cap
+ Prevent growth of the fishery
+ Protects historical participants in the fishery
- Will not restrict individual increase in effort
- Additional regulation
- Cannot be considered for action unless there is no other means of achieving sustainable harvest in the fishery

C. Eliminate the shellfish license and require a SCFL with a shellfish endorsement for shellfish harvest
+ Reduces some fishing effort in the fishery
- Increase license cost to fishermen who only have a Shellfish license
- Would require fishermen who only have a shellfish license to go through the eligibility pool application process to obtain a SCFL
- Cannot be considered for action unless there is no other means of achieving sustainable harvest in the fishery

D. Limit shellfish license holders to hand harvest only
+ Reduces some fishing effort in mechanical harvest of shellfish
- Increase license cost to those fishermen who mechanically harvest and only have a Shellfish License
- Additional regulation

MANAGEMENT RECOMMENDATIONS

AC/DMF - Status quo

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.1.2 MECHANICAL AND HAND HARVEST TRIP LIMIT DIFFERENCES

ISSUE

North Carolina oystermen in the northern region of the state have voiced concern over the differences between oyster trip limits in the mechanical and hand harvest fisheries. Should North Carolina Division of Marine Fisheries (DMF) promote a less destructive harvest practice by increasing trip limits for hand harvest methods?

BACKGROUND

As per rule 15A NCAC 03K .0201, the oyster season may open October 15 and can continue to May 15. The DMF Director has proclamation authority under this rule to specify days of the week, areas, means and methods, time periods, quantity (not to exceed 50 bushels) and minimum size limits (not less than 2 ½ inches). Currently the hand harvest season for oysters opens on October 15 and continues into March with harvest limits of 5 bushels per day, not to exceed a total of 10 bushels in any combined commercial fishing operation. Hand harvest methods are defined by proclamation as taking oysters by hand or hand operated implements only. Currently the mechanical harvest season opens in November and closes in March with harvest limits of 15 bushels per fishing operation. Mechanical methods include, but are not limited to, dredges, patent tongs, stick rakes and other rakes when towed by engine power and other methods that utilize mechanical means to harvest oysters.

Hand harvest gear accounts for the majority of the landings and is the dominant harvest gear for oysters in North Carolina (Figure 10.1). However in the northern region of the state the oyster dredge is major harvest gear (Figure 10.2). With increased concerns over oyster dredging being detrimental to existing oyster reefs and oyster habitat, the DMF closed several bays along the western side of the Pamlico Sound to mechanical harvest (Figure 10.3) under authority of the North Carolina Oyster Fishery Management Plan (FMP) in 2003. This action was initiated in the 2001 FMP, with a recommendation to the North Carolina Marine Fisheries Commission (MFC) to adopt criteria for the further designation of areas limited to hand harvest methods and designate those areas by rule. The MFC further promoted the hand harvest fishery by adopting a recommendation to increase cultch plantings in hand harvest areas. These management options predominantly affected the northern region of the state including the Neuse River, Pamlico River, western Pamlico Sound, and Roanoke Sound. Areas in the southern region from Carteret County south were already closed to mechanical harvest of oysters. In response to the management measure to increase cultch plantings in hand harvest areas; the DMF has planted 109,690 bushels of cultch in Hyde County and 42,871 bushels in Dare County.

Although there has been an increased effort to expand and promote hand harvest resources, the hand harvest limits have remained unchanged. The current limit of 5 bushels per day/10

bushels per operation was set to protect intertidal oyster reefs in the southern part of the state. Intertidal oyster reefs are vulnerable to over harvest due to the nature of the fishery. In contrast, the hand harvest areas in the northern region of the state are exclusively subtidal reefs with depths of 2 to 6 feet in which hand tongs are used. Even though the hand harvest season opens earlier than the mechanical season and typically has more harvest days, low trip limits may prevent northern oystermen from participating in the less destructive hand harvest fishery.

A review of oyster season proclamations from 1993/94 to 2005/06 shows that, based on coastwide opening and closure dates for the two oyster harvest categories, the mechanical harvest oyster season averages approximately 92 harvest days. Mechanical harvest season opens around 20 harvest days after hand harvest begins and closes roughly eight harvest days before hand harvest ends. The commercial hand harvest season averages 120 harvest days. Closures due to pollution and management of individual areas were not included in this analysis. Based on these figures and established trip limits, mechanical harvesters could harvest 1,380 bushels per fishing operation on average each season while commercial hand harvesters could possibly take 1,200 bushels per operation. The actual situation observed by DMF staff is that many harvesters, both by mechanical and hand harvest methods, fish alone. Since hand harvesters are limited to 5 bushels per person and mechanical harvesters have no individual limit, the difference in seasonal limits is more accurately 1,380 bushels for mechanical harvesters versus 600 bushels for hand harvesters. Landings data from 1999 to 2005 indicate mechanical harvesters take around 10 bushels of oysters per harvest day while hand harvest fishermen take approximately 4 bushels.

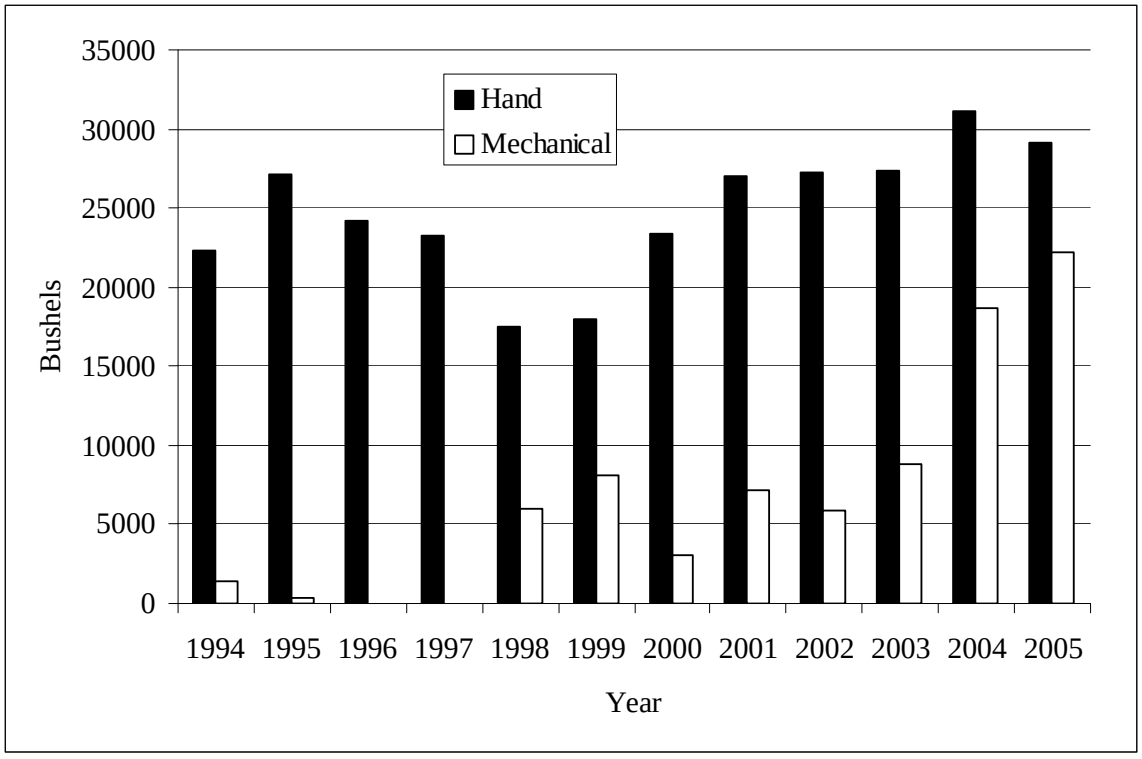


Figure 10.1. Annual oyster landings (bushels) by hand and mechanical gears, 1994-2005.

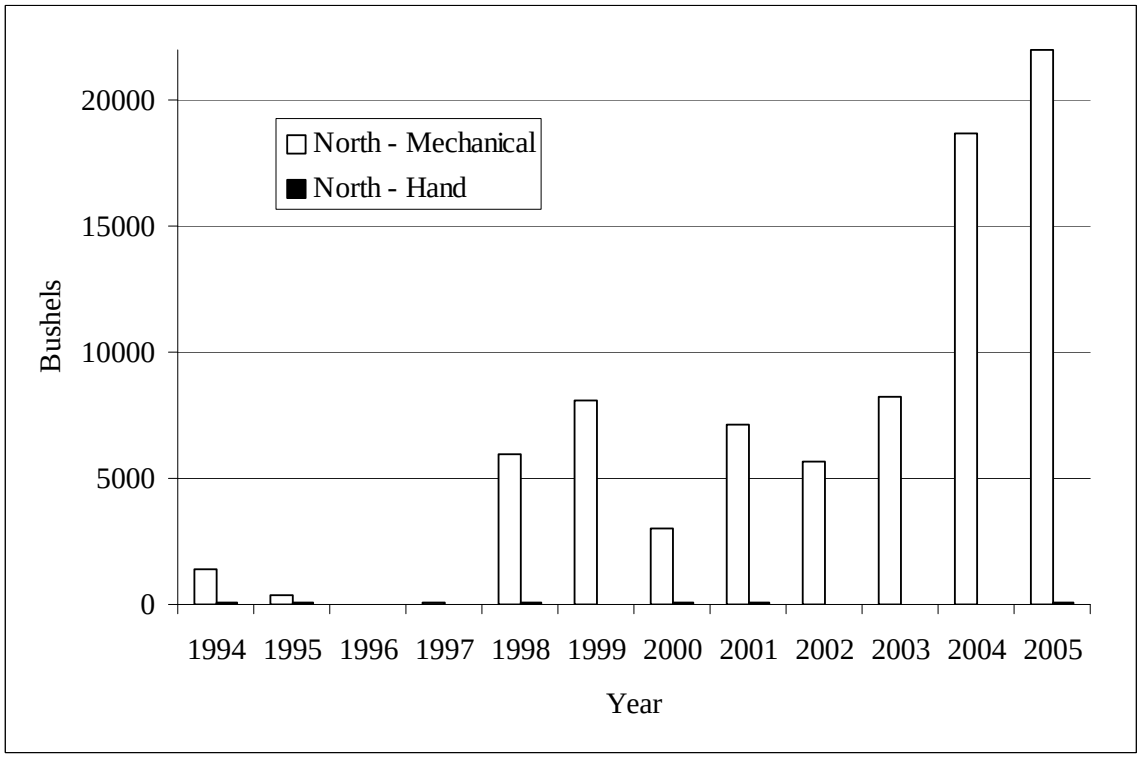


Figure 10.2. Annual oyster landings (bushels) by hand and mechanical gears for areas north of Core Sound, 1994-2005 (DMF Trip Ticket Program).

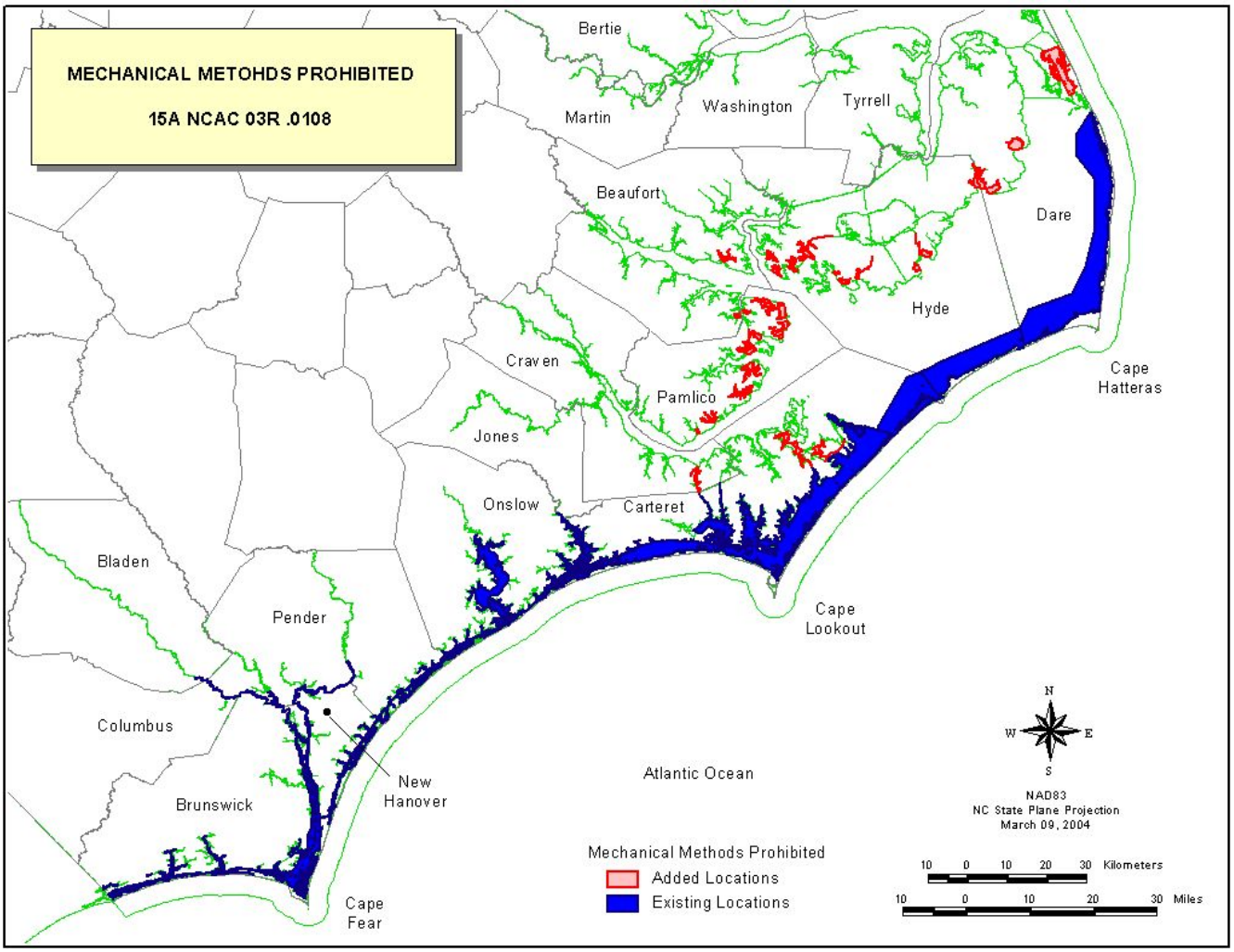


Figure 10.3. Areas where mechanical harvest of oysters is prohibited (DMF GIS Database).

CURRENT AUTHORITY

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0201 Open Season and Possession Limit
03K .0204 Dredges/Mechanical Methods Prohibited
03R .0108 Mechanical Methods Prohibited

DISCUSSION

The 2003 Oyster FMP and the DMF Stock Status Report continued to list the stock status as concern. This status was assigned because a stock assessment could not be completed on oysters and a trend of declining and continued low commercial harvest levels was apparent. Reduced harvest levels could be linked to less effort however it is generally recognized that oysters appear to be at very low levels. Therefore, any increase in trip limits should take into

consideration the concern status and not compromise the stock. Studies on effects of oyster dredging on habitat have shown that excessive dredging of cultch planting sites can reduce profile by 29%. Promoting a hand harvest fishery as introduced in the 2001 FMP with the creation of additional hand harvest areas is a step in promoting less destructive harvest practices and could lessen habitat degradation, which in turn could conserve the fishery.

To further promote hand harvest methods for oysters, the hand harvest limit could be made equal to the harvest limit for mechanical methods. The current hand harvest trip limit in the northern region discourages fisherman from participating full time in a less destructive fishery because of the higher allowed trip limits using mechanical methods earns more money. However, due to the intertidal habitat of the southern oyster reefs found in areas south of Core Sound, regional harvest limits may be necessary to successfully conserve the resource. The "cull as you go" practice of harvesting can quickly diminish the population of an intertidal reef. With exposed oyster reefs, harvest consist of selecting only the legal oyster and therefore not much time is spent culling which can result in reaching harvest limits quickly. Subtidal harvest with hand tongs requires increased physical effort due to increase water depths. Hand tonging also incorporates more culling time because the gear is not selective. Therefore the impact of hand harvesting in these areas may be less severe than mechanical harvesting and an increased harvest limit may be appropriate for subtidal areas. Increasing the hand harvest trip limit for the Pamlico Sound area (Figure 10.3) could be an option to promote the hand harvest fishery in a region that has traditionally been a mechanical harvest area. One option for increasing the hand harvest limit would be to allow a 10 bushel hand harvest trip limit regardless of the number of individuals in an operation. This change would allow a single harvester more incentive to participate in the hand harvest fishery.

The area along the shallow reef west of the Outer Banks from Oregon Inlet to the Wainwrights is currently closed to mechanical methods (Figure 10.3). This area is dominated by Submerged Aquatic Vegetation (SAV) and thus is protected from bottom disturbing gear. Increasing hand harvest trip limits in this region is not likely to compromise SAV beds because the major oyster beds located in this region are DMF planting sites. These areas could be considered a put-and-take fishery and DMF could include the same regional harvest limit changes for Pamlico Sound. If increasing trip limits in this region is a viable option, DMF will need to consider increasing cultch planting in these hand harvest areas.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ No changes in management
+ No additional burden on law enforcement
+ Limiting harvest for a concerned stock
- Not promoting less destructive harvest gear
- No economic reward for participating in less destructive fishery

B. 10 bushel limit for all methods and areas
+ Equity among harvest gears
+ Less confusion over regulations
+ More economically feasible for hand harvester in northern areas
- Decreased mechanical harvest limit with possible economic strains
- Potential increase in the exploitation of intertidal oyster reefs
- Potential decrease in southern area season

C.15 bushel trip limit for all methods and areas
+ Equity among harvest gears
+ Less confusion over regulations
+ Possible increase in oyster harvest
- Potential increase in the exploitation of intertidal oyster reefs
- Possible increased stress on a concerned stock
- Potential decrease in southern area season

D. 15 bushel hand harvest limit for mechanical harvest areas
+ Equity among harvest gears in mechanical methods areas
+ Promoting a less destructive gear
+ More economic incentive to explore hand harvest methods
- Enforcement problems due to differences in harvest limits between areas

E. Regional/area trip limits
+ Provide case-by-case management for specific areas
+ No rule change
+ Possible increase in oyster harvest
- Increased demand for law enforcement
- Increased proclamations
- Possible increased stress for a concerned stock

1. Increase hand harvest trip limit for Pamlico Sound area
+ Promote a less destructive harvest method
+ More economical for hand harvester
+ Recover harvest loses due to area closures for mechanical methods
- No equity with southern region harvesters
- Increased stress for a concerned stock

2. 10 bushel hand harvest trip limit per operation regardless of number of individuals involved for Pamlico Sound area
+ More economical for individual harvester
+ Recover harvest loses due to area closures for mechanical harvest
+ Promote a less destructive harvest method
- No equity with southern region harvester
- Possible increased oyster harvest in a concerned stock

3. 15 bushel hand/mechanical harvest limit in Pamlico Sound mechanical harvest-areas outside the bays, 10 bushel hand/mechanical harvest limit in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound

+ Equity among harvest gears
+ Promote a less destructive harvest method
+ More economical for hand harvester
- No-equity with southern region harvester
- Reduces mechanical harvest limit in bays
- Law enforcement issues with different limits between areas

MANAGEMENT RECOMMENDATIONS

DMF/AC - Recommend a 15 bushel hand/mechanical harvest limit in Pamlico Sound mechanical harvest areas outside the bays, 10 bushel hand/mechanical harvest limit in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound.

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

- Establish triggers for harvest season closures.
- Provide a more timely management response to harvest pressure.
- Evaluate harvest closure.

10.1.3 RECREATIONAL AND WEEKEND SHELLFISH HARVEST PROVISIONS

ISSUES

A. The rule intended to restrict shellfish harvest from public bottoms on weekends to recreational limits (15A NCAC 03K.0105) is ambiguous creating many challenges that commercial harvest is also allowed. The rule also contains a limit on recreational blue crab harvest that is out of place.

B. The definition of commercial fishing equipment or gear currently (by default) includes rakes, tongs and by hand indicating that these gears require a shellfish license or a shellfish endorsement on a standard commercial fishing license for use. These gears are typically used for unlicensed recreational harvest.

C. Shellfish rules have been unclear about the taking and unloading of commercial quantities of oysters and clams from shellfish leases and franchises on Saturdays and Sundays. Shellfish lease and franchise holders contend they should not be restricted in how they handle shellfish they already own.

BACKGROUND

There have been several bills to institute licensing requirements for recreational shellfishing introduced in the NC General Assembly since the 2001 Hard Clam and Oyster FMPs were adopted with that recommendation. These bills prompted staff to look at existing recreational shellfishing rules to anticipate necessary changes should those bills be passed. That review and concerns raised during normal shellfishing activities through the years identified several areas needing rule changes. Several of the changes are needed even though a licensing requirement for recreational shellfishing was never passed.

Historically, shellfish lease and franchise holders have been held to the same restrictions on shellfish harvest as public bottom fishermen with the exception that they could sell oysters during the regular closed oyster season. The rationale for applying the same standards was that allowing lease and franchise holders to sell more or smaller shellfish, or harvest and sell shellfish from their private grounds while commercial shellfishing was not allowed on public bottom, would create black market opportunities for public bottom shellfishermen and cause overharvesting of the resource. Those concerns have diminished in recent years as exceptions have been made for shellfish aquaculture products raised from hatchery-reared seed that are sold at less-than-legal public bottom sizes without significant recorded violations from public bottoms.

CURRENT AUTHORITY

North Carolina General Statutes
113-169.2. Shellfish licenses for North Carolina residents without a SCFL.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03I .0101 Definitions
03K .0105 Harvest of Crabs and Shellfish
03K .0106 Taking or Unloading Oysters and Clams on Sunday or at Night
03K .0201 Open Season and Possession Limit
03K .0301 Size and Harvest Limit

DISCUSSION

Rakes, tongs, scoops, hands and sometimes feet are typically used to take oysters and hard clams for recreational purposes. These methods were inadvertently left off of the list of gears that are defined as “not being” commercial fishing equipment meaning a standard commercial fishing license with a shellfish endorsement or a shellfish license is required to use these gears. A rule change is proposed to align rules with intended practices.

There are two references in the rules to the shellfish license statute, G.S. 113-169.2, using it as an indicator of the harvest limit for taking several shellfish species for recreational purposes. Section (i) of that statute does set forth the amounts of shellfish that can be taken without purchasing a commercial license but it does not establish the recreational harvest limit for those shellfish species. The recreational harvest limit could be set through rule making or by proclamation authority at a level lower than that established in the statute. The

references to G.S. 113-196.2, while convenient, are not accurate and should now be corrected with up-to-date wording.

Since G.S. 113-169.2 (i) only sets the harvest standards for when a person must purchase a license to shellfish, DMF and the MFC have been allowing that statute to set the personal use or recreational shellfish limits by default. There have not been any problems with this situation since the harvest amounts for the listed shellfish species are well known and readily quoted when questions and discussions about recreational shellfish harvest arise. However, it would improve visibility of the restrictions to formally adopt them in rule and, since the Fisheries Director has proclamation authority over recreational harvest limits for oysters and scallops, recreational limits should be set in those proclamations.

The reason for setting a license requirement based on the amount of shellfish harvested is also unclear. More recent statutes set the requirement for licenses based on the gear that is used and the disposition of the catch (G.S. 113-168 and 113-174). Allowable harvest amounts under the various licenses are set by the MFC through rule making or by proclamation authority given to the Fisheries Director. In the event the Fisheries Director decided to set recreational shellfish limits lower than the license requirement amounts, it would cause considerable confusion and dissatisfaction. In order to avoid that situation, it would be advisable to repeal G.S. 113-169.2 (i) and require shellfish licensing according to the same criteria as other commercial licenses.

The rule regarding recreational harvest of shellfish also contains the limits for the recreational harvest of blue crabs that makes finding this information difficult. The recreational harvest limits for blue crabs should be found in the section on crabs.

It has generally been unclear whether the rules allowed the taking and unloading of commercial quantities of shellfish from leases and franchises on weekends. There does not appear to be any reason to limit the quantity of shellfish taken by the lease or franchise holder from his private shellfish ground.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo

+ Current rules have generally been in place for a long period and the public is accustomed to current interpretation and enforcement
- The current interpretation and enforcement of these rules is incorrect
- Current rules on weekend harvest unnecessarily limit harvest from shellfish leases and franchises
- Statutory criteria for determining commercial/recreational use by harvest volume is archaic and different from all other species groups

B. Adopt the rule changes as proposed

+ Properly places recreational shellfish limits in rule
+ Removes unnecessary limitation on shellfish lease and franchise harvest
+ Properly classifies shellfish harvest gear as recreational or commercial
+ Limits harvest on weekends to recreational purposes as intended
- Statutory criteria for determining commercial/recreational use by harvest volume is archaic and different from all other species groups

C. Adopt the rule changes as proposed and recommend repeal of G.S. 113-169.2 (i) and base shellfish license requirements on harvest by a commercial fishing operation

+ Properly places recreational limits in rule
+ Removes unnecessary limitation on shellfish lease and franchise harvest
+ Properly classifies shellfish harvest gear as recreational or commercial
+ Limits harvest on weekends to recreational purposes as intended
+ Align shellfish license requirements for shellfish with other species
- Requires further changes to a statute that was recently amended

MANAGEMENT RECOMMENDATIONS

DMF/AC - Adopt the rule changes as proposed and recommend repeal of G.S. 113-169.2 (i) and base shellfish license requirements on harvest by a commercial fishing operation

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.1.4 REQUIRE ALL SHELLFISH TO BE TAGGED AT DEALER LEVEL

ISSUES

Marine Fisheries rule 15A NCAC 03K .0101 (d) (1) (2) (3) requires tagging of shellfish by the harvester when taken or possessed only from North Carolina coastal waters. This presents the following issues.

The Division of Marine Fisheries (DMF) cannot enforce misbranded or untagged shellfish if shellfish are from waters outside North Carolina because dealers can fraudulently claim that untagged or miss tagged shellfish are not from North Carolina waters. The dealer can use shellfish receipts from out-of-state to substantiate the claim.

By allowing DMF to enforce shellfish (out-of-state) tagging requirements at the dealer level, this would allow DMF and Shellfish Sanitation equal enforcement authority. Shellfish Sanitation already has the authority to inspect all shellfish at the dealer level.

BACKGROUND

Currently the Shellfish Sanitation Section of the NC Division of Environmental Health (DEH) has inspection authority on all shellfish sold and handled in North Carolina. This Section's Inspection Program is responsible for the permitting and inspection of shellfish processors statewide. Anyone who purchases shellfish from a harvester, shucks shellfish, repacks or re-labels shellfish must be permitted by the Inspection Program.

Shellfish processors are certified shellstock shippers and reshippers. All shellfish products offered for sale must be properly tagged or labeled by a certified dealer. North Carolina certifies both intrastate and interstate dealers. Intrastate dealers may only sell tagged product within North Carolina. Interstate dealers may sell anywhere in the country and are listed on the U.S. Food and Drug Administration (FDA) Interstate Certified Shellfish Shippers List.

In the event of a shellfish related illness, tags used in concert with records, provide for traceability of live shellfish from the final consumer back through every middle man, (retailer, wholesaler, carrier, and dealer) who handled the product, to a specific growing area, harvest date, and ultimately, if possible, the individual person who harvested the shellfish.

When an outbreak of disease attributable to shellfish occurs, health departments and other appropriate state and federal agencies must be able to determine the source of shellfish contamination to prevent any further outbreaks from this source. This can be done most effectively by using the records kept by the shellfish harvesters and dealers to trace a shellfish shipment, through all the various dealers who have handled it, back to its point of origin. Shellfish tags are the first important records concerning the origin of shellfish and the harvest area. Shellfish Sanitation does not have any criminal authority, just civil (embargo) authority to seize shellfish from the harvester or dealer.

The U.S. FDA along with Interstate Shellfish Sanitation Conference required North Carolina to comply with tagging requirements of the National Shellfish Sanitation Program. In 1993 the MFC established a rule requiring shellfish tagging by the shellfish harvester when shellfish was taken from North Carolina waters. North Carolina’s failure to comply with this requirement would have affected the State’s ability to ship interstate shellfish. Currently, the tagging requirements only apply to shellfish harvested from North Carolina waters when the harvester is in possession of a commercial amount or if the shellfish are to be sold by fishermen.

Enforcement of the current tagging requirements at the dealer level only applies if the shellfish that have been taken came from North Carolina waters. Shellfish from out-of-state do not have to meet harvester tag requirements by current rule. Bulk shipments of shellfish do not have to meet the harvester tag requirement for each bag of shellfish. Bulk shipments may have only one dealer tag attached to each lot. When shellfish are harvested from one harvest area on a single day, multiple containers may be utilized on a wrapped pallet and the unit tagged with a single tag.

CURRENT AUTHORITY

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0101 Prohibited Shellfish Areas/Activities

DISCUSSION

Attempts to enforce shellfish tagging requirement at the dealer location have been difficult at times due to the fact that tagging requirements only apply to shellfish taken from North Carolina waters. Situations have occurred in the past when officers have suspected illegal shellfish (harvest area issues or bag limit issues) that were not tagged. Quite often the dealer would indicate that the shellfish were not tagged because they were purchased out-of-state and produce a receipt from an out-of-state dealer. This situation hampers enforcement effort at the dealer.

Requiring tags for all shellfish would allow officers to better track and manage local shellfish as well as out-of-state shellfish that would be at the shellfish dealer. By allowing DMF to enforce tagging requirements on all shellfish at the dealer, this would close a loophole in the rules and allow DMF and Shellfish Sanitation to share responsibility for enforcing tagging requirements.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ Requires no regulatory changes
+ Allows fisherman and dealers to continue operating under current tagging requirement rules
+ Allows out-of-state shellfish to be untagged
- Unable to enforce shellfish bag limits at dealer level if source is from out-of-state
- Allow dealers to possibly possess shellfish from illegal harvesting

B. Amend current rule 03K .0101 to require tags on all shellfish including from out-of-state.
+ Would control illegal bags of untagged shellstock at dealer location
+ Better trace ability of shellfish to harvest area during a disease outbreak
+ Require dealers to have all shellfish tagged
+ Brings DMF and DEH rules in line with one another

C. Remove all shellfish tagging requirements
- No enforcement of shellfish tagging requirements
- Out of compliance with NSSP
- Would stop all interstate shellfish shipments

- Would not be able to track shellfish back to harvester or dealer after illness

MANAGEMENT RECOMMENDATIONS

DMF/AC - Amend current rule 03K .0101 to require tags on all shellfish including from out-of-state.

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.1.5 MECHANICAL HARVEST OF OTHER SHELLFISH

ISSUE

There are occasional requests by fishermen to use mechanical harvest methods on public bottom to take shellfish other than oysters, hard clams, rangia clams and scallops (other shellfish). Since the rules prohibiting the use of mechanical shellfish harvest gears are specific to the species (e.g. It is unlawful to use any dredge or other mechanical method to take *oysters* in areas designated in 03R .0108.), it could be interpreted that it is *lawful* to take conchs or whelks with dredges in the areas designated in 03R .0108. The only area where general mechanical shellfish harvesting gears are prohibited is in primary nursery areas.

BACKGROUND

Requests to use mechanical shellfish harvest gear have included conchs or whelks, arks, sunray venus clams, and even diamond back terrapins. Prior to a rule rewrite in 2004, similar concerns existed with harvest of rangia clams by mechanical gear due to requests by harvesters to use clam kicking trawls in areas not normally opened to that gear. The most recent requests were from fishermen seeking to take conchs with oyster dredges in areas that are closed to the use of that gear. Requests for this activity were made independently in the Central and Northeast districts.

DMF has consistently denied requests to use mechanical shellfish harvest gear outside of the areas where it is allowed to take oysters, hard clams, and bay scallops, respectively. However it is unclear whether current rules establish that authority.

In 2004 rule changes were made concerning the mechanical harvest of rangia clams in order to avoid a similar situation with that fishery. Rangia clams are typically harvested with oyster dredges in low salinity tributaries. Many of these areas were closed to the taking of oysters with mechanical gear (dredges) as a part of the 2001 Oyster Fishery Management Plan. In order to protect those shallow water shellfish habitats and provide for effective

enforcement, rangia clam harvest with mechanical gear was limited to the area open for the mechanical harvest of oysters and clams.

CURRENT AUTHORITY

North Carolina General Statutes
113-134. Rules.
113-182. Regulation 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.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03I .0101 Definitions
03K .0201 Open season and Possession Limit
03K .0204 Dredges/Mechanical Methods Prohibited
03K .0302 Mechanical Harvest Season
03K .0404 Dredges/Mechanical Methods Prohibited and Open Season
03K .0501 Bay Scallops – Seasons and Harvest Limits
03K .0503 Prohibited Bay Scallop Dredge

DISCUSSION

It is clearly the intent of the MFC and DMF to only allow the various mechanical harvest shellfish fisheries to operate in areas, at times and with gears that minimize impacts on the habitat and non-target species. A problem has occurred because in making these restrictions they have only been considered for existing mechanical harvest fisheries. MFC rules need to be broadened to limit the use of mechanical harvest gear for any species of shellfish to ensure proper habitat protection and to clarify shellfishing rules.
One way to structure a new rule to limit mechanical harvest of other shellfish would be to pattern it after the mechanical harvest rule for rangia clams. That rule states, in essence, that shellfishermen cannot use mechanical gear to take rangia clams anywhere mechanical methods for oystering and mechanical methods for clamming are prohibited and that the only circumstances allowing mechanical gear to be used for shellfishing is when, where and how it is allowed for oysters and clams. In order to encompass all existing mechanical harvest possibilities, the restrictions for bay scallops would need to be added. This option would allow some mechanical harvest of other shellfish and would allow time to develop rules for the specific fishery if warranted. It would also afford habitats the current level of protection during this process.

Another option would be to prohibit the taking of other shellfish with mechanical gear. This option would provide optimum protection to fish habitats and other species. It would also preclude any bycatch in mechanical harvest shellfisheries or development of mechanical harvest fisheries for new species.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo

+ Current rules have generally been in place for a long period and the public is accustomed to current interpretation and enforcement
- There is no guidance in current rules on the use of mechanical gear to take shellfish other than oysters, clams, scallops, and Rangia clams.
- It could be perceived that there are no restrictions on taking other shellfish with mechanical gear causing damage to fish habitat and other species.

B. Adopt a new rule limiting mechanical harvest of other shellfish to areas where mechanical harvest gear for shellfish is allowed in existing fisheries.

+ Uses current authority to protect all areas where mechanical harvest gear is not appropriate
+ Limits gears to those currently in use
+ Allows for some experimentation to develop new fisheries
- Does not provide maximum protection for all habitats and other species

C. Adopt a new rule to prohibit the taking of other shellfish with mechanical gear

+ Provides maximum protection for all habitats and other species
- Does not allow for experimentation or growth in the mechanical harvest of shellfish
- May make current bycatch illegal if markets develop

MANAGEMENT RECOMMENDATIONS

DMF/AC - Adopt a new rule limiting mechanical harvest of other shellfish to areas where mechanical harvest gear for shellfish is allowed in existing fisheries.

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.1.6 INCREASED DREDGING RESTRICTIONS IN PAMLICO SOUND BAYS

ISSUE

Adopt an additional management strategy concerning the harvest of oysters that restricts the mechanical harvest of oysters in the bays around Pamlico Sound to dredges weighing no more than 50 pounds with a toothbar no longer than 36 inches and that substantially limits harvest times, bag limit and season.

BACKGROUND

The NC Oyster FMP (2001) contained discussions concerning the effect of oyster harvesting and other fishing practices on oyster habitat but only considered the complete elimination of mechanical oyster harvesting in certain areas as a management strategy to reduce negative habitat effects (Section 9.1.1) (NCDENR 2001). The MFC Shellfish Committee undertook discussion during 2004 and 2005 at several meetings on the detrimental effects that mechanical oyster harvesting has on the resource in the shallow bays around Pamlico Sound and in particular the pronounced damage that these heavy dredges have on cultch planting sites that are numerous in these areas. The Committee's finding was that dredging oysters in the bays around Pamlico Sound should be substantially restricted as shown below.

Days of the week harvesting will be allowed:	Monday, Wednesday, Friday
Areas:	All Pamlico Sound bays outside hand harvest only areas
Means and methods:	Dredges weighing no more than 50 pounds and no more than 36 inches wide on the tooth bar
Time period:	Sunrise to 2:00 pm
Quantity:	6 bushels
Season:	Mid November – January 1
Special provision:	Dredges weighing more than 50 pounds may not be carried aboard a vessel harvesting in 50-pound dredge areas

CURRENT AUTHORITY

North Carolina General Statutes
G. S. 113-182.1. Fishery Management Plans.
G. S. 143B-289.52. Marine Fisheries Commission-powers and duties.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
3K .0201 Open season and possession limits
03I .0120 Possession or transportation limits

DISCUSSION

Early attempts at managing mechanical harvest of oysters in NC included depth limitations where oyster dredges could be used. The original statutory provision restricted dredging to waters eight feet in depth or greater but was later changed to waters greater than ten feet in depth. These restrictions primarily applied to Pamlico Sound and adjacent waters. The ten-foot depth restriction was in effect from 1895 to 1903. Currently, mechanical harvest of oysters is restricted by area, not water depth, and all coastal waters from Cedar Island to the South Carolina State line and behind the Outer Banks are closed to the mechanical harvest of oysters. At its July 2004 meeting, the MFC also approved the closure of 31,000 acres in the bays around Pamlico Sound and in Roanoke Sound to mechanical oyster harvesting. At this time, all waters open to the mechanical harvest of oysters allow the use of dredges up to 100 pounds with no tooth bar length restriction except in the Atlantic Ocean where there is no weight limit.

Further restrictions on mechanical oyster harvesting equipment historically came in the form of a prohibition on the use of power winches or winders to raise the catch. This restriction kept the size of the dredge dependent on the physical strength of the operators but was not a definitive size limit. Powerboats were limited to use of these "hand" dredges from 1931 until 1946. More recently, a hand dredge provision (no power winders) was in place for Roanoke Sound from 1967 through 1976.

North Carolina's 100 pound dredge weight limit was implemented in 1948 and has been in effect in all open dredging areas except the Atlantic Ocean since that time. This limit is fairly restrictive compared to other states. Maryland has a 200-pound dredge weight limit (36-42 inch toothbar) and Virginia's dredge weight limit is 150 pounds with a 50-inch toothbar. Both of these states have recently implemented hand dredge/scrape areas but these areas are within traditional hand tonging areas and were established to help oystermen make a decent catch of the low oyster population levels there; not to protect oyster habitat. Virginia has a 22-inch limit on the catch bar of scrapes. Maryland's only size limit is that the dredges be operated by hand.

During their deliberations, Shellfish Committee members received information on a 1952 report of investigations with oyster dredges weighing 100, 165 and 225 pounds (Chestnut 1952). Tooth bar length on the dredges was 46, 54 and 60 inches, respectively. When the speed of the tow vessel and length of the towline were held constant, the heavier dredges caught more oysters. However, it was also found that all dredges would catch oysters when the speed of the boat and the length of the towline were properly adjusted to meet the conditions. Oyster fishermen contend that lighter dredges harm the habitat because more tows are required to catch the same amount of oysters that could be caught in a few tows with a heavier dredge.

The Shellfish Committee also received a review of six reports published in scientific journals on the effects of oyster dredging on oyster habitat (Table 10.4). Four of the six reports investigated impacts on natural oyster habitat by comparing old (20-100 years) surveys of oyster habitat with current conditions. All four of the reports found considerable loss of

oyster habitat profile and reduction in areal extent. Three of the reports blamed the loss of habitat on oyster fishing, primarily dredging (Rothschild et al. 1994, McCormick-Ray 1998, Haven and Whitcomb 1983), while the fourth report surmised that natural and manmade factors other than oyster fishing were the reason for the loss or gain (Powell et al. 2001). None of the four studies measured the direct effects of oyster dredging on natural oyster habitat.

The other two studies did measure direct effect of oyster dredging on the oyster resource. A study conducted in NC measured the effect of heavy oyster dredging (all legal oysters removed) on cultch planting sites and found a 29% reduction in profile of planting sites due to the dredging. Unharvested sites had a natural profile reduction of only 1% (Lenihan and Peterson 1998). A Delaware Bay study measured the effect of oyster dredging on natural oyster populations but not on the habitat. The study found that moderate dredging of no more than four complete sweeps of natural oyster rocks per season has little long-term impact on the oyster population (Powell et al. 2001).

Proposed rules with supporting maps were developed to implement the proposed amendment and standing and regional committees reviewed the proposed amendment during November and December 2004. Public meetings were also held to receive public input on the proposal during January 2005. The amendment was supported by four of the six committees but was roundly criticized at all of the public meetings that were held in Morehead City, Bayboro and Swanquarter. The DMF position was to delay the proposed amendment for further study and to implement a predetermined mechanical harvest season for the Pamlico Sound bays in the interim. This season would be set at approximately six weeks under current harvest restrictions. The restricted season for the bays would be implemented under current proclamation authority and could be extended if subsequent sampling indicates significant harvestable oyster resources remaining in the areas. The comments received at the public meetings and the lack of data on the effect of lightweight dredges revealed that more data is needed before changing this management strategy. The MFC supported the DMF position at its June 2005 business meeting and action on the proposed amendment was delayed until field study comparing the effects of 50 and 100 pound dredges could be conducted.

Table 10.4. Review of the literature on the effects of oyster dredging.

AUTHOR	TITLE	PUB. & DATE	FINDINGS	METHODS
Rothschild, Ault, Goulletquer, Heral	Decline of the Chesapeake Bay oyster population: a century of habitat destruction and overfishing	Marine Ecology Progress Series 1994	50 % loss of oyster bar acreage associated with intense fishing pressure early in the century, stock overfishing, remaining habitat affected	Compared oyster habitat maps from 1907, 1980 and 1990 Did not measure direct effects of dredging
McCormick-Ray	Oyster Reefs in 1878 Seascape Pattern – Winslow Revisited	Estuaries 1998	Oyster beds fragmented, lost and reduced by human harvest. Unharvested oyster beds grow vertically about 0.5 meter per 100 years. The greater and more frequent the mechanical damage, the greater the time needed for recovery, repair and regrowth.	Compared oyster bed aerial and vertical dimensions and locations with 1878 data. Did not measure direct effects of dredging
Powell, Aston-Alcox, Banta, Bonner	Impact of Repeated dredging on a Delaware Bay Oyster Reef	Journal of Shellfish Research 2001	Over a long time, dredging may significantly influence oyster bed physiography and community structure. However, once the bed becomes a fished bed, this study suggests that moderate dredging that results in a yearly swept area of no more than four times the area of the bed is unlikely to result in significant further impact on the oyster population living there	Actual commercial dredging used to measure effects of intensity. Measurements on live:box ratios, condition index, Dermo infection, and oyster size frequency. 240,000 m^2 dredged on each site. Did not measure effects on oyster habitat.

Table 10.4. Continued

AUTHOR	TITLE	PUB. & DATE	FINDINGS	METHODS
Lenihan and Peterson	How Habitat Degradation through Fishery Disturbance Enhances Impacts of Hypoxia on Oyster Beds	Ecological Applications 1998	Commercial oyster dredging on restored oyster reefs reduced reef height by 29% when reefs were harvested until all marketable oysters were taken. Unharvested reefs shrank 1%.	Commercial oyster fisherman hired and dredged until marketable oysters declined to near zero. Starting oyster concentrations ranged between 420 – 610 individuals per m^2.
Powell, Song, Ellis, Wilson-Ormond	The Status and Long Term Trends of Oyster Reefs In Galveston Bay, Texas	Journal of Shellfish Research 1995	No evidence found to suggest that the oyster fishery contributed to reef attrition. Reefs deeper due to subsidence. Reefs lost and accreted due to natural and manmade factors.	1991 survey conducted and compared to 1970 survey. Compared fished and unfished reefs for areal extent and vertical relief. Did not measure direct effects of dredging
Haven and Whitcomb	The Origin and Extent of Oyster Reefs in the James River, VA	Journal of Shellfish Research 1983	Oyster harvesting scatters shells and oysters off of rocks and into areas where oysters may not grow. Oyster reefs in James River lost 6 inches of profile over 100 years. No major differences in oyster density between 1911 and 1981.	Observation and comparison with 1910 survey by Moore. Did not measure direct effects of dredging

A dredge comparison study was conducted during the late fall and winter 2005/06. Initially comparison between the two dredges types was to be conducted in areas regularly open to dredging and in control areas closed to dredging, prior to normal oyster harvest. However, due to delays in funding and restrictions on State travel due to gas shortages caused by Hurricane Katrina, this project was not initiated until after dredging activities had already started. Comparisons were conducted at five locations [Ditch Creek (Jones Bay), Mouth of Pamlico River (off Rose Bay), Abel Bay, Germantown Bay (Spencers Bay), Crab Hole (off Stumpy Point)]. Each gear type was used consecutively (gear type used first at each site was alternated) and all oysters caught were separated from the cultch and all material was retained until both gear types had been used. UNC Wilmington and DMF staff conducted the surveys with participation by a local commercial oysterman. The 50 and 100 pound dredges were loaned to the study by commercial fishermen. Modifications were made to DMF boats used in the study so that towing angles and retrieval and deployment of the dredges mimicked commercial operations.

Because of a scarcity of oysters at all locations, sample size was set at: all material collected while harvesting one bushel of live oysters regardless of size. While sampling was designed and intended to mimic normal dredge practices, there were a few modifications to the sampling to control for the area and duration of dredging. All samples were made using transects across the reef profile. When necessary, "test" tows were conducted before sampling to determine the setback (scope) for each dredge to insure the gear fished properly and to verify the gear was over the reef. Buoys were dropped at each end of the tow site to standardize tow length for that site. Tow lengths were not standardized between sites. Table 10.5 contains the summary data for each gear type and location.

The goal of this project was to evaluate the potential impact between the two gear types under normal conditions, because of the small sample size (volume of cultch per one bushel live oysters) cultch collections were adjusted both for one bushel of legal oysters (estimated at 300 per bushel) and for a 15 bushel limit (Table 10.5). It should be noted that although there was a size difference between tooth bar length on the 50 lb and 100 lb dredge (32 in. and 48 in. respectively) the two dredges covered nearly the same area to collect a single sample at Germantown Bay, mouth of Pamlico River and Ditch Creek. These results most likely indicate that oyster coverage was relatively uniform (although sparse) at each site and oyster catch rates were proportionally similar for the two gears at these sites (Figure 10.4). Oyster catch rates showed discernable differences at Abel Bay and Crab Hole with the 50 lb dredge covering more area to obtain the one-bushel sample. Although the 100 lb dredge consistently collected slightly more material at all sites, substantial differences were only detected for Abel Bay and Mouth of Pamlico River for the data adjusted for legal harvest (Figure 10.5).

Table 10.5. Oyster Dredge Comparison Chart

Site	Dredge Size	Depth	No. of Tows[1]	Bu. Cultch/Bu Oyster[2]	Bu. Cultch Adj. for Legal Bu.[3]	Bu. Cultch Adj. for Legal Harvest[4]
Ditch Creek	50	4.5	6	2.88	6.00	90.00
	100	4.5	3	3.00	6.43	96.43
Mouth Pamlico River	50	18.0	9	2.40	10.75	161.19
	100	18.0	6	4.00	18.46	276.92
Abel Bay	50	6.0	9	0.75	2.68	40.18
	100	6.0	4	1.50	6.92	103.85
Germantown Bay	50	X	6	1.50	3.17	47.54
	100	X	4	1.75	3.78	56.65
Crab Hole	50	X	8	4.25	12.50	187.50
	100	X	4	4.90	14.41	216.18

1. Number of tows needed to get one bushel of oysters
2. The bushel of oysters contains legal and sub-legal specimens
3. This value calculated by using number of legal oysters in sample compared to the average number of legal oysters (300) found in a bushel of oysters
4. This value calculated by multiplying the column Bushels Cultch Adjusted for Legal Bushel value by 15.

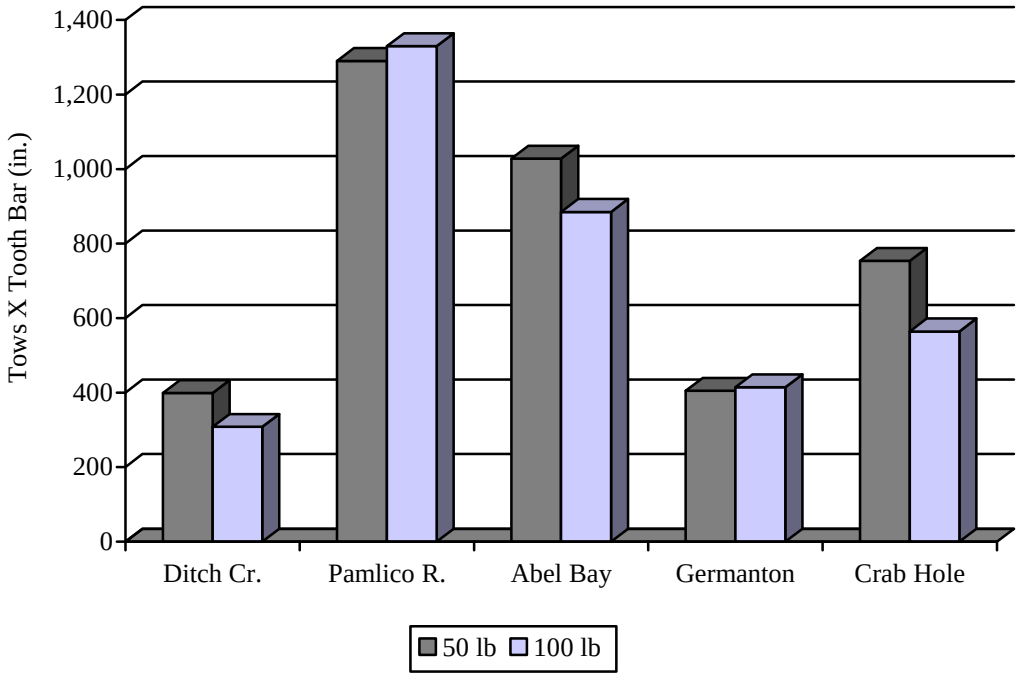
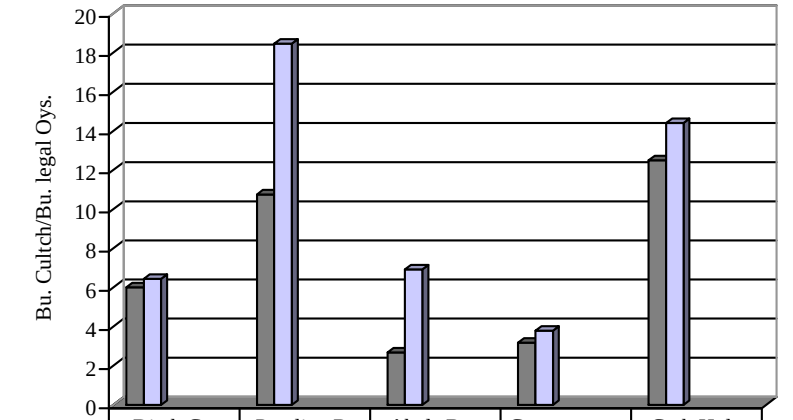


Figure 10.4. Area Dredged per Bushel of Legal Oysters



	Ditch Cr.	Pamlico R.	Abels Bay	Germantown	Crab Hole
50 lb.	6	10.75	2.68	3.17	12.5
100 lb.	6.43	18.46	6.92	3.78	14.41
Bottom	Firm	Soft	Hard	Firm	Firm
Cultch	Oyster	Oyster	Marl	Marl	Oyster
Type	Planted	Natural	Planted	Planted	Natural
Area	Bay	Sound	Bay	Bay	Sound

Figure 10.5. Bushels of cultch per bushel of legal oysters.

These data should be evaluated cautiously because they may not represent the actual performance of these gear types under normal conditions. Collections were made near the end of the oyster dredge season when density of oysters in the dredge areas was low. Nonetheless, these data are conservative and should give a worst-case scenario of the area covered and amount of cultch disturbed during oyster dredging operations.

The end result of the sampling did not give a clear indication of which gear would have the least impact on oyster habitat. The Shellfish Committee agreed with this assessment and recommended more sampling be conducted with the goal of having more conclusive data prior to the end of the FMP review.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo

+ Current rules restricting oyster dredging were put in place in October 2004 and the public is still adjusting to new hand harvest only areas
+ Available data does not give a clear picture of differences between 50 and 100 pound dredge effects
+ Oyster dredgers have serious concerns over the effects of using lighter dredges and their ability to profitably harvest oysters under the proposed restrictions
+ NC already has one of the most restrictive oyster dredge weight rules on the East and Gulf coasts
- Four MFC committees have endorsed the proposed mechanical harvest management changes
- Oyster dredging is viewed as a major cause of oyster habitat loss and failure to support further restrictions may be seen as detrimental, irrespective of the data

B. Collect more data comparing the effects of 50 and 100 pound dredges prior to making a decision on this issue

+ Further sampling may give a clear indication of differences between the two gears
- Past studies indicate that dredge operators may have more influence over catch efficiency and impacts than dredge weight
- Further sampling may not give a clear indication of differences between the two gears

C. Adopt the provisions as specified for the outer portions of Pamlico Sound bays except for the 50-pound dredge weight limit

+ Brings oyster catch limits with dredges more in line with hand harvest limits
+ Avoids possible enforcement problems of possessing illegal dredges while

traversing area with different weight limits on dredges

+ Reduces effort, and possibly habitat impacts, in the bays without having to address what appear to be minimal differences between the effects of 50 and 100 pound dredges
- Oyster dredgers have serious concerns over their ability to profitably harvest oysters under the proposed restrictions

D. Adopt the proposed provisions for dredging oysters in Pamlico Sound bays

+ The proposed provisions have been endorsed by four of six MFC committees
+ Reduces effort, and possibly habitat impacts, in the bays
- Past studies indicate that dredge operators may have more influence over catch efficiency and impacts than dredge weight
- Oyster dredgers have serious concerns over their ability to profitably harvest oysters under the proposed restrictions
- Currently no clear difference in dredge effects between 50 and 100 pound dredges

MANAGEMENT RECOMMENDATIONS

DMF - 10 bushel mechanical gear harvest limit in the Pamlico Sound bays with a six week (mid November through December) season (until triggers are established) [See recommendations in Mechanical vs. Hand Harvest Trip Limit Differences]
- Collect more data comparing the effects of 50 and 100 pound dredges prior to making a decision on this issue

AC - Collect more data comparing the effects of 50 and 100 pound dredges prior to making a decision on this issue

MFC Selected Management Strategy – Same as DMF

RESEARCH RECOMMENDATIONS

- Further studies on the impacts of oyster dredging on oyster habitat
- Further studies on the effects of dredge weight and size on habitat disturbance and oyster catches
- Determine a protocol and triggers for closures of oyster harvesting areas

10.1.7 CHANGE OF DATES FOR OYSTER SEASON

ISSUE

The Division has received requests from the public that the opening date for hand harvest of oysters be delayed until November. In addition the Division would like to propose changing the rule that allows oyster harvest until May 15 of each year.

BACKGROUND

The opening of oyster season has changed over the years based primarily on input from harvesters and the industry. The traditional opening of oyster season has been October 15 except that until 1987 hand harvest of oysters began on October 1 in the southern portion of the state. The current Marine Fisheries Commission (MFC) rule 15A NCAC 03K .0201 allows the Fisheries Director to open the season for any period of time from October 15 through May 15 and the traditional hand harvest season has been from October 15 through March 31 state wide since 1987, although Brunswick County has closed earlier in March depending on the availability of oysters.

The rule governing oyster harvest dates was changed in 1996 based on a recommendation by the Blue Ribbon Advisory Council on Oysters (BRACO) to allow harvest until May 15 if conditions warrant. The rationale was to allow harvest of oysters that would die of disease prior to the fall opening of the season. The closing date of oyster season under the Director's proclamation authority has not extended past March 31since this rule change was put in place due to the inability to predict disease effects at that time of year. The two parasites affecting NC oyster populations typically cause oyster mortalities beginning in late summer and spring/summer temperatures and rainfall play such an important role in determining mortality rates that it is impossible to predict disease impacts in March.

CURRENT AUTHORITY

North Carolina General Statutes
113-134. Rules.
113-182. Regulation of fishing and fisheries.
113-202. Legislative findings and declaration of policy; authority of Marine Fisheries Commission.
113-221.1. Proclamations; emergency review.
143B-289.52. Marine Fisheries Commission - powers and duties.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0201 Open Season and Possession Limit

DISCUSSION

The opening date for hand harvest of oysters is currently October 15 and has been on this date since 1987. Prior to that year the season opened on October 1 in the southern portion of the state. This delay was requested by harvesters and dealers who cited the poor quality of the oyster meats in early October. They felt that in most years the oysters would be "fatter" by the 15th of October to warrant harvest. The current request for delay until November 1 is based on the same rationale of allowing the oysters to become "fatter" prior to allowing

harvest. There is some biological basis for this observation because in the fall oysters shift their energy from production of eggs and sperm to production of other somatic tissues.

The opening date of oyster season has become traditional and is not changed frequently because there are many oyster roasts and festivals which are scheduled based on the October 15 opening date. The shift from the October 1 to October 15 opening resulted in confusion about scheduling of community events, thus, any change in the hand harvest opening date would need to be advertised at least two years prior to implementation to allow these events to adjust their scheduled times.

The effect on landings for the hand harvest sector of the fishery is unknown. Averaged over the last eleven oyster seasons 10.4% of the annual hand harvest is taken in the last two weeks of October, and has ranged from 4.4% to 15.0% probably dependent on weather conditions and closures. Many of the harvesters and dealers feel that the loss of harvest for these first two weeks would be regained during the remainder of the season.

This proposal could be instituted under the current authority of the Fisheries Director and no statute or rule changes are needed. This proposed change is an economic and social issue and would have little or no effect on the oyster resource.

The closing date for oyster season can be as late as May 15. The BRACO recommended this date to allow harvest of oysters that would die of Dermo or MSX prior to the opening of the fall season. A majority of the legal size oysters have been taken by the end of March and an extension of the season would reduce the availability of resource the following fall. In reality it is not possible to determine the level of fall oyster mortality in the spring as disease infestations are not fully manifested at that time. Experience has shown that mortality occurs in late September and early October and is difficult to predict even at that time. The May 15 closing date is not practical and does not serve its intended purpose. Therefore, it is proposed to change the rule back to the March 31 date to avoid confusion over oyster season closure and to align the rule with current management practices.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ Current opening date has been in effect since the 1987 and the public is accustomed to it.
+ No effect on landings
- Yield from oyster resource not reaching full potential

B. Delay opening until November 1
+ Potential increase in yield from fishery
- Potential negative effect on total landings
- Change of traditional date may cause confusion of public

C. Change existing rule to set the latest season closure date at March 31

+ Would codify current management strategy
+ Reduce confusion over current practice in proclamation and existing rule
+ No existing methods to predict Dermo mortality six months in advance
- Loss of flexibility in setting oyster season due to unforeseen circumstances

MANAGEMENT RECOMMENDATIONS

DMF/AC - Change existing rule to set the latest season closure date at March 31

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.2 PRIVATE CULTURE

10.2.1 SHELLFISH DEPURATION PLANTS

ISSUE

There are no shellfish depuration facilities located in North Carolina at this time. The establishment of depuration plants in this State could potentially increase shellfish production by utilizing shellfish from public bottom and private culture areas currently closed to harvesting due to pollution, however, there have been problems associated with depuration plants in those states that have allowed them.

BACKGROUND

Depuration is defined by the Interstate Shellfish Sanitation Conference (ISSC) as "the process of reducing the pathogenic organisms that may be present in shellstock by using a controlled aquatic environment as the treatment process". North Carolina Marine Fisheries rules define depuration as "purification or the removal of adulteration from live oysters, clams, and mussels by any natural or artificially controlled means". Division of Environmental Health (DEH) rules define depuration as "mechanical purification or the removal of adulteration from live shellstock by any artificially controlled means". The latter meaning best describes the use of the term depuration in this issue paper.

The issue originates from shellfish leaseholders whose leases are closed to harvest due to pollution and are seeking a means to maintain their shellfish production. Although the term "pollution" can carry various definitions, for the purposes of this issue paper, the term is restricted to fecal coliform bacteria contamination. Fecal coliform standards are used across the country to regulate shellfish growing waters and subsequent harvest of shellfish. The idea

of a state managed depuration facility has also surfaced occasionally but has not gathered much support.

New Jersey, Massachusetts, and Maine currently have at least one depuration facility located within their state. These facilities, both private and state-owned, are used in some cases to process only shellfish harvested from certain areas closed to harvesting and in other cases to process all shellfish harvested from open as well as closed harvest areas.

Currently, North Carolina fisheries rules only allow the harvest and depuration of shellfish from closed waters that would otherwise be destroyed in maintenance dredging operations. The provisions for depuration in the rule were developed in 1987 in response to a situation where shellfish were transported to a depuration plant in South Carolina. In the past, polluted shellfish threatened by maintenance dredging operations on public bottoms have been transplanted to open harvest areas by DMF for cleansing. Typically this has involved the harvest of shellfish (usually clams) from a navigation channel by DMF staff or commercial shellfishermen and relaying the product to an area that is closed until the shellfish meet consumption standards.

In lieu of mechanical shellfish depuration from public bottoms, North Carolina fisheries rules allow for the relaying of shellfish from polluted areas to private shellfish leases during a six week period each year, and the DMF also conducts a relay program each spring in the southern area of the state in which oystermen are paid to move oysters from polluted areas to open public bottom. These programs constitute the extent of shellfish cleansing operations in North Carolina.

CURRENT AUTHORITY

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0107 Depuration of Shellfish

North Carolina Environmental Health Rules (15A NCAC 18A)
.0700-.0713 Requirements for Operation of a Depuration Facility

National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish
Chapter XV. FDA Requirements for Operation of Depuration Plants

DISCUSSION

Several states currently utilize shellfish depuration plants. New Jersey has two depuration plants, a privately owned plant and one owned and operated by a Bay Cooperative. One New Jersey plant processes more clams than any other in the country, approximately 80 to 100,000 clams per day, and operates year round. On average, 85 clammers are regularly involved in harvesting for depuration, and despite receiving reduced prices for their clams due to high depuration costs, continue to participate in the program Sewage and water quality improvements have led to decreased use of these facilities, and officials indicate that associated monitoring of harvest and transport of shellfish imposes substantial financial and

manpower demands on the departments involved (Cali Alexander, NJ Dept. of Health, pers. comm. 2007).

Currently there are no depuration plants in the Southeastern section of the United States. Since the early 1990s, ten depuration plants in Florida have closed because these depuration plants were responsible for contracting with private U. S. Food and Drug Administration (USFDA) certified laboratories to process the substantial number of water and product samples required by state and federal rules (David Wiggins, USFDA, pers. comm. 2007). North Carolina DEH laboratories would not be available to process samples from a depuration plant due to current staffing and workload levels.

For a depuration plant to be feasible, a constant supply of polluted shellfish would be required, preferably from a single location. With the scattering of relatively small polluted areas throughout the coastal counties in North Carolina the oversight of transport of shellfish to the depuration plant would require a substantial commitment from North Carolina Marine Patrol. The varying concentrations of shellfish in each of these polluted areas may also make it difficult to ensure a constant supply of shellfish for plant operators. In addition, some closed areas are opened temporarily from time to time for public harvest when conditions permit. Such areas would not be included as source sites for depuration operations.

New Jersey officials indicated that the two depuration plants operating in their state require a single state inspector position for those plants. Current NCDEH workloads are such that an additional shellfish inspector position would be required if a depuration plant were established in the state.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo

+ No risk of contaminated shellfish reaching the market through incomplete depuration treatment or during transfer from harvest area to depuration plant
+ Concentrations of shellfish in polluted areas that may act as spawning stock not removed or disturbed
- Risk of contaminated shellfish reaching market directly from poaching in closed areas remains
- Allows no additional use of polluted areas for shellfish harvesting
- Fails to allow use of all available methods to purify contaminated shellfish

B. Change DMF rules to allow harvest of shellfish from polluted areas for processing in depuration facility.

+ Allows additional use of polluted areas for shellfish harvesting
+ Allows use of all available methods to purify contaminated shellfish

+ Reduces potential of contaminated shellfish reaching market from poaching in polluted areas
- Risk of contaminated shellfish reaching the market through incomplete depuration treatment or during transfer from harvest area to depuration plant
- Substantial increase in DMF enforcement and DEH inspection and sampling burdens
- Potential to disrupt / destroy shellfish spawning stocks in polluted areas

C. Amend DMF rules to allow harvest of shellfish from shellfish leases and franchises in polluted areas for processing in depuration facilities.
+ Allows continued use of shellfish leases and franchises in polluted areas for shellfish cultivation
+ Allows use of all available methods to purify contaminated shellfish
+ Reduces potential of contaminated shellfish reaching the market through incomplete depuration treatment or during transfer from harvest area to plant
- Substantial increase in DMF enforcement and DEH inspection and sampling burdens

D. Establish state-operated depuration facilities within the state Hatchery Program's three new hatcheries.
+ Removes the need to have a constant supply of product for depuration
+ Mitigates the state's failure to maintain water quality
- Likely to have a low cost:benefit ratio
- Removes the focus on maintaining and restoring water quality
- No such plans exist

MANAGEMENT RECOMMENDATIONS

DMF - Status quo.

AC - Amend DMF rules to allow harvest of shellfish from shellfish leases and franchises in polluted areas only from North Carolina for processing in depuration facilities.

MFC Selected Management Strategy – Same as DMF

RESEARCH RECOMMENDATIONS

Stock assessments of clams and oysters located within polluted areas would be beneficial in determining whether a depuration operation would be feasible and aid in sizing the facility. A thorough review of current depuration programs in other states would be advisable in fully researching the pros and cons associated with such programs. This would help educate all involved including regulators, industry, and harvesters, prior to initiating such a program here. Review of current DEH rules and possibly updating the rules may be necessary to fully reflect current technologies.

10.2.2 ALLOCATION OF AREAS FOR SHELLFISH LEASES

ISSUE

Investigation into the allocation of areas for shellfish leases to reduce protests by concerned citizens and relieve the burden placed on prospective leaseholders was raised as an issue by the Plan Development Team, Shellfish Advisory Committee, and through public comment. This issue was included in the 2001 FMP and is being updated for inclusion in the 2006 FMP review.

BACKGROUND

The granting of exclusive shellfishing rights to State residents is controversial in several coastal areas. Commercial fishers and some tourist industry/residential groups oppose shellfish leasing because they feel it infringes on their use of public trust resources. Shellfish lease applicants complain because they are often criticized in their own communities for selecting a site for a shellfish lease even though it meets the statutory standards.

Available records indicate that the selection of shellfish lease sites has always been the responsibility of the applicant. The site is then judged on several standards that have been fairly constant through the various statutes and amendments that have governed private shellfish cultivation. While there have been several provisions governing the size of individual site applications and the total area that could be held by an individual, family or corporation, there has never been a cap on the total acreage that could be leased in the state. There have also never been any areas set aside for individual shellfish leases although the idea has been discussed for over a decade.

There are currently two areas where the leasing of shellfish bottoms is indefinitely banned. The coastal waters of Brunswick County have been exempt from the shellfish lease statute since 1967. No history could be located on the events that preceded this action. The other area is an indefinite ban on shellfish lease issuance covering more than half of the eastern side of Core Sound and a portion of Pamlico Sound in Carteret County that was initiated in May of 1996 (Area A, Figure 10.6). In addition, the remainder of the Core Sound area, Western Core Sound, is permanently limited to only leasing bottoms that were currently under lease when the provisions of Session Law 2003-64 were implemented on June 30, 2003 (Area B, Figure 10.6).

Legislative action banning shellfish leases in Core Sound began after a seven acre lease was granted on the eastern side of the sound in 1993. The shellfish leases existing at the time were all on the western side of Core Sound and a petition with over 875 names was received to protest the granting of the lease near Core Banks because it interfered with fishing and recreational activities in the area.

The MFC approved the lease over the protest because it found that the application met the statutory standards. The General Assembly took action and imposed a two-year moratorium on the granting of shellfish leases for all of Core Sound that expired on July 1, 1995. The moratorium legislation included a mandate to study the leasing of shellfish bottoms in the

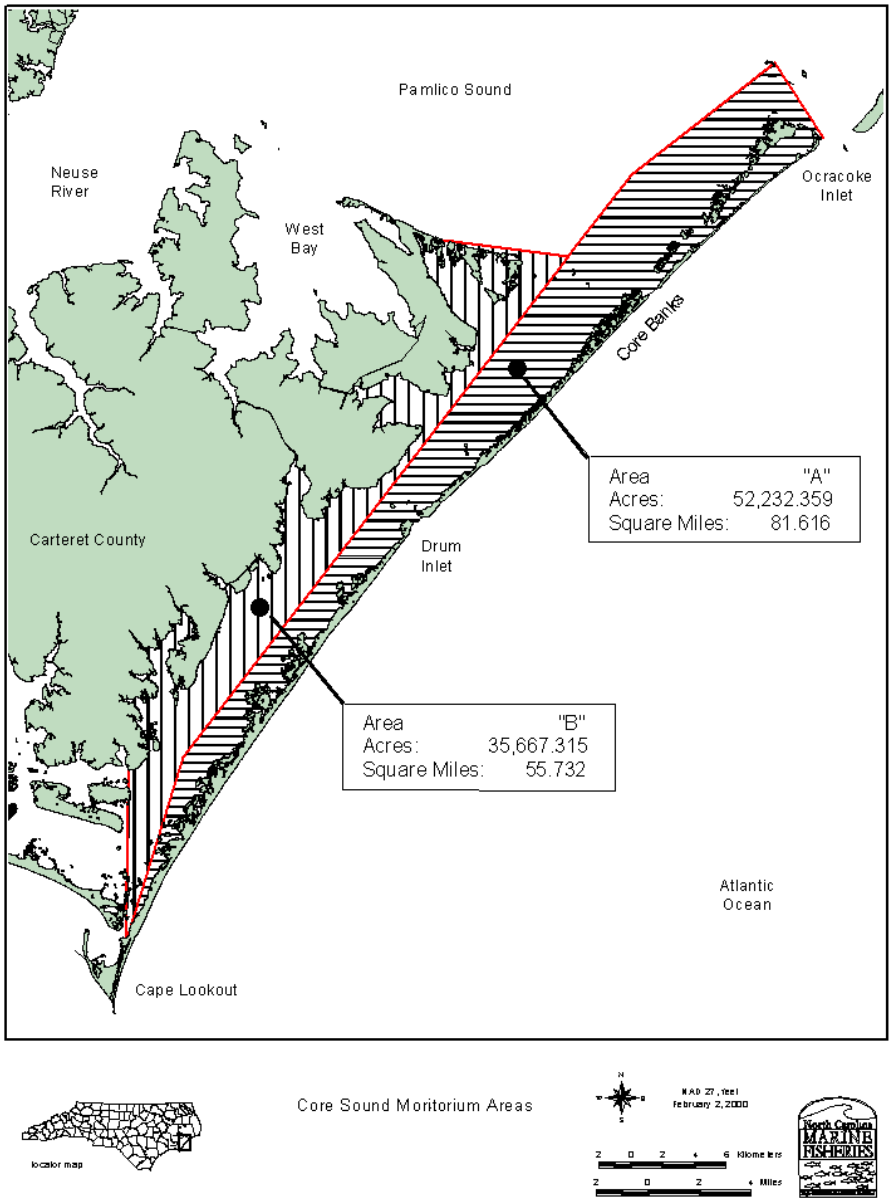


Figure 10.6. Core Sound shellfish lease indefinite moratorium Area A and restricted lease Area B.

area but no work was accomplished and no changes were made to shellfish lease rules or statutes. Immediately after the moratorium lifted, DMF received eight applications for lease areas also on the East Side of Core Sound. More than 400 protests were received on these applications and the legislation presently in place banning shellfish leases in the area was passed before any agency decision was made.

A similar situation existed in Hyde County in 1989 when a fishermen's organization was formed to fight the granting of four shellfish leases near Swan Quarter. The Hyde County group was unsuccessful at getting legislation passed banning shellfish leasing in that county. The towns of Pine Knoll Shores and Topsail Beach have also attempted to stop shellfish leases in nearby waters but have been unsuccessful.

On the other hand, the Onslow County Commissioners passed a resolution asking the Governor to take steps to increase private shellfish culture in their county but gave no specifics on amount or locations. The BRACO also encouraged expanded shellfish culture and more user-friendly means for obtaining shellfish leases but only identified large areas in Pamlico Sound as areas for pre-approved shellfish lease sites.

The 1988 version of the Oyster, Clam and Scallop Committee (now known as the Shellfish Committee) recommended that changes be made in the shellfish lease rules and statutes to allow for block leasing which consisted of one mile square lease blocks containing 64 ten-acre lease sites. They proposed that DMF select the areas using the existing criteria and that state surveyors survey the sites. They reasoned that lease blocks would reduce the improper marking problems commonly found on shellfish leases and encourage a community watch system that would eliminate the significant poaching problem. They did not offer guidance on how the leaseholders in these areas would be selected.

An attempt at solving the problems surrounding the selection of shellfish lease sites was conducted by the Shellfish Working Group – a subcommittee of the Joint Legislative Commission on Seafood and Aquaculture. The 15 member subcommittee met during the fall of 1996 under a legislative charge to study the shellfish lease program and consider specific issues; among them (1) establishment of a maximum percentage of available water body for leases and (2) preservation of areas used substantially by commercial and recreational fisherman. The group drafted a suite of recommendations concerning the shellfish lease program and made major recommendations concerning the selection of shellfish lease areas. The recommendations included the establishment of shellfish culture zones with pre-approved lease sites or areas within the zone. Corridors for access by the public would be maintained within the zones. A cap on shellfish leasing of an additional 2% of the State's shellfish waters was also recommended. The cap was to be applied to each of the 89 Shellfish Sanitation growing areas to avoid disproportionate growth in any local area.

The JLCSA accepted the recommendation on capping shellfish lease growth but failed to act on the shellfish culture zone proposal. The JLCSA also chose to recommend funding a human use mapping pilot project for Core Sound to answer the charge of preserving areas of substantial use by commercial and recreational fishermen. The human use mapping proposal was approved by the NC General Assembly but the cap on shellfish lease growth was not.

CURRENT AUTHORITY

North Carolina General Statutes
113-201. Authority of the Marine Fisheries Commission
113-202. New and renewal leases for shellfish cultivation
113-202.1. Water column leases for aquaculture
113-202.2. Water column leases for aquaculture for perpetual franchises

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03O .0201 Standards for Shellfish Bottom and Water Column Leases

DISCUSSION

The underlying fear expressed by commercial fishing interests opposing the issuance of shellfish leases was that the uncontrolled proliferation of lease sites would eventually deprive them of their livelihood by overtaking traditional fishing areas or by driving down shellfish prices because of an oversupply from culture operations or control of shellfish culture by large corporations. In the area of the most recent and intense outcry from the public, only 0.1% of the total acres of estuarine bottom were under lease at the time of the protests. Statewide only 0.18% of the waters with salinities suitable for oyster and clam growth are under shellfish lease or franchise and that percentage has not changed appreciably for twenty years. Even so, shellfish cultivation has increased substantially in other states like Florida and the best approach for managed growth appears to be careful identification of existing uses, shellfish resources and environmental parameters necessary for shellfish cultivation.

The human use mapping project funded by the legislature included a provision for a user coordination plan to be developed using the human use data, DMF shellfish mapping data and input from the public about problems and issues in the area. The results of the project appear to be a template for establishing managed shellfish lease growth in North Carolina. Areas of heavy public use are recognized and public preferences for resolution of the current leasing bans are identified. However, long-term data is needed for better trends analysis. The provision for a cap on lease acreage is also included.

The approach of identifying areas where leasing is not suitable rather than designating suitable shellfish lease sites is appealing from a management perspective because it continues to allow a degree of flexibility for shellfish lease applicants who have needs outside the statutory standards. It also removes the possibility that unsuitable sites could be identified by staff that could result in attempts at recourse by dissatisfied leaseholders.

Utilization of human use mapping and user coordination planning information would involve identification of incompatible fishing and recreational uses in the water body and establishment of a incompatible use threshold above which the sampling block would not be used for shellfish leasing. The legislation that spawned the idea for human use mapping also indicated an overall standard should be adopted that preserves areas of substantial use by commercial and recreational fishermen. So, a two tiered approach assessing individual use conflicts and cumulative conflicts could be developed. Since only one water body has been

sampled, data is not conclusive as to what the appropriate thresholds might be or whether use levels are comparable between different areas. Adoption of threshold levels of use should be accomplished through rule making if possible.

The MFC, AC and DMF were unanimous in their support of Management Option C. below in the 2001 FMP but no action for funding was taken by any legislative committees. In a related FMP matter, there was also no legislative support for the recommendations of the Core Sound Stakeholder Committee and the MFC in 2003 that sought to improve the public perception of all shellfish leases and operation of the Shellfish Lease Program. Instead, the General Assembly took action to severely limit the area that could be leased in Western Core Sound. The only available means for obtaining a shellfish lease in Western Core Sound, an area with excellent characteristics for shellfish culture, is to transfer or re-lease a site that was part of the 101.6 acres (0.3% of the area) under lease at the time of implementation of the 2003 session law.

There have only been twenty-two shellfish lease applications coast wide in the six year period since the 2001 FMP was adopted and these applications did not receive any formal protests leading to administrative hearings. Interest in shellfish leasing is low most likely due to generally poor prices for hard clams and oysters and uncertainty due to fear of Dermo related mortality in oysters.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ Provides maximum flexibility for selecting lease sites
+ Shellfish lease application activity has been low since 2001
+ Addresses fears of Core Sound area residents
- Highly contentious method for lease site selection
- Fails to address concerns expressed by the public
- Hinders shellfish culturists seeking to expand operations
- Data to address all issuance standards is not presently available
- Removes a shellfish area with high culture potential from consideration

B. Establish predetermined shellfish lease sites.
+ Removes site selection responsibility from applicants
+ Conducive to manageable boundaries and shared responsibility
+ Lease groups can be shaped to conform to standards
- Removes flexibility to address applicant's needs
- Requires a mechanism for selecting successful applicants (i.e. eligibility pool)
- Places burden for selecting successful sites on DMF
- Data to address all standards is not presently available

C. Utilize user coordination plans for shellfish lease issuance coast wide.

+ Gathers and utilizes data necessary to address issuance standards
+ Likely to retain some flexibility for applicants in site selection
+ Addresses water usage in a comprehensive manner
+ Addresses public concerns
- Much time and funding needed to expand to coast wide coverage
- Site selection responsibility remains on applicant

D. Propose repeal of the session laws restricting shellfish lease activity and utilize user coordination plans for shellfish lease issuance.
+ Gathers and utilizes data necessary to address issuance standards
+ Likely to retain some flexibility for applicants in site selection
+ Addresses water usage in a comprehensive manner
+ Addresses public concerns
+ Considers all public trust areas equally
- Much time and funding needed to expand coast wide
- Site selection responsibility remains on applicant
- Will likely result in more protests

E. Enact a prohibition on issuance of new shellfish leases in all NC coastal fishing waters.
+ Removes a contentious program
+ Maximizes public use of public trust waters
+ Addresses concerns of some fishing groups and municipalities
- May eliminate a traditional fishing occupation
- Eliminates potential growth of a seafood industry
- May create a high demand for existing shellfish leases

MANAGEMENT RECOMMENDATIONS

DMF/AC - Utilize user coordination plans for shellfish lease issuance coast wide

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.2.3 TECHNICAL SUPPORT FOR SHELLFISH LEASEHOLDERS

ISSUE

Expansion of governmental efforts to develop methods and support services for shellfish leases and franchises could lead to more success in the state's shellfish culture industry and in increased associated public benefits, but also, to reduced funding available for other facets of shellfish resource restoration and harvest management.

BACKGROUND

In North Carolina, the stock status of the hard clam (*Mercenaria mercenaria*) is "unknown," as little data on the species have been collected in North Carolina (http://www.ncdmf.net/stocks/hardclam.htm). Commercial landings, however, are below the ten-year average. Growth rates and survival are highly dependent on temperature, food availability and genetic disposition.

The eastern oyster (*Crassostrea virginica*), on the other hand, is listed as a fishery of "concern" (http://www.ncdmf.net/stocks/oyster.htm). There has been a long-term decline in population size caused by over harvesting, habitat disturbances and pollution. More recently, populations have been stressed by protozoan infections. Harmless to humans, Dermo (*Perkinsus marinus*) wears down oysters over many months, killing them before they reach a harvestable size. There also have been isolated incidents of MSX — another protozoa that typically thrives in cooler waters north of North Carolina. 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 (Frankenberg 1995).

Shellfish aquaculture assists in reducing harvest pressure on wild stocks by providing supplementary product for market demand, in addition to adding to the spawning stock. Oysters grown on the bottom, or those that settle on planted cultch, may not all be harvested on stocked leases, thus allowing some potential additions to the spawning stock. Research suggests that shellfish aquaculture can establish large shellfish populations sustainably (Shumway et al. 2003) and restore the ecological role of shellfish beds, particularly of oyster reefs. Through planting of cultch or seed shellfish, most types of shellfish culture provide excellent habitat and attract a diverse population of juvenile fish, crustaceans, fouling organisms and forage species (Coen et al. 1999, Ferraro and Cole 2001, Obeirn et al. 2004). Oyster reef structures can even act as a stabilizing force in the sediments of an estuary (Piazza et al. 2005). Additionally, shellfish stocked for the purpose of culture, or newly settled oysters following cultch plantings, provide water-filtering capacity until harvest, improving water quality through removal of suspended solids and nutrients (Rice 2001).

Recognizing the potential ecological benefits of shellfish aquaculture, the North Carolina Division of Marine Fisheries (DMF) grants shellfish cultivation leases (bottom and water-column), but only if the public interest will benefit from issuance of the lease. Some of the public have protested expansion of shellfish lease acreage in North Carolina coastal waters citing the unfettered use of public trust lands and waters as one foundation for their opposition. The increased use of suitable, but currently unproductive, bottom areas underlying coastal fishing waters for the production of shellfish often results in economic and ecosystem benefits that counterbalance potential loss of public use.

Shellfish bottom leaseholders must produce and market 10 bushels of shellfish per acre per year and plant either 25 bushels of seed shellfish per acre per year or 50 bushels of cultch per acre per year. A combination of cultch and seed shellfish, where totals are at least 100 percent, is also allowable. Water-column leaseholders must produce and market 40 bushels

of shellfish per acre per year or plant 100 bushels of cultch or seed shellfish per acre per year to meet the minimum commercial production requirement. If a leaseholder fails to maintain a planting effort of cultch or seed shellfish, the lease is terminated at time of renewal because the holder of private shellfish rights is depriving the public access to public trust resources in navigable waters. The production and marketing rates are averaged over the most recent three-year period after January 1st following the second anniversary of initial bottom leases and franchises and throughout the terms of renewal leases. For water-column leases, these production and marketing rates are averaged over the first five-year period for initial leases and over the most recent three-year period for renewal leases. Three-year averages for production and marketing rates are computed irrespective of transfer of the shellfish lease or franchise.

In 2005, there were 268 leases for a total of 1,906 acres under cultivation. From these leases, 7,144 bushels of clams (11% of total landed) and 10,000 bushels of oysters (16% of total landed) were produced, a farm gate value of $1 million (Losordo et al. 2006). Currently, there are 257 leases in the state for a total of 1,845 acres under cultivation, so 2006 reflects a decline in leased bottom. The breakdown by county is as follows: Carteret - 99, Dare - 5, Hyde - 20, New Hanover - 3, Onslow - 83, Pamlico - 10, and Pender - 37. In 2006, there were five new bottom-lease applications and one water-column amendment application (i.e., applicant requesting use of the water column above a bottom lease for floating trays, etc.). Of those applications, one was approved – the water-column amendment application. One application was withdrawn, and three applications are still in the application process. Four leases were terminated. One termination was for failure to meet production requirements, and three leaseholders voluntarily gave up their leases. Their reasons are unknown, but most probably stem from a lack of profitability. Termination of shellfish leases and franchises at time of renewal for failure to produce and market shellfish, for failure to maintain a planting effort of cultch or seed shellfish, or for lack of profitability means that the public interest does not benefit from what was ten years of constrained use of submerged public trust lands.

The BRACO investigation of other states showed North Carolina does not support adequately private shellfish cultivation (Frankenburg 1995). State Fishery Management Plans (FMPs) for oysters and hard clams were adopted in August, 2001, by the North Carolina Marine Fisheries Commission (MFC). Recommendations regarding development of technical support services for shellfish leaseholders currently are being implemented. The DMF presently offers site evaluation services and provides assorted information on grow-out techniques to shellfish lease applicants. Oyster growers can obtain wild stock via relay from polluted areas or seed management areas. During the summer months, the DMF "plants" shell and rock (called cultch) to provide additional habitat for larval oysters and clams. The DMF conducts annual spatfall sampling on all (cultch) planted sites for three years after construction, thus providing some information as far as actual larval availability and timing of larval settlement for leaseholder use. The DMF also monitors wild oysters for prevalence of some diseases.

CURRENT AUTHORITY

North Carolina General Statutes

106-756. Aquaculture Development Act.
113-201. Legislative findings and declaration of policy; authority of Marine Fisheries Commission.
113-203. Transplanting of oysters and clams.
113-204. Propagation of shellfish.
113-206. Chart of grants, leases and fishery rights; overlapping leases and rights; contest or condemnation of claims; damages for taking of property.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0103 Shellfish or Seed Management Areas
03K .0104 Permits for Planting Shellfish from Prohibited/Polluted Areas
03O .0201 Standards for Shellfish Bottom and Water Column Leases
03O .0208 Cancellation

DISCUSSION

Shellfish culture is a successful industry in other parts of the United States and the world. Success stems largely from governmental efforts to develop methods and support services for growers. As an example, disease diagnosis, spatfall prediction and site evaluation are among the many services offered to the shellfish aquaculture industry by the New Brunswick (Canada) provincial government (Department of Agriculture, Fisheries and Aquaculture 2006). The objective of these activities is to optimize the performance of New Brunswick's aquaculture industry in order to make it more competitive in national and international markets.

Of all support services, seed supply is the most important to successful shellfish production. Some New England states, such as Maine and Massachusetts, enhance clam production in public areas. The local communities in those states plant seed clams and manage the clam beds for subsequent public harvests (McHugh 2001). Louisiana and Connecticut assist private oyster growers by planting cultch in areas of high larvae abundance to collect seed, thus creating seed management areas (Dugas 1988, MacKenzie 1996). The cultch, with spat attached, is then harvested and moved to better areas for grow-out. These methods, however, require substantial capital investments on the part of state governments and usage of large areas of public bottom. North Carolina shellfish cultivation leaseholders are limited in the methods they can utilize to stock their leases with shellfish, particularly oysters. Oyster growers can either obtain wild stock from seed management or polluted areas, or distribute cultch for natural spat settlement.

In North Carolina, the DMF manages several Seed Oyster Management Areas (SOMAs) - a mix of naturally-occurring and planted sites - all of which are available for relay to leases. There are currently four natural oyster seed areas and two planted seed areas available for relay to leases. Some areas were enhanced in the early to mid 1990's. The Wanchese/Roanoke Island SOMA received several thousand bushels of cultch material. Between 2002 and 2004, the Bay River SOMA received approximately one thousand bushels of cultch material. Cultch planting on SOMAs, however, has been limited in recent years. Future efforts currently depend on SOMA use and requests. Oyster growers themselves

cannot plant cultch in designated seeding areas for later relay to leases. Large-scale, bottom-lease oyster farmers, therefore, primarily plant cultch on their own leases and hope for a good natural spat set. Oyster spat sets, though, vary over space and time and there is no predictability for the best setting areas.

The North Carolina oyster relay program consists of harvesting oysters from areas in which they would routinely be destroyed by normal state or federal channel dredging activities or from polluted waters. Leaseholders who wish to participate in the relay program must obtain a relay permit in which the time, area and method of harvest are determined. For oyster relay, a six-week period between the season closure and June 30th is selected by the DMF Director. The open and closure of private leases where relayed oysters have been stocked also is accomplished by the DMF Director via proclamation upon recommendation from the Division of Environmental Health.

Currently, there are 214 shellfish leaseholders that utilize bottom culture, of which 55 participate in the relay program. These 55 growers mainly reside in the central and southern coasts. The majority (44) relayed only oysters with their permit, and another 10 relayed both clams and oysters. The remaining grower relayed only clams. Relaying oysters and clams allows for a relatively inexpensive means of providing shellfish for future harvest. Survival is not guaranteed with this method, but for oysters specifically, relaying offers some advantages over intensive culture and natural recruitment on planted cultch. Intensive oyster culture requires greater levels of time and labor, while cultch planting for natural recruitment is highly variable with season and location. Further, relayed shellfish are stocked on a lease at a larger size, allowing for a greater chance for survival. Data are needed to assess survival and productivity of relayed oysters compared to natural recruitment on planted cultch.

During the summer months, the DMF plants cultch (oyster shell, clam shell or marl) to provide additional fishing opportunities for both commercial and recreational fishermen. Large vessels transport the cultch out to a designated site, and the shells are either dumped off with a front-end loader or sprayed off with a high-powered hose. Approximately 300,000 bushels of cultch material are planted annually. Newly created plant sites are monitored for spatfall in January/February for three years after creation, but beyond this and some spatfall research performed in the late 1980's and early 1990's, the DMF has conducted limited studies as far as actual larval availability and timing of larval settlement for leaseholder use. Due to efforts to maximize cultch planting before and during the peak spat-set, the DMF staff is limited to conducting spatfall studies in "real time." The DMF continues to modify their procedures to attempt to complete as much cultch planting as possible, while simultaneously investigating timing of oyster spatfall, larval dispersal and transport.

Understandably, larval monitoring can be time consuming and/or relatively expensive for the returns of a small industry, like that of North Carolina, but expansion of a monitoring program could be helpful not just to industry but to ongoing state oyster restoration efforts. If better larval abundance and transport information was available, it could increase the effectiveness of existing state cultch planting programs by determining the best timing and locations for cultch plants. In France, the oyster industry is supported by government monitoring of larval shellfish abundance, but monitoring is done collaboratively with

industry (Comité national de la Conchyliculture 2006). The information is shared to determine the best areas for collecting oyster seed.

While the majority of efforts to cultivate shellfish involves little more than transplanting small clams and oysters from one area to another where they would grow better, be better protected from predators and disease, or be easier to harvest, the most intensive culture methods involve spawning shellfish in a hatchery. Animals are acclimated from hatchery water to field conditions in this system and are distributed for restoration, resource enhancement and commercial growers. For oysters specifically, the eyed-larvae (those ready for settling out on substrate) are allowed to set on cultch at the growers' sites, called remote setting. The resulting seeded cultch is planted on large bottom areas for grow-out.

The Washington state oyster culture industry relies heavily on hatcheries to produce eyed-larvae because water temperatures in the area rarely reach levels high enough to induce spawning of the non-native oysters cultured there (Chew 2006). Largely due to reliable supply and low prices of eyed larvae, approximately 80 to 90 percent of the oyster seeds for the west coast came from large-scale hatcheries by as early as the 1980's. Washington state is now the leading producer of farmed bivalve shellfish in the United States. Estimated production of farm-raised oysters in 2000 was 77 million pounds, a value of $57,750,000 (Puget Sound Action Team 2003).

In North Carolina, 19 people, representing 23 shellfish leases, purchase seed from out of state, as no state shellfish hatchery currently exists. Sixteen purchased clam seed. One purchased oyster seed, and two purchased both oyster seed and clam seed. The North Carolina Aquariums, with assistance from the DMF and an interagency Oyster Hatchery Planning Advisory Team, have developed a plan to establish an integrated system of shellfish hatcheries and remote-setting sites (http://www.ncoysters.net/docs/NCOHP%20Final%20Report.pdf). Potential state shellfish hatcheries could provide the necessary seed stock not only for shellfish rehabilitations and oyster sanctuaries, but also, for shellfish aquaculture. A full-scale, production hatchery will allow for early life stage development. Larvae from the hatchery will set at remote sites, which could include shellfish growers' lease sites. This process is most commonly done for setting oyster larvae on shells, tubes or other cultch material. When the program is fully functional, it will produce five billion eyed oyster larvae and 225,000 bushels of seeded shells per year for DMF restoration efforts. Research hatchery facilities will provide the technology and test-bed for work with shellfish leaseholders and aquaculture professionals on scientific issues confronting the shellfish culture industry. Through practical education and training, and in conjunction with the community college system, a demonstration hatchery could help develop a highly-skilled shellfish aquaculture workforce. A research hatchery also will work towards development of disease-resistant or fast-growing strains of shellfish and to establish brood stock development programs.

Disease remains one of the most serious problems in both cultured and wild oyster populations and has limited production severely. The methods by which oysters are cultured make it very difficult to treat them with drugs in much of the production cycle, and there is a scarcity of drugs that can be used legally or that leave the oyster suitable for human

consumption. Larger (and longer-living) oysters could have a genetic makeup that is resistant to some diseases, which scientists can use for selective breeding. While generating genetic lines is a long-term goal, significant gains can be seen in just one generation - 10 to 20 percent drop in mortality rate (Allen, Jr., et al. 1993). Researchers in Virginia, Maryland, Delaware and New Jersey have been working on this theory for years - some started as early as the 1960's - and have generated a half-dozen genetic lines that show a better survival rate than the local eastern oysters (http://www.vims.edu/abc/ResearchProjects.html). They have had trouble generating enough oysters to supply the aquaculture industry, however, so oysters are available for purchase for research purposes only. Thus, an ideal setup for North Carolina would include a smaller research hatchery to develop brood stock and a production hatchery that could then make them available to those involved in aquaculture. The initial use of these oysters would be in aquaculture because there is unresolved debate on whether selectively bred, disease-resistant oysters can pass effectively those traits on to wild populations (Allen, Jr., et al. 2003, Angione 2005). The Virginia Institute of Marine Science's (VIMS) Aquaculture Genetics and Breeding Technology Center does improve brood stocks of hard clams and make these specialized brood stocks available to commercial hatcheries (http://www.vims.edu/abc/ClamBreed.html).

In addition to operating the state shellfish culture hatchery and research facilities, the VIMS staff provides some disease diagnostic services to growers. Routine disease assessments of cultured oysters could suggest crop harvest dates in advance of possible mass mortalities from a diagnosed infection of MSX or Dermo. The DMF currently has an oyster disease monitoring program for Dermo, but no disease diagnostic services are available to individual operators. Quebec has a unique veterinary service for operators from a suite of aquaculture industries, not just shellfish (Fisheries and Oceans Canada 2002). The program includes mechanisms for local veterinarians to provide services on a subsidized, fee-for-service basis. Nonetheless, veterinary services to individual operators are constrained by the lack of dedicated field staff. Further, modern facilities for fish and shellfish disease diagnosis and research come at an extensive price, as they include scanning and transmission electron microscopes with an X-ray micro-analysis suite for biological and environmental samples.

Within the United States, the Marine Program of Cornell Cooperative Extension assists in aquatic disease diagnosis and referral (Rivara 1997). Within North Carolina, researchers at the North Carolina State University School of Veterinary Medicine, through a 2006 North Carolina Fishery Resource Grant (Noga and Newman, unpubl. data), have discovered that eastern oysters have an antibiotic in their tissues that can kill many pathogens. If they can succeed in accurately and reproducibly measuring this antibiotic in oyster blood (hemolymph), and if they can show that there is evidence that it can measure health status in oysters, this would provide justification for further research to acquire the needed information (i.e., biology) and technology (test format) that would give producers and others rapid, useful information on the health status of their oyster stocks.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo

+ No reduction in funding available for other facets of shellfish resource restoration and harvest management
- No additional provision of necessary resources for traditional shellfish culture
- Majority of hard clam and oyster landings will continue to be wild-caught

B. Increase number and/or geographic distribution of SOMAs

+ Provides necessary seed supply for traditional oyster culture
+ Temporarily creates reef habitat and ecological services
- Reduces some funding available for other facets of oyster resource restoration and harvest management
- Dedicated use of a portion of the resource to one user group is opposed by some other stakeholder groups

C. Allow oyster growers to plant cultch in SOMAs for relay to private leases

+ Provides necessary seed supply for traditional oyster culture
+ Temporarily creates reef habitat and ecological services
+ Reduces state cultch planting personnel and financial burdens
- Requires state training of leaseholders on proper cultch planting and removal techniques and spatfall monitoring
- Mechanism needed to designate proprietary use of portions of SOMA's for individual leaseholders

D. Expand state oyster larval monitoring services to annual spatfall assessment for all plant sites

+ Helps oyster industry with spat collection and production
+ Provides data on larval availability and timing of larval settlement for other facets of oyster resource restoration and harvest management
- Larval monitoring is time consuming and relatively expensive for the returns of a small industry

E. Develop public/private oyster larvae monitoring program

+ Helps oyster industry with spat collection and production
+ Provides data on larval availability and timing of larval settlement for other facets of oyster resource restoration and harvest management
+ Shares cost of the program with users of the program
- Requires research to develop monitoring protocol and mechanism for best information-sharing, in addition to training of leaseholders

F. Support construction of an integrated system of shellfish hatcheries and remote-setting sites

+ Provides some of the necessary seed stock for shellfish aquaculture
+ Produces seed for existing NCDMF shellfish restoration and oyster sanctuary programs

+ Establishes an extension component to educate and train growers
+ Promotes and links existing shellfish restoration and aquaculture educational efforts by multiple agencies
+ Creates research, along with a brood stock-development program, and growing of disease-resistant lines
- Primary allocation of seed would be for existing DMF shellfish restoration and oyster sanctuary programs
- Potentially reduces some funding available for other facets of shellfish resource restoration and harvest management
- State competition with private enterprise

G. Develop a subsidized, fee-for-service disease diagnosis program
+ Routine disease assessments of cultured oysters could suggest crop harvest dates in advance of mass mortalities
+ Permits DMF use of bivalves as indicators of ecosystem health on a more comprehensive, coast-wide scale
+ Allows some state recoup of program costs
+ Potential for expansion of veterinary service for operators from a suite of aquaculture industries, not just shellfish
- Services to individual operators could constrain dedicated field staff for shellfish resource restoration and harvest management
- Facilities come at an extensive price, requiring elaborate microscopy equipment

MANAGEMENT RECOMMENDATIONS

DMF - Support construction of an integrated system of shellfish hatcheries and remote-setting sites
- Develop a subsidized, fee-for-service disease diagnosis program

AC - Support construction of an integrated system of shellfish hatcheries and remote-setting sites
- Support public/private oyster larvae monitoring programs
- Develop a subsidized, fee-for-service disease diagnosis program

MFC Selected Management Strategy – Same AC except dropped public from oyster larvae monitoring programs

RESEARCH RECOMMENDATIONS

- Explore new technologies for off-bottom culturing methods
- Further develop new types of biomarkers that can be used to select more effectively for disease-resistant genetic stock
- Develop disease-resistant or fast-growing strains of shellfish
- Establish a brood stock (hard clam and oyster) development program
- Develop methods to determine health of shellfish stocks to various diseases

- Assess survival and productivity of relayed oysters vs. natural recruitment on planted cultch
- Investigate timing of oyster spatfall, larval dispersal and transport
- Determine the hydrodynamics of the areas for restoration and culture activities

10.2.4 SEED OYSTER MANAGEMENT AREAS

ISSUE

Seed oyster management areas are designated through an antiquated process and their existence is currently documented only in the minutes of the Marine Fisheries Commission creating administrative and public awareness problems. Some of the existing seed oyster management areas are poorly utilized and several suffer from encroachment of polluted area harvest closures limiting their use for seed oyster transplanting. A thorough review of the administration and use of seed oyster management areas is necessary.

BACKGROUND

The use of natural and managed oyster producing areas as a source of seed for oyster culturists has been a major resource for the oyster industry in many states including Connecticut, New Jersey, Delaware, Virginia, and Louisiana. The oyster areas set aside as a source for seed typically (but not always) contain oyster stocks that exhibit growth or survival characteristics that make them unsuitable for production of marketable oysters. These oysters can be transplanted to more suitable environmental and habitat conditions and produce a marketable product. Transplanting of seed oysters is usually done by holders of private shellfish rights but can also be accomplished by government agencies on public bottoms.

Seed oysters are normally stunted, slow growth or coon oyster resources found in areas near the limits of environmental tolerances for the species. When removed from overcrowding and salinity stresses, these oysters change their growth patterns and become harvestable in a period ranging from 10-12 months to three years depending on source and growout area conditions. The importance of seed oyster areas has diminished as relaying of polluted oyster stocks increased due to proliferation of closed harvest areas and a much shorter time to market of from six weeks to 4 or 5 months. However, sources of seed continue to be a concern in areas where permanent harvest closures are not abundant.

The current NC General Statute authorizing designation of seed oyster areas and adoption of permitting requirements for their use was ratified in 1921 and requires initiation by a recommendation from the county commissioners of the affected area. The concept of having county commissioners act on fisheries issues has become outdated as evidenced by the fact that local fishing laws were abolished in the General Statutes in 1965. During the most recent seed oyster area designation process, the Pamlico County Commissioners were quite surprised that they were involved in deciding on fisheries issues and expressed concern because of lack of expertise on the issue. DMF staff researched the latest proposed seed

oyster area as part of a recommendation from the Blue Ribbon Advisory Council on Oysters and presented the proposal to designate an area in Bay River to the Pamlico County Commissioners. The issue to designate the area did not arise with the county commissioners.

If the county commissioners role in designating seed oyster areas were repealed, the MFC would have sole authority over shellfishing issues. G.S. 113-201 already gives them broad authority limited only by the provisions on seed oyster areas in 113-203. The public also already has a mechanism that could be used for requesting the designation of seed oyster areas in 15A NCAC 03P section .0300 which specifies the steps for submitting a petition for rulemaking. The rulemaking process includes many occasions for public input and would include input from county commissioners. Placing seed oyster areas in rule would also increase public awareness.

During the period 1991-2005 there were 621 reports filed by shellfish growers holding permits to transplant oysters from seed oyster management areas. They reported transplanting 87,370 bushels of seed oysters during that 15-year period. On average, 41 permit holders each reported transplanting 141 bushels of seed oysters annually (DMF Resource Enhancement Section). Transplanting activities are allowed from open harvest areas from April 1 through September 30 each year. Most of the transplanting activity occurs in the Pender County seed oyster areas.

There are currently six designated seed oyster management areas in North Carolina: two in Dare County at the southern end of Roanoke Island, one in Pamlico County in Bay River, one in White Oak River that occurs in Carteret and Onslow counties, and two in Pender County in and near Virginia Creek. The seed oyster areas in Virginia Creek and White Oak River have been impacted by pollution closures. Pollution closures limit the time allowed for transplanting since relay from polluted areas can only occur during a six-week period following the closure of oyster season.

CURRENT AUTHORITY

North Carolina General Statutes
113-134. Rules.
113-182. Regulation of fishing and fisheries. Legislative findings and declaration of policy; authority of Marine Fisheries Commission.
113-203. Transplanting of oysters and clams
143B-289.52. Marine Fisheries Commission – powers and duties.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0103 Shellfish or Seed Management Areas

DISCUSSION

Regionally oyster markets have been soft for an extended period making investment in oyster culture unappealing even though supplies are at record lows. Even though local and seasonal markets can still be viable, the threat of losses to disease and the inability to market product

due to pollution closures further deters oyster culture activity. Additionally, transplanting seed oysters is hard work especially since most NC shellfish growers must rely on manual labor and seed mortality during warm weather transplanting can be high. All of these factors contribute to modest use of the existing seed oyster management areas. On the other hand, the most highly used seed oyster areas are those in close proximity to shellfish leases and shellfish leaseholders without nearby access to seed or polluted stocks complain about lack of available resources.

The resources utilized from seed oyster areas are surprisingly similar to those taken from polluted areas on a average, annual per permit basis: 141 bushels for seed areas vs. 196 bushels for polluted areas. The differences become evident when comparing cumulative numbers over the 15-year analysis period where there were 391 more permit reports filed and 111,383 more bushels reported for relay activities (DMF Resource Enhancement Section). These differences are most likely attributable to the widespread availability and much larger resource base of polluted areas.

The administrative problems described in the background section are self-explanatory and are not a major problem primarily due to the stability of the existing seed oyster areas. However, consistent procedures for designating and codifying areas managed for fisheries purposes are desirable.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ Seed oyster management system works reasonably well as is
- Attempts to modify seed oyster management will be cumbersome
- Procedures to repeal or modify seed oyster areas are not specified
- Seed oyster area locations are not officially published by DMF
- Seed oyster areas are unenforceable due to proper legal documentation of areas

B. Recommend repeal of G.S. 113-203 [Eliminates seed oyster areas] and supporting rules
+ Polluted area relay is more accessible and productive than seed areas
+ Pollution closures are common in typical seed oyster areas
- Seed oyster areas offer more flexibility for transplanting
- Polluted area relay is not a viable source of seed in some areas
- Oyster culturists need a variety of resources to be successful

C. Update seed oyster management in statutes and rule *
+ Formally recognizes seed oyster areas in official publications
+ Provides a modern approach to designation of seed oyster areas
+ Provides for responsive management of seed oyster areas in rule

- Without increased resources, seed oyster areas will continue to decrease in importance relative to polluted area relay
- Even with more resources, oyster markets may not recover to levels where more seed is needed

D. Update seed oyster management in statutes and rule and increase resources through designation and enhancement

+ Formally recognizes seed oyster areas in official publications
+ Provides a modern approach to designation of seed oyster areas
+ Provides for responsive management of seed oyster areas in rule
- Even with more resources, oyster markets may not recover to levels where more seed is needed
- There are philosophical questions about how to expend limited DMF resources for public and private oyster enhancement

MANAGEMENT RECOMMENDATIONS

DMF/AC - Update seed oyster management in statutes and rule.

MFC Selected Management Strategy – Same DMF/AC

RESEARCH RECOMMENDATIONS

None

10.2.5 COWNOSE RAY INTERACTIONS AND THEIR EFFECTS ON CLAMS AND OYSTERS

ISSUE

What are the effects of cownose ray ((*Rhinoptera bonasus*) predation on clams and oysters?

BACKGROUND

There are several species that prey on clams and oysters and include the blue crab, (*Callinectes sapidus*), several kinds of mud crabs, several whelks (*Busycon sp.*), the oyster drill (*Urosalpinx cinerea*), moon snails (*Polinices sp.*), starfish (Asterias sp.), several kinds of waterfowl and cownose rays (*Rhinoptera bonasus*)(Flimlin and Beal 1993). In North Carolina cownose rays have been blamed, in part, for the demise of the bay scallop population. Recently, there have been increases in the amount of predation on cultured hard clams and oysters, especially in Virginia and Maryland as well as in North Carolina attributed to cownose rays.

Cownose rays are large stingrays that can reach a disc width of 100 cm and weigh up to 23 kg. They occur along the east coast of the United States from southern New England to Florida and throughout the Gulf of Mexico. During summer, cownose rays are very

abundant in lower Chesapeake Bay and migrate south in fall, with schools occurring off Cape Hatteras by mid-October and northern Florida by early December. Juveniles are the last to leave and can remain in Chesapeake Bay until late October. As coastal waters begin to warm, cownose rays migrate north with schools of adults arriving near Cape Lookout by mid-April and back into Chesapeake Bay in early May (Smith and Merriner 1987). Cownose rays are euryhaline and can be found in salinities ranging from 8 to 30 ppt. and are known to go into coastal rivers.

Schools of cownose rays feed mostly on bivalve mollusks and crustaceans, crushing them with their terrazzo-like tooth plates and powerful jaws (Smith and Merriner 1985; Powers and Gaskill 2005). Schools of rays move onto shoals with the rising tide and retreat during the last half of ebb tide. Cownose rays feed by probing the bottom with subrostral fins, perhaps using electroreceptive ampullary pores to detect excurrent flow from burrowed bivalves while the pectoral fins perform stirring motions. They are also known to feed on large gastropods, lobsters and crabs off southern New England, soft-shelled clams (*Mya arenaria*) in New York and sunray venus clams *(Macrocallista nimbosa*) off the west coast of Florida. Gut analysis of cownose rays from lower Chesapeake Bay by Smith and Merriner (1985) showed they fed mostly on soft-shell clams and also included eastern oyster, hard clam , as well as macoma clams (*Macoma sp.*), stout razor clam (*Tagelus plebeius*), ribbed mussel (*Geukensia demissa*), dwarf surf clam (*Mulinia lateralis*), blue mussel (*Mytilus edulis*) and Atlantic jackknife clam (*Ensis directus*) (Merriner and Smith 1979). Otwell and Lanier (1978) also described the rays as a nuisance due to the consumption of oysters in Chesapeake Bay and to scallop fishermen in North Carolina. Powers and Gaskill (2005) found bay scallop remains in cownose rays collected in North Carolina but did not record oysters or hard clams.

Cownose ray predation on oysters has been a problem in Chesapeake Bay since the 1970s when several Rappahannock River oyster growers reported great losses of seed and harvestable oysters to cownose rays. In 1975, several Virginia oyster growers asked for aid in reducing ray predation. Evidence addressing the possibility of an increase in cownose ray populations seemed to exist at the time, based on literature by Hildebrand and Schroeder (1928) who noted them as rare in Chesapeake Bay and later by Musick (1972), who listed them as abundant to common in the Bay (Merriner and Smith 1979). Pound net gear and haul seines had also decreased in number resulting in reduced fishing mortality on rays and increased survival. It was also noted that the preferred food of the cownose ray is soft-shelled clam whose numbers may have plummeted in the Rappahannock River after Tropical Storm Agnes in June 1972 (Andrews 1973). The combination of reduced fishing mortality along with a decrease in its preferred food item may have caused a shift in predation toward oysters in the Rappahannock River (Merriner and Smith 1979). Leaseholders in North Carolina have also experienced predation by cownose rays on their leases.

During the same time period, Otwell and Lanier (1978) tried to establish markets for cownose rays because of their high abundance and to reduce their predation on oysters in Chesapeake Bay and bay scallops in North Carolina. European markets were explored where there was an established market for various species of skates. Frozen wing samples of cownose rays from Core Sound were shipped to England and distributed to France, Sweden,

Germany, and Italy but met with disappointing responses. Apparently, they were marketed as 'skate', which has a white flesh, compared to the cownose ray, which has a red bloody flesh. Taste tests and experimental harvesting of rays by long haul seines around Barden Inlet were conducted. Harvested rays were iced, processed (wings cut from the body and bled), packaged and frozen manually at the seafood house. It was concluded that there were potential foreign and domestic markets and that processors were willing to handle the product if there was enough profit to allow dealing through international brokers. However, further work was needed in their utilization technology (i.e., product quality, handling problems, etc.).

In June of 2006, a cownose ray workshop was held by Virginia Sea Grant and brought together marine scientists, resource managers, fishermen and industry representatives to discuss methods for sustainable management of cownose rays in Chesapeake Bay. Developing a fishery for cownose rays was discussed, as were methods of excluding rays from shellfish beds using fences, cages, or chemical repellents.

CURRENT AUTHORITY

North Carolina General Statutes
113-202.1 Water column leases for aquaculture
113-202.2 Water column leases for aquaculture for perpetual franchises

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0103 Shellfish or Seed Management Areas

DISCUSSION

There has been a growing concern in North Carolina about predation on oysters and clams along with bay scallops by cownose rays. Some scientists and fishermen believe that the number of cownose rays is rising. Indices of long-term abundance suggest that the cownose rays are increasing in number as abundance of large sharks (predators of cownose rays) decrease (Ransom Meyers, Dalhousie University, pers. comm. 2005). However, other scientists believe that cownose rays have always been abundant. There are no quantitative data for abundance of cownose rays in Chesapeake Bay; however, the species has been abundant in the Bay since the 1970s as evident from Merriner and Smith (1979). Claims that cownose rays have "exploded" are not justified because their intrinsic rate of population increase is limited due to late maturity and low fecundity. Independent gill net survey data collected by DMF since 2001 show a consistent abundance of cownose rays in the Pamlico Sound area (Figure 10.7). In Chesapeake Bay, aggregations of rays are dynamic in that their foraging locations will change with time over the summer. In dry summers they penetrate farther up into the tributaries because of higher salinities while in wet years they may be more concentrated in the lower bay, so periodic local shellfish damage in Chesapeake Bay is more a function of this ray movement rather than abundance (J. A. Musick, VIMS, pers. comm. 2005).

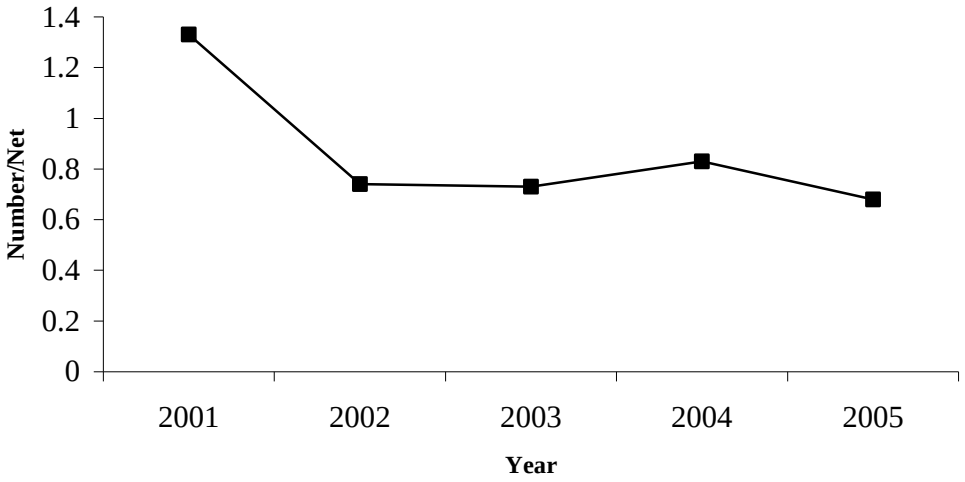


Figure 10.7. Average CPUE (number/net) of cownose rays in the independent gill net survey in Pamlico Sound (DMF biological sampling)

Major declines in sharks occurred in the 1980s, but some populations have rebounded to at least 50% of their former abundance (J. A. Musick, VIMS, pers. comm. 2005). The DMF's 2006 stock status report on sharks states that the large coastal shark complex as a whole is not overfished with the exception of two species and the small coastal shark complex is also not overfished with the overall status of sharks designated as recovering (DMF 2006).

Efforts to restore the bay scallop fishery have lead to consideration of various options that could also be considered in the protection of clams and oysters. These various options include: 1) the use of stake-fencing using large mesh net fences or stockades as a short-term method of protecting oysters and clams, or 2) to develop a fishery for cownose rays (Merriner and Smith 1979; Peterson et al. 2001; Powers and Gaskill 2005). Transplantation of clams and oysters to areas where rays may not be as abundant is another possible solution worth exploring.

Potential problems of fencing or stockading oyster and clam beds include hazards to navigation, maintenance, and monitoring of beds because of the size of the area that may need protection. Transplantation of natural stocks may be more manageable. Fencing and stockading may be viable options for leaseholders trying to protect their leases. For the past four or five years, leaseholders have experienced 100% mortality of their product if they were not protected from the predation of cownose rays. However a water column lease is required in order to utilize fencing and stockading. Building fencing and stockades are also labor intensive. Other methods that are currently employed by leaseholders to protect their beds include covering their shellfish with plastic or nylon screens, flexible netting or heavy extruded mesh. These coverings keep out other predators such as crabs while allowing good water flow (Flimlin and Beal 1993). These types of protection work against cownose rays; however, the rays will lie over the screens and beat their wings, uncovering clams and

making them more vulnerable to other predators or covering them more and suffocating them. Other problems with covering with screens or netting are the need to clean them in order to prevent suffocation of their product. Leaseholders in Virginia spend a lot of time and expense taking up and putting down nets because of the need to clean them to prevent suffocation.

The development of a commercial fishery for cownose rays is another option that may be considered in addressing the predation problem. However, in order to develop a profitable fishery, there must first be a market. Possible markets may include the bait industry, food industry (pet and human), the supplement industry (pet and human), and the fertilizer industry. There were experiments in the 1970s on the use of cownose ray wings as bait in the crab pot industry in Virginia. Compared to menhaden as bait, the ray wings lasted longer and caught as many crabs as menhaden bait (Joseph Smith, NMFS, pers. comm. 2005). The food industry may benefit from cownose rays as both a protein source and a supplement source of chondroitin sulfate, glucosamine, and oil. For any ingredient to be pursued by a pet food manufacturer consistency of supply is crucial and ingredients that may vary by season are not often of interest. Pet food is the most highly regulated food product in the world; so stable inputs of quality ingredients are needed year round (Nancy Cook, Pet Food Institute, pers. comm. 2005). Another concern would be if cownose rays would fit any of the current feed ingredient definitions used by the North Carolina Department of Agriculture (Sheila Jordan, NC Department of Agriculture, pers. comm. 2005).

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

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

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo

+ No extra expenses
+ No navigation hazards
- No protection of oyster or hard clam populations

B. Construction of fencing or stockades around the most productive beds
+ Protects oysters and/or clams from predation by cownose rays
- Hazards to navigation
- Maintenance of fencing
- Difficult to monitor

C. Educate leaseholders about construction of fencing/stockades and covering leases
+ Provides information for leaseholders about protection of product from predation by cownose rays
- Cost of materials

D. Explore options for water column use by leaseholders during cownose ray migration
+ Allows leaseholders to protect their leases with stockades/fencing from cownose ray predation
+ Reduces leasing expenses for leaseholders
- Requires a prorated rental system of some type that does not presently exist
- Creates another use of the water column that would hinder public trust uses

E. Transplantation of oysters and/or clams from areas where high numbers of cownose rays congregate to areas with little or no cownose rays
+ Reduced chance of predation by rays
- Expensive to move, and monitor
- Chance of high mortality during transportation

F. Development of a commercial cownose ray fishery
+ Decrease in cownose ray population feeding on oysters and clams
+ Another source of income for commercial fishermen
- Still may have high predation rates
- Must establish a market
- Must establish a fishery management plan on a species whose stock status is unknown

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

MANAGEMENT RECOMMENDATIONS

DMF/AC - Status quo
- Monitor seeded oyster sanctuaries for cownose ray predation

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

AC - Collect population information on cownose rays

PDT - Collect population information on cownose rays
- Explore uses of cownose rays for food in the pet food industry and the human food industry
- Explore uses of cownose rays as a source of chondroitin/glucosamine or oil for pet and human supplements
- Investigate markets for cownose rays

10.2.6 STATUS OF PRE-DEALER SEED SHELLFISH SALES

ISSUE

North Carolina General Statute 113-168.4. Sale of fish. states that is unlawful for any person licensed under Article 14A to sell fish taken from coastal waters except to a licensed dealer or to the public if the seller is also a licensed fish dealer. NC G.S. 113-168.2 further requires that a trip ticket be generated for each sale of fish taken from coastal waters. Shellfish culturists operating under an Aquaculture Operation Permit (AOP) sometimes engage in sale of undersized shellfish to lease holders or culturists that may not be dealers or may not generate a trip ticket for the transaction.

BACKGROUND

Shellfish lease holders, UDOC permit holders, and aquaculture operations must produce their own hatchery reared seed or purchase them from a hatchery or other aquaculture operation. Occasionally other situations arise where aquaculture operations sell shellfish still needing further rearing by leaseholders and culturists. Permitted oyster and hard clam aquaculture operations are exempt from size and bag limit restrictions making these sales possible. If these shellfish are raised through the use of coastal waters, either in raceways, upwellers, or overboard, they could be considered subject to the provisions of G.S. 113-168.4 and the sale transaction must be through a licensed fish dealer.

If these transactions must be conducted through a fish dealer, then they are subject to the requirement for generation of a trip ticket pursuant to G.S. 113-168.2. DMF has discouraged the recording of seed shellfish sales on trip tickets to avoid multiple counting of seafood products since these clams will be sold again and recorded on a trip ticket when they are sold

for public 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.

CURRENT AUTHORITY

North Carolina General Statutes
113-168.2. Standard Commercial Fishing License.
113-168.4. Sale of fish.
113-169.1. Permits for gear, equipment, and other specialized activities authorized.
113-210. Under Dock Oyster Culture.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03I .0101(b)(19) Aquaculture Operation.
03K .0207 Oyster size and harvest limit exemption.
03K .0305 Clam size and harvest limit exemption.
03O .0501 Procedures and requirements to obtain permits.
03O .0502 Permit conditions; General.
03O .0503(f) Aquaculture Operations/Collection Permits.

DISCUSSION

Hard clams raised in traditional culture operations must meet the current minimum size limit prior to being sold. Currently, permitted oyster and hard clam aquaculture operations are exempt from bag and size limit restrictions and can sell their products that do not meet the size or bag limit restrictions as long as they are affixed with a tag or label. However, the rules that exempt these sales from the bag and size requirements (15A NCAC 03K .0207 and 03K .0305) do not exempt the sale from going through a licensed dealer and do not exempt that fish dealer from generating a trip ticket. An exemption from the requirement to sell to a licensed dealer for seed being sold for further grow out is necessary to bring current practices into compliance with existing laws. The permit condition requiring AOP products to carry special tagging information allows Marine Patrol to continue to track seed calms sold under the new exemption. Continuation of current practices appears to violate the statute and cannot be allowed to continue.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ The public is accustomed to the current policies regarding seed clam sales for grow out
- The current interpretation and enforcement of AOP exemptions does not follow governing statutes

B. Propose a statutory change for an exemption from G.S. 113-168.4 (b) (1) when the sale is to shellfish lease, UDOC permit, or Aquaculture Operations permit holders for further rearing

+ Aligns rules with statutes and current practices
+ Keeps landings data composed of sales for consumption

C. Enforce current rules and statutes

+ Keeps enforcement in compliance with governing statutes
- Reduces the quality of the data from the Trip Ticket Program

MANAGEMENT RECOMMENDATIONS

DMF/AC - Propose a statutory change for an exemption from G.S. 113-168.4 (b) (1) when the sale is to shellfish lease, UDOC permit, or Aquaculture Operations permit holders for further rearing

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.2.7 LEASEHOLDER EDUCATIONAL TRAINING

ISSUE

The recommendation from the 2001 Oyster/Clam Fishery Management Plans (FMP) to require shellfish culture training certification for new lease applicants resulted in the General Assembly enacting legislation (Session Law 2004-150) amending General Statute 113-201 to provide the Marine Fisheries Commission authority to adopt rules establishing training requirements for new lease applicants. Session Law 2004-150 became effective in August of 2004. This Statute does not require training certification of individuals that purchase or have shellfish leases transferred to them. What are the current needs of the Shellfish Lease Program concerning training requirements?

BACKGROUND

The impetus for the recommendation in the 2001 FMP to require training for new lease applicants was the belief that leases were issued to applicants without the necessary knowledge and understanding of the rules pertaining to shellfish leases, environmental requirements for the selection of a suitable site, or mariculture techniques necessary to conduct a successful operation. Historically, public opinion existed that the majority of shellfish bottom leases were underutilized for the commercial production of shellfish as they were intended. The training requirements along with mandatory annual commercial production and planting standards were recommended to ensure that new shellfish leases would produce and market commercial quantities of shellfish. The impacts of Dermo

(*Perkinsus marinus*) on the oyster population and the "soft" market for the smaller market grades of hard clams have inhibited the expansion of the shellfish mariculture industry in the state in recent years.

The 2001 FMP committee discussions that lead to the training recommendation proposed that DMF, N.C. Sea Grant, and specific Community Colleges would collaboratively develop a shellfish lease training package to include information on the application process, pertinent Fisheries Rules, lease standards, and information on shellfish culture techniques and materials. Training sessions were to be held at convenient coastal locations, during reasonable hours and intervals for applicants to attend, and for the attendees to receive a certification of completion at the conclusion of the training session. Although each entity has continued to develop and implement their individual share of the mandated training and support, (DMF continues to update the Lease Application Information package and work with applicants during the application process, N.C. Sea Grant provides extension and technical support, and the Community College System provides aquaculture training at several institutions) the collaboration and implementation of the formal training has not occurred.

The General Assembly passed legislation in 2004 authorizing the Marine Fisheries Commission to develop a permit that would allow private dock owners to cultivate oysters in containers under their docks for their private use. The issuance of the Under Dock Oyster Culture (UDOC) permit is dependent on several conditions, one of which was successfully completing training and receiving certification of that training. The mandated educational package and certification was jointly developed by DMF and N.C. Sea Grant. The educational package contained permit application forms, permit conditions and conditions acceptance forms, a twenty-one page document that outlined the program, program requirements, oyster biology, oyster culture methods, health concerns, additional resources contacts, and a twenty question quiz based on information contained in the package. The amount of interest and the number of potential applicants was difficult to gauge. Various means of distributing the information and certifying the quiz score were explored. Having the packages available at DMF District offices, on request by mail, and through the DMF website seemed appropriate until the level of interest in the permit could be identified. These options provided individuals interested in the program the opportunity to access the information from several sources, review the information, and provide the required documentation and application at their convenience. This process allows DMF to review and evaluate the application package and issue the permit upon verification of the applicant meeting the conditions and requirements. The UDOC permit activity has been limited during the first year with fourteen permits issued, four denied due to the docks being located in prohibited shellfish harvest waters, and three are currently in process.

CURRENT AUTHORITY

North Carolina General Statutes

113-201. Legislative findings and declaration of policy; authority of Marine Fisheries Commission.

113-202. New and renewal leases for shellfish cultivation; termination of leases issued

prior to January 1, 1966.

DISCUSSION

The DMF provides an information package to any individual interested in the Shellfish Lease Program. The information in this package includes: application, rent, and renewal fees; application process; required actions by the applicant; standards for proposed leases; and production and planting requirements. A DMF contact person is identified and an option to have a preliminary investigation of the proposed lease site at no cost is offered. The application package contains forms for application, riparian owner consent, and the required management plan for the proposed lease and a map of the proposed lease site with examples. Also included in the package is renewal information and criteria for initiation of the lease termination process.

The initial contact between potential applicants and representatives of the Shellfish Lease Program provides the basis for understanding the application process, standards and requirements, and intended purpose of the program. That information is reinforced if an applicant chooses to have a preliminary or informal lease investigation of the proposed site. The informal investigation is free and is more of an "extension" site visit than a true sampling investigation. The DMF representative provides input on the site suitability with regards to physical and biological characteristics of the site and discusses the possibility of conflicts with historical uses. This informal visit also allows for the discussion of management plans including meeting planting and production requirements, current mariculture techniques, and sources of materials, cultch and seed. Timelines for the application process and impediments to the timelines are discussed, for example: the time required for a survey by a licensed surveyor.

A sector of potential lease holders that is missed by both the General Statute requiring shellfish lease training and the extension component of the shellfish lease application process is individuals that purchase or have shellfish leases transferred to them. The limitations on individuals that have existing leases transferred to them requires that they are residents of North Carolina and the transfer will not increase the amount of leased bottom over the fifty acre maximum allowed by an individual, family, or corporation. Discussions with individuals interested in acquiring shellfish leases through transfers have identified limited knowledge of lease rules especially concerning planting and production requirements. Shellfish leases at risk of termination due to underutilization by leaseholders are offered for sale prior to the impeding termination as a last chance effort by the leaseholder to profit from the lease. The production and planting requirements follow the lease through transfers and are not renewed with the transfer of the lease. A lease that is in danger of termination must adhere to planting and production requirements prior to renewal regardless of a transfer. The lack of knowledge by prospective purchasers with regards to meeting the production requirements results in the loss of the purchase cost and the lease due to the unfeasibility of complying with production standards for lease renewal. Adding a requirement for transferees to complete the same training as new lease applicants prior to acquiring a lease may address the "buyer beware" nature of lease transfers. A comprehensive public outreach and educational effort is required to inform perspective transferees of production compliance

issues associated with the lease renewal prior to the transfer. Alternatively, a grace period could be established that allows transferees to obtain the training during a specified time period after the transfer or face lease termination. The latter would be beneficial in inheritance situations but both options present challenges in developing effective implementation standards.

The development of an educational package similar to the one used for the UDOC Permit focusing on the shellfish bottom and water column leases could provide the flexibility to meet the varied needs of potential shellfish lease applicants while complying with General Statute 113-201. The package could provide the necessary information on the purpose of the Shellfish Lease Program, criteria for issuing a lease, the application process, fees, production and planting requirements, marking requirements, and grounds for lease termination. The information package could be made available electronically, in DMF District Offices, by mail, or at training seminars. The package could include information from other agencies such as DEH Shellfish Sanitation Section, Division of Coastal Management, U.S. Army Corps of Engineers, N.C. Sea Grant, and the North Carolina Aquariums Division and links to various websites for further information. A quiz could be used to ensure an appropriate level of knowledge and understanding for all new applicants or just for "home schooled" applicants, while those that attended the seminars could receive certification for attendance.

The recent focus on the health of the State's estuarine resources, and particularly the status of the oyster population as an indicator of the systemic condition, has resulted in increased cooperation and collaboration of State and Federal agencies, non-government organizations, and universities and community colleges, to address the needs and plans required to restore the oyster population and its ecological and biological benefits. The General Assembly has acknowledged the value of a healthy oyster population through appropriations supporting the expansion of the Shellfish Rehabilitation Program, Oyster Sanctuary Program, Oyster Shell Recycling Program, Shellfish Mapping Program, implementation of the Coastal Habitat Protection Plan, and the Oyster Hatchery Program. A key component of the restoration recommendations of the various working groups and committees addressing the oyster population recovery is public outreach and education. The Oyster Hatchery Program under the direction of the N.C. Aquariums Division has included in their scope the establishment of an extension component to educate, train, and engage shellfish growers; and to develop an education program linking and promoting existing educational efforts by various agencies. The DMF, N.C. Sea Grant, the N.C. University system and the N.C. Community College system have all participated in the planning phases of the Oyster Hatchery Program. The mandated training for shellfish applicants would be an appropriate use of the educational/outreach component of the hatcheries. The locations of the three existing aquariums and the proposed hatchery facilities would provide the convenient locations for the training due to the coastal locations of the facilities, all being located in proximity to shellfish sustaining waters. Participation in seminars held at these facilities by various agencies DMF, Sea Grant, DEH - Shellfish Sanitation would be an appropriate venue for various levels of education and outreach including Lease Training, UDOC, Oyster Gardening, and volunteer restoration, etc. Required training as well as precautionary information (rules and health concerns) could be made available at these sessions.

The DMF has received ten applications for new leases since Session Law 2004-150 was passed in 2004. Of the ten applications five have been approved, two applicants withdrew their applications, and three are in process (Table 10.6). The level of interest in shellfish leases could rebound however with the reduced impacts from Dermo seen during the last several years and a growing interest by North Carolina restaurants and seafood markets for a consistent supply of local oysters. Ensuring that new shellfish leaseholders are aware of the lease requirements and rules, impacts of harvest closures, and the availability of technical assistance and support, should help enhance the State's mariculture industry.

Table 10.6. Results of shellfish lease applications, 2001-2006. (DMF Resource Enhancement Section)

Year	Applications	Results			
		Approved	Withdrawn	Denied	Pending
2001	1	1			
2002	9	4	2	2	
2003	2	2			
2004	4	3	1		
2005	1	1			
2006	5	1	1		3

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ Does not require any addition education/training development
+ No additional burden on new applicants
- Out of compliance with G.S. 113-201
- Does not provide venue for increased awareness for new applicants

B. Develop an educational package in coordination with the Oyster Hatchery Program, N.C. Sea Grant, other state agencies, and organizations to be presented at seminars and require mandatory attendance for new lease applicants to meet educational requirements
+ Complies with G.S. 113-201
+ Extension, education, and training could be consolidated into several presentations annually
- Training limited to seminar dates and locations
- Delays in applicant attending seminars will delay application process
- Assumes applicants learn the necessary lease requirements and rules, and information from other agencies

C. Develop an independent education package as described in B. with mandatory

completion of a quiz with a passing score to meet education requirements

+ Complies with G.S. 113-201
+ Provides flexibility for new lease applicants
+ Provides a reference document for pertinent lease information
- Requires developing a quiz that adequately and reasonably tests the applicants understanding of the necessary lease requirements and rules, and those of other agencies
- Requires a passing score for certification
- May require addressing the special needs of some applicants

D. Require the satisfactory completion of a quiz based on pertinent information in the training package irrespective of whether the applicant has obtained instruction voluntarily or is reviewing the information independently

+ Ensures a level of awareness of the necessary information in the training package
+ Proves adequate level of awareness regardless of training form i.e. "home schooled," seminar attendance, formal education, etc.
- Requires "certification" of a passing score
- May require addressing the special needs of some applicants

E. Request that appropriate agencies such as the Oyster Hatcheries and N.C. Sea Grant conduct shellfish lease training as part of their educational and outreach activities

+ Provides increased availability to potential applicants
+ Correlates with the scope of activities of both agencies
- May encounter issues with workloads and staff availability of these agencies to conduct the training

F. Modify G.S. 113–201 to include a requirement for training for persons acquiring shellfish leases by lawful transfers unless they have a shellfish lease that is currently meeting production requirements

+ Increased awareness of rules especially production and planting criteria for lease renewals
+ Provides information on potential production and planting compliance, shellfish closures, or lack of suitability of a lease – addresses the "buyer beware" issue through increased awareness of rules and information resources
- May result in delays in transactions
- Requires developing a quiz that adequately and reasonably tests the transferees understanding of the necessary lease requirements and rules, and those of other agencies
- Requires modification to G.S. 113-201

MANAGEMENT RECOMMENDATIONS

DMF/AC - Develop an independent education package as described in B. with

mandatory completion of a quiz with a passing score to meet education requirements
- Require the satisfactory completion of a quiz based on pertinent information in the training package irrespective of whether the applicant has obtained instruction voluntarily or is reviewing the information independently
- Request that appropriate agencies such as the Oyster Hatcheries and N.C. Sea Grant conduct shellfish lease training as part of their educational and outreach activities
- Modify G.S. 113–201 to include a requirement for training for persons acquiring shellfish leases by lawful transfers unless they have a shellfish lease that is currently meeting production requirements

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.2.8 EDUCATION ON SHELLFISH HEALTH RISKS

ISSUE

There is a need for more education of consumers and harvesters on the health risks associated with the consumption of raw or partially cooked shellfish.

BACKGROUND

Consumption of raw or partially cooked molluscan shellfish is known to cause human illness and mortality. In the USA typically 85% of seafood related illnesses are caused by consumption of raw or undercooked molluscan shellfish (FDA 1991). Certain medically compromised individuals are at increased risk from common marine bacteria known as the vibrios that are unrelated to pollution. *Vibrio* bacteria are naturally present in marine waters. Pathogenic strains in marine waters include non-01 *Vibrio cholerae*, *Vibrio parahaemolyticus* (*Vp*), and *Vibrio vulnificus* (*Vv*). Individuals with predisposed medical conditions are at high risk of illness from these bacteria and include those with liver disease, alcoholism, diabetes, cancer, stomach or blood disorder, or weakened immune system.

Prevention of illness due to consumption of molluscan shellfish begins with ensuring shellfish are harvested from approved waters, are handled in a sanitary manner, are brought under temperature control quickly, that any further processing is conducted under strict sanitary guidelines and all shellfish are properly tagged and labeled. Perhaps the foremost means of preventing illness is consumer education about the risks involved in consuming raw shellfish and industry education about safe and sanitary means of handling and storing shellfish.

Public health controls of shellfish became a national concern in the U. S. in the late 19th and early 20th century when public health authorities noted a large number of illnesses associated with consuming raw oysters, clams, and mussels. During the winter of 1924, there occurred a widespread typhoid fever outbreak, which resulted in a request that the Surgeon General of the United States Public Health Service develop necessary control measures to ensure a safe shellfish supply to the consuming public. This program continues today as the National Shellfish Sanitation Program (NSSP) governed by the Interstate Shellfish Sanitation Conference (ISSC) of which DEH and DMF are voting members.

The NSSP is the federal/state cooperative program recognized by the U. S. Food and Drug Administration (FDA) and the ISSC for the sanitary control of shellfish produced and sold for human consumption. The purpose of the NSSP is to promote and improve the sanitation of shellfish (oysters, clams, mussels and scallops in any form, except when the final product form is the adductor muscle only) moving in interstate commerce through federal/state cooperation and uniformity of state shellfish programs. Components of the NSSP include program guidelines, state growing area classification, dealer certification programs, control of harvesting and FDA evaluation of state program elements.

The ISSC strongly believes that education is one of the foremost means of informing the public of the risks involved in consuming raw shellfish. Furthermore, through the Shellfish Sanitation Program dealer certification process, all shellfish dealers are adequately informed of safe handling and record keeping practices and temperature controls. Shellfish Sanitation does not have contact with the harvesters whereas DMF licenses the harvesters and thus has the contact to disseminate educational materials.

There is limited educational information available for consumers from the Shellfish Sanitation Section linked within the Department of Environment and Natural Resources website on selling of raw shellfish (N.C. Shellfish Sanitation and Recreational and Water Quality Section 2007). The ISSC has also produced a number of educational materials regarding the public health issues of shellfish consumption.

CURRENT AUTHORITY

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03I .0119 Prohibited Fishing Activity Due to Public Health or Safety
03K .0101 Prohibited Shellfish Areas/Activities

Division of Environmental Health Rules (15A NCAC 18A)
Section .0300 - .0800 Sanitation of Shellfish
Section .0900 Classification of Shellfish Growing Waters

DISCUSSION

The *Vibrio* bacteria are naturally occurring environmental marine organisms and are found worldwide. With the exception of the 01 or 0139 serogroups of *Vibrio cholorae*, almost all other vibrios, including non-01 cholorae are not associated with fecal contamination of

growing waters. The two *Vibrio* species reported to the Centers for Disease Control and addressed under the NSSP are *Vv* and *Vp*. *Vibrio vulnificus* is the most dangerous of the vibrios and can cause serious infection in people with compromised immune systems. *Vibrio vulnificus* can produce septicemia in immunosuppressed individuals and over 50% of patients with primary septicemia die. *Vibrio parahaemolyticus* causes moderate to severe gastroenteritis. The state of Washington experienced a large *Vp* outbreak this past fall with over 100 illnesses confirmed and again this spring with over 200 confirmed cases. Intertidal oysters in shallow, warm waters were implicated.

Vibrio related illnesses have typically come from consumption of oysters from the Gulf Coast waters in the warm summer months but the bacteria is common in our waters as well. Harvesting of oysters from private shellfish leases continues during the warm summer months in North Carolina. From 2000 to 2005 there has been an almost 10 fold increase in the number of bushels of oysters harvested from private leases during the summer months increasing the possibility of a *Vibrio* related illness (Figure 10.8).

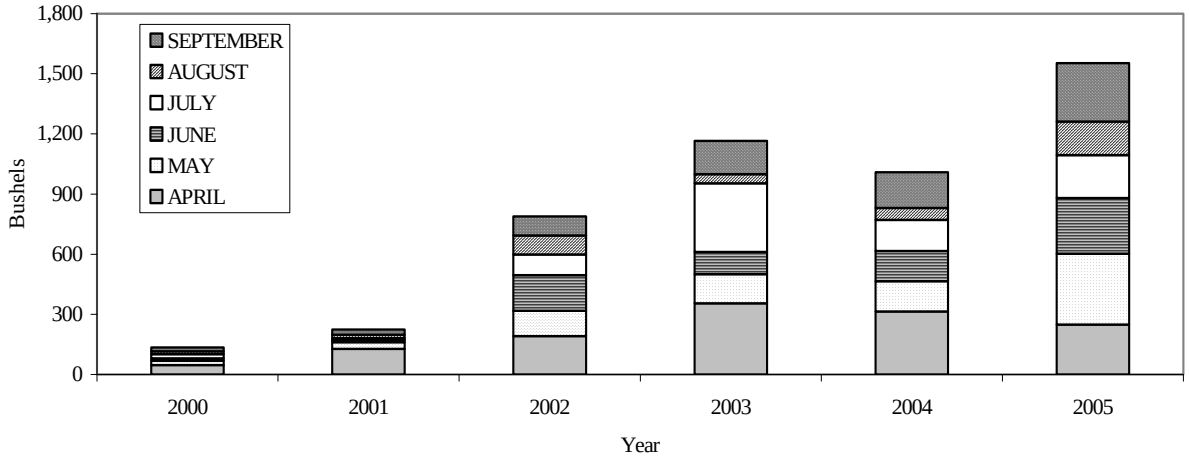


Figure 10.8. Commercial oyster harvest (bushels) from private leases during the closed oyster season (April – September), 2000-2005 (DMF Trip Ticket Program).

Since North Carolina has seen an increase in the levels of harvest of shellfish from private shellfish leases in the summer months, the risk of having a *Vibrio* related illness also increases. There has been one *Vp* case in North Carolina from non-commercially harvested oysters. If there are 2 or more confirmed shellfish-borne *Vibrio* illnesses traced to the consumption of commercially harvested raw or undercooked oysters that originated from N. C. waters implementation of a *Vibrio* management plan is required under the guidelines of the NSSP. Requirements of the *Vibrio* management plan differ for *Vv* and *Vp* and can be as simple as consumer and harvester education. More complex requirements if the *Vibrio* management plan is initiated can range from developing a plan to identify and define growing areas, require reduction in time from harvest to refrigeration, close harvest between the months of May through September and require labels to read “For Shucking Only”, require phase in of post harvest treatment, require all shellfish to be cooked, or a total closure of the harvest area.

The ISSC has produced a number of educational materials regarding the public health issues of shellfish consumption. Additionally the Division of Public Health of the North Carolina Department of Health and Human Services has available on their website information regarding *Vv* and the risks associated with this bacteria with regard to consumption of raw shellfish and safety advice for fishermen. Information about *Vibrio* can be added to both the DMF webpage (www.ncdmf.net) and the Shellfish Sanitation webpage (www.deh.enr.state.nc.us).

Development and dissemination of educational materials is necessary to inform the public of the risks associated with consumption of raw or partially cooked shellfish. Shellfish harvested from approved waters, packed under sanitary conditions, and properly handled are usually safe for raw consumption by healthy individuals. The ISSC has recently produced a brochure and DVD entitled "The Safe Handling of Shellstock, Overboard Discharge and No-Discharge Zones" which is available for states to distribute and use in educational programs.

It would be beneficial for North Carolina to be proactive on these issues and implement educational programs geared toward consumers of raw molluscan shellfish and stress the importance of time-temperature controls to commercial shellfish harvesters, leaseholders, and UDOC permit holders especially during the warm summer months. Control from harvest to refrigeration starts when water temperature exceeds 75 ^{o}F. The higher the water temperature means the shorter the harvest time.

If North Carolina has to implement either a *Vv* or *Vp* management plan the implications can be detrimental to the shellfish industry because it will lose consumer confidence and could potentially lose the ability to sell product during summer months. Both the DMF and Shellfish Sanitation state agencies will be forced to use more resources to manage this plan. Marine Patrol will be required to spend more time on enforcing more closed areas and inspection of more harvesters to monitor harvest tags for time harvest started. Shellfish Sanitation will be required to collect more water and shellfish samples. Shellfish Inspectors will spend more time at shellfish plants checking time/temperature records and work with Marine Patrol to insure that harvesters are providing proper information on tags.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo

+ No *Vibrio* (*Vv* or *Vp*) illnesses or deaths from consumption of North Carolina commercially harvested shellfish to date
- Potential loss in consumer confidence if illnesses or death occurred from eating contaminated commercially harvested shellfish
- Would have to initiate Vibrio management plan if two or more illness are etiologically confirmed from commercially harvested contaminated shellfish

B. Eliminate out of season oyster harvest from leases

+ Almost eliminates the possibility of *Vibrio* (*Vv*) related illness or mortality from consumption of North Carolina oysters
- Reduces sales and profits from summer oyster harvest

C. Provide educational materials to consumers, leaseholders, UDOC permit holders, and shellfish dealers
+ Provides consumers information about the risk of consuming raw shellfish
+ Provides information to harvesters of the importance of time-temperature controls
+ Pro-active response to concerns with *Vibrio* illnesses
- Cost of materials to produce educational brochures
- Cost to implement and maintain

D. Red tag summer oysters with consumer advisory.
+ Provides educational material direct to the consumer
- Additional cost and effort to tag bushel bags

E. Encourage harvesters to take volunteer time and temperature control measures on their product
+ Proactive response to concerns with *Vibrio* illnesses
+ Provides information to harvesters of the importance of time-temperature controls

MANAGEMENT RECOMMENDATIONS

DMF/AC - Provide bilingual (English and Spanish) educational materials to consumers, leaseholders, UDOC permit holders, shellfish dealers, and other DENR state regulatory agencies
- Encourage harvesters to take volunteer time and temperature control measures on their product.

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.2.9 MODIFY SHELLFISH LEASE PROVISIONS

ISSUE

During the 2001 planning process, the North Carolina Marine Fisheries Commission (MFC) identified several modifications to the statutory provisions of the Shellfish Lease Program that would provide for increased accountability and public acceptance. The Hard Clam and

Oyster FMP Plan Development Team recommends that these changes be considered again in this review.

BACKGROUND

The MFC is on record in the 2001 North Carolina Oyster and Hard Clam Fishery Management Plans (FMPs) 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. Shellfish aquaculture, if properly managed, has the potential to increase seafood production, employment in the seafood industry, and improve fisheries habitat.

The MFC received reports on Core Sound human use mapping and shellfish mapping pursuant to Session Law 1999-209 and used that information to develop recommendations for improving the Shellfish Lease Program in the 2001 Oyster and Hard Clam Fishery Management Plans. Following adoption of the FMPs, that information was also used to develop recommendations for resolution of concerns that caused the moratorium on new shellfish leases in Core Sound (now a prohibition on new shellfish leases, Session Law 2003-64). In order to get input from current users on shellfish lease problems, a stakeholders committee of ten people, representing various interests, was appointed to provide recommendations on the issue to the MFC. The MFC found that the recommendations from the stakeholder group would be beneficial in improving the Shellfish Lease Program in not only Core Sound but also coast wide. That opinion was confirmed when they received a favorable review on the proposed changes from all four of the MFC regional committees and the MFC Shellfish Committee.

Specifically, the MFC recommended to the Joint Legislative Commission on Seafood and Aquaculture that the following statutory changes be made based on the recommendations of the Stakeholder and MFC committees:

1) Change the provision for a ten year shellfish lease term to a five year lease term;
2) Allow leases that would be terminated to be made available to a member of a current pool of applicants by a random selection process instead of reverting to public bottom;
3) Require that shellfish lease applicants and new leaseholders meet educational requirements unless they already have a lease that is meeting production requirements (This provision is identical to the educational requirements in the Oyster and Hard Clam Fishery Management Plans);
4) Create authority for the MFC to establish regional caps on total shellfish lease acreage; and
5) Change provisions limiting the amount of shellfish lease acreage that can be held:
    a) To limit any person from having an interest in more than 50 acres regardless of corporate affiliations,
    b) To give the MFC authority to require full listing of officers, directors and stockholders from corporations submitting a shellfish lease application,
    c) To give the MFC authority to require individuals or partnerships applying for leases to list their interests in corporations and update it annually, and
    d) To adopt provisions discouraging corporations from holding shellfish leases.

The MFC intended to implement the changes listed above and to make the following specific rule changes if the statutory changes were made:

1) Change the current three year running shellfish production average for shellfish leases to a five year running average;
2) Limit acreage per shellfish lease application to 5 acres, except in areas open to the mechanical harvest of oysters where the limit will be 10 acres, and eliminate the opportunity to justify additional acreage;
3) Require leaseholders holding at least 5 acres of shellfish bottom to meet shellfish production requirements before the Secretary will accept applications for any additional acreage; and
4) Require markers for shellfish lease boundaries to be recorded in latitude and longitude along with standard survey metes and bounds descriptions.

The provision that shellfish leaseholders meet education requirements was the only statutory change made by the NC General Assembly from these recommendations.

CURRENT AUTHORITY

North Carolina General Statutes

113-201. Legislative findings and declaration of policy; authority of Marine Fisheries Commission.

113-202. New and renewal leases for shellfish cultivation; termination of leases issued prior to january1, 1966.

DISCUSSION

The Stakeholder Committee's hard work produced valid recommendations which addressed problems and issues regarding shellfish leasing that the MFC felt must be resolved before public perception can be changed concerning leases in traditional commercial fishing communities. A discussion summarizing the Stakeholder's position on each of the recommendations is listed below:

1. **Observation:** Public sentiment toward the shellfish lease program suffers because unproductive leases are allowed to continue. Some leaseholders are just holding bottom in an attempt to exclude the public.

   Recommendation: Enforce shellfish lease production requirements in a more timely manner.

   Discussion: It has proven most effective to enforce requirements at time of renewal of the lease contract rather than during the term of the contract. The current lease contract period is ten years, which allows some unproductive leases to be maintained for several years.

Proposed Action: Change the current rule specifying a three year running production average to a five year production average and change the statutory provision for a ten year lease contract to a five year contract.

Committee Recommendations (2002): Supported by the four regional and Shellfish committees.

2. **Observation:** If established shellfish leases continue to meet the standards for issuance but cannot be renewed because of lack of production, they should be transferred to shellfish lease applicants to avoid leasing existing public shellfish bottom.

   Recommendation: Transfer unproductive leases to new applicants instead of leasing new bottom.

   Discussion: Existing leases have gone through an extensive review process and have existed in known locations for several years. Therefore, the public is already accustomed to their existence. If these leases continue to meet the standards for leasing, it would be less intrusive to reissue the existing lease than to have a new site removed from public shellfish harvest.

   Proposed Action: Make a statutory provision that allows shellfish leases that would not be renewed due to failure to meet production requirements to be made available to a member of a current pool of lease applicants on a first come, first serve basis.

   Committee Recommendations (2002): Supported by the four regional committees. Not supported by the Shellfish Committee. DMF staff voiced serious concerns about the administration of this program.

3. **Observation:** Concern was expressed that, prior to the recent moratorium, several applications had been accepted for clam leases the exceeded the 5 acre per application guideline for maximum lease size because the applicants were allowed to justify the need for more acreage. Stakeholders felt that 5 acres was more than enough acreage for new leases or for expanding lease holdings.

   Recommendation: Limit acreage per shellfish lease application to 5 acres with no opportunity to justify additional acreage.

   Discussion: Most of the shellfish lease applications received propose to lease less than 5 acres. Two possible reasons for the large size of the sites applied for in 1995 (10 acres) were pent up demand caused by the 1993 moratorium or fear of future moratoriums.

   Proposed Action: Limit acreage per shellfish lease application to 5 acres.

Committee Recommendations (2002): Supported by the four regional and Shellfish committees.

4. **Observation:** Granting of additional lease acreage to leaseholders that are currently not meeting lease production requirements could create unnecessary proliferation of shellfish leases and creation of unproductive lease acreage.

   Recommendation: Require that any current lease acreage held by a shellfish lease applicant meet production requirements prior to issuance of new lease acreage.

   Discussion: This recommendation is necessary to prevent circumvention of the recommendation to allow an applicant to apply for no more than 5 acres. This action will cause leaseholders to either meet production requirements or give up their existing lease acreage prior to applying for additional sites.

   Proposed Action: 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.

   Committee Recommendations (2002): Supported by the four regional and Shellfish committees.

5. **Observation:** The use of metes and bounds surveys to describe the location of shellfish leases is burdensome to the leaseholder and in the enforcement of proper lease locations.

   Recommendation: Allow shellfish lease locations to be recorded in GPS coordinates (Lat./Long.) rather than requiring a registered land survey.

   Discussion: There are many natural and man induced events that can cause lease markers to be lost and returning them to their proper location in an environment where reference points are nonexistent or constantly changing is difficult. The use of current navigation technology would remove some of the difficulty.

   Proposed Action: Allow lease locations to be recorded in GPS coordinates (Lat./Long.) rather than requiring a registered land survey if compatible with state law. A registered land survey is required irrespective of survey methods so the recommendation was changed to required latitude and longitude coordinates on all corners along with the survey.

   Committee Recommendations (2002): Supported by the four regional and Shellfish committees.

6. **Observation:** Even with limitations on shellfish lease application acreage and requirements that acreage be productive prior to issuance of additional leases, there is no limitation on the number of persons that can obtain leases as long as they are state

residents. Therefore, shellfish leases could cover large areas of coastal fishing waters over time.

Recommendation: Establish regional caps on the total shellfish lease acreage that can be issued.

Discussion: Even though there is less than 0.1% of coastal waters under shellfish lease, many protestors express concern that granting leases would affect their recreational use of the state waters or in some way limit their ability to fish commercially. (Some protestors feel that leasing public bottoms to individuals is simply inappropriate.) Limiting the acreage that can be leased should help address their concerns.

Proposed Action: Develop regional lease acreage caps based on established use of water bodies.

Committee Recommendations (2002): Supported by the Central and Northeast committees. Supported if implemented on a regional basis considering regional use patterns by the Southeast, Inland and Shellfish Committees.

7. **Observation:** The apparent intent of G.S. 113-202 (c) is to limit an individual to holding no more than 50 acres of shellfish cultivation leases. Yet, when corporate law is applied to shellfish lease holdings, a person could have an interest in an indefinite amount of shellfish lease acreage.

Recommendation: Limit an individual to an interest in no more than 50 acres of shellfish cultivation leases irrespective of corporate affiliations.

Discussion: A recent example showed that one individual had interest in 105 acres of shellfish bottom leases in Carteret County through personal holdings and by acreage held by corporations in which the individual was the corporation's agent. If all of the corporations are bona fide operations, this situation is legal but clearly outside the intent of the 50-acre limitation. The feeling of the committee was that, if a member of a corporation already held 49 acres under shellfish lease, the corporation could hold only one acre of shellfish lease thereby limiting any individual from holding more than 50 acres. There was also some concern that family holdings allowed individuals access to more than the 50-acre limit.

Proposed Action: 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 or family holdings.

Committee Recommendations (2002): Supported by the four regional and Shellfish committees.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status Quo

+ Many leaseholders prefer the current lease term because it offers some reassurance for long-term investment
+ The majority of leaseholders are able to meet current production requirements
+ Very few applicants request more than 5 acres of leased bottom
+ An acreage cap would prevent additional growth in some areas limiting expansion of some shellfish culture operations
- DMF would continue to have problems dealing with leaseholds that do not conform to standards
- Public perception and fears are based on instances of noncompliance with existing standards
- Without an acreage cap some individual waterbodies can become overcrowded with lease markers and collectively impact water use

B. Adopt the recommendations as proposed

+ Problems dealing with leaseholds that do not conform to standards would be significantly reduced
+ Public perception and fears would be reduced because instances of noncompliance with existing standards would diminish
+ Without an acreage cap some individual waterbodies can become overcrowded with lease markers and collectively impact water use
- Many leaseholders prefer the current lease term because it offers some reassurance for long-term investment
- The majority of leaseholders are able to meet current production requirements
- Very few applicants request more than 5 acres of leased bottom
- An acreage cap would prevent additional growth in some areas limiting expansion of some shellfish culture operations

C. Review the recommendations and choose those that are currently appropriate (Could have all the pros and cons of the previous options depending on those selected)

+ Allows for selection based on current conditions
- The previous recommendations had a very thorough discussion and review

MANAGEMENT RECOMMENDATIONS

DMF - Review the recommendations and choose those that are currently appropriate. DMF selected all of the recommendations except #2 – Transfer unproductive leases to new applicants instead of leasing new bottom

AC - Adopt the recommendations as proposed

MFC Selected Management Strategy – Same as DMF

RESEARCH RECOMMENDATIONS

None

10.2.10 MOVEMENT OF CULTURED SEED SHELLFISH FROM POLLUTED WATERS

ISSUE

Relaying rules are unnecessarily restricting the transplanting of seed clams from nurseries utilizing waters closed to harvest by reason of pollution to leases and franchises in open harvest areas.

BACKGROUND

The National Shellfish Sanitation Program's (NSSP) Guide for the Control of Molluscan Shellfish - Model Ordinance (www.cfsan.fda.gov/~ear/nss3or06.html) exempts hatcheries, nursery products that do not exceed 10 percent of market weight, and nursery products that are six months or more growing time from market size (i.e. seed shellfish) from the requirements of the model ordinance on shellfish aquaculture. This means that shellfish meeting the exemptions do not have to meet requirements for relaying or depuration when seed are raised in waters with conditionally approved, restricted or conditionally restricted classifications. Marine Fisheries Rule 15A NCAC 03K .0104 Permits for Planting Shellfish from Prohibited/Polluted Areas makes it unlawful to take oysters or clams from prohibited (polluted) public waters for planting on leases and franchises unless the activity is accomplished under a permit issued by authority of the Secretary. This rule does not include the NSSP exemptions so all NC shellfish, regardless of size, must follow permit requirements. The NSSP allows member states to adopt provisions more restrictive than the model ordinance. The current permit establishes April 1 through May 15 as the only season for transplanting clams from prohibited (polluted) public waters unless the clams would otherwise be lost due to maintenance dredging operations. A current applicant for an Aquaculture Operation Permit has plans for clam culture meeting the exemptions in the model ordinance but the applicant cannot move clams to open growing areas during the normal seed planting period that occurs in the fall.

CURRENT AUTHORITY

North Carolina General Statutes
113-203. Transplanting of oysters and clams.
113-134. Rules.
113-182. Regulation of fishing and fisheries.
143B-289.52. Marine Fisheries Commission – powers and duties.

DISCUSSION

Restrictions on the movement of shellfish from prohibited (polluted) public waters to open harvest waters for cleansing and subsequent harvest are implemented to protect the public health by establishing manageable time periods for direct supervision and creating documentation for monitoring the activities. These controls are particularly important for large-scale operations where multiple lease or franchise holders are handling market or near-market size product from public bottom harvest sites. The risk of public illness and subsequent market impacts is high in these situations. MFC rules on movement of shellfish out of prohibited (polluted) public waters are based on this risk scenario.

The MFC requirements for movement of shellfish from prohibited (polluted) public waters support the NSSP Model Ordinance except for exemptions for seed shellfish in aquaculture. Shellfish aquaculture operations can operate under the current rules if they can develop means to coordinate nursery production with the timing of the current relay season. The NSSP considers there to be low risk that small seed shellfish from closed harvest areas will reach markets and that normal grow out to market size will provide for adequate removal of any pollutants in their meats.

North Carolina must support the Model Ordinance but may adopt more stringent requirements. It appears that the State is in compliance with the provisions concerning relaying shellfish in aquaculture operations at this time. However, shellfish culturists may be unnecessarily restricted if there is low risk to human health and DMF is able to adequately monitor shellfish aquaculture operations utilizing seed from prohibited (polluted) public waters. Virginia and Florida have less stringent requirements for handling and movements of seed in polluted area aquaculture operations and appear to have had few problems. The need for shellfish culturists to use conditionally approved, restricted or conditionally restricted classifications is also likely to increase as shoreline access to open waters continues to be reduced due to increases in classifications that restrict harvest.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo

+ The current seasons and permit requirements are well known and equal for all users
+ Current rules offer a high degree of consumer protection
- Current rules unnecessarily restrict movement of seed shellfish due to low risks
- Current rules have the potential to curtail growth of shellfish aquaculture

B. Remove all restrictions on the movement of seed shellfish from hatcheries, nurseries, leases and franchises in prohibited (polluted) waters to open lease or franchise areas for grow out

+ Opens up many areas for the production of seed shellfish
+ Protects existing hatcheries and nurseries from the effects of harvest closures
- In water-based operations it will lead to unnecessary responses by Marine Patrol to enforce restrictions on shellfishing in polluted areas because of lack of a notification process
- False alarms above could result in decreased responses to actual poaching in closed harvest areas
- Increases the risk that contaminated shellfish could reach the market because illegal harvest could occur under the guise of seed transplanting

C. Exempt permitted shellfish aquaculture operations from the season requirements set out in 15A NCAC 03K .0104 (b) and set a maximum size limit for transfers at 12 millimeters. A permit would still be required.

+ Opens up many areas for the production of seed shellfish
+ Protects existing hatcheries and nurseries from the effects of harvest closures
+ Provides for efficient monitoring of transplanting through documentation
- Increases the risk that contaminated shellfish could reach the market because illegal harvest could occur under the guise of seed transplanting
- Increases paperwork burden on shellfish culturist
- Increases enforcement burden on Marine Patrol

MANAGEMENT RECOMMENDATIONS

DMF/AC - Status quo

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.3 INSUFFICIENT DATA

10.3.1 NO DATA ON RECREATIONAL HARVEST OF SHELLFISH

ISSUE

No recreational shellfish harvest data are currently being collected.

BACKGROUND

Despite the importance of the commercial shellfish fisheries (molluscan and crustacean) to the state, very little data exists on recreational shellfish 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 compared to an average of approximately 7% for finfish (D. G. Mumford, DMF, pers. comm. 2005).

Recreational data are being collected by MRFSS for finfish, but the survey does not currently collect shellfish data. Although the Fisheries Reform Act of 1997 (FRA) created a Recreational Commercial Gear License (RCGL) to allow recreational fisherman to use limited amounts of commercial gear to harvest seafood for personal consumption, shellfish gear was not authorized under this license. However, any state resident is able to purchase a commercial shellfish license, at a lower cost than a RCGL, and use any commercial shellfishing gear to harvest shellfish in commercial quantities. Therefore, recreational harvest data is not captured by MRFSS surveys, RCGL surveys, or commercial shellfish license data. This lack of recreational shellfish landings data makes it impossible to estimate the impacts of recreational harvest on shellfish. In addition, the 1997 Fisheries Reform Act (FRA) requires DMF to prepare FMPs for all of the State's commercially and recreationally significant species. Our state's shellfish fisheries are exclusively under North Carolina jurisdiction, so effective state FMPs are extremely important.

CURRENT AUTHORITY

North Carolina General Statutes
113-169.1. Permits for gear, equipment, and other specialized activities authorized.
113-169.2. Shellfish license for NC residents without a SCFL.

DISCUSSION

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

The best way to capture recreational shellfish harvest data is to have a coastal recreational fishing license for both finfish and shellfish. This would create a sampling 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 Hard Clam FMP (DMF 2001a) and Oyster FMP (DMF 2001b) supported the adoption of a mechanism that would provide data on recreational shellfish harvest. As a result of the recommendation by the Oyster and Hard Clam FMPs in 2001, House Bill 1427 was introduced before the general assembly in 2004 to establish a recreational shellfish license.

This license would have been for shellfish only and would have been instituted on a trial basis for three years. However, the bill was never passed. In 2004, House Bill 831 did pass a saltwater fishing license that mandated those individuals recreationally fishing for both finfish and shellfish to 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 January 1, 2007, is only required when targeting finfish. It is not required for shellfishing. Although the Bay Scallop FMP is still in draft form and the recommendations are not yet finalized, both the advisory committee and DMF supported a license to collect data on the recreational harvest of shellfish (DMF 2006).

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

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

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

MANAGEMENT OPTIONS/IMPACTS

(+ Potential positive impact of action)

(- Potential negative impact of action)

A. Status quo
+ No additional regulation on recreational fishery
- Insufficient information available for recreational harvest estimates

B. Institute a survey with limited sampling universe

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

2. Phone survey
+ Identifies kinds of species caught
+ Gear data collected
+ Some effort information (number of trips)
+ Ability to gather socioeconomic data
- Sampling universe not defined
- Expensive to implement
- Unable to get individual species data (lengths, etc.)
- Survey dependent on memory
- Intercept survey required to extrapolate trip data
- Estimates would be less precise

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

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

C. 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

D. Require recreational shellfish harvesters to be permitted to provide a sampling universe for surveys

+ Defines a sampling universe
+ Ability to gather socioeconomic data
- Additional regulation on the recreational fishery
- No revenue to implement a permit
- No current infrastructure for implementing a permit of this magnitude

MANAGEMENT RECOMMENDATIONS

DMF - Recommend requiring recreational shellfish harvesters to be licensed to provide a sampling universe for surveys.

AC - Status quo, no change.

MFC Selected Management Strategy – Same as AC

RESEARCH RECOMMENDATIONS

None

10.4 ENHANCEMENT ACTIVITIES

10.4.1 OYSTER SANCTUARY DEVELOPMENT/CONSTRUCTION

ISSUE

There has been an increasing concern for the decreasing oyster populations of North Carolina. Should North Carolina Division of Marine Fisheries (DMF) continue to expand the oyster sanctuary program and then place these and future sanctuaries into rule for long-term protection?

BACKGROUND

Adherent to the Blue Ribbon Advisory Council on Oysters (BRACO) recommendation to establish oyster sanctuaries in the Albemarle/Pamlico system, five oyster/artificial reef sanctuaries were constructed in North Carolina previous to the 2001 Oyster FMP adoption. These sanctuaries were developed in Bogue Sound, West Bay (Tump Island), Deep Bay (Swan Quarter), Croatan Sound, and Clam Shoal behind Hatteras Village (Figure 10.9). However, the site in Bogue Sound has become covered with sand by natural processes while

all other sites still have bottom relief. The sites were planted using large fossil stone and funded with Artificial Reef Program monies due to separate funds were not allocated for oyster sanctuaries in the restoration efforts of the State. Data collection and monitoring are ongoing in these sanctuaries with reasonable signs of oyster attachment. Oyster/artificial reef sanctuaries are designated under North Carolina Marine Fisheries Rule 15A NCAC 03K .0103 as oyster management areas, which prohibits harvest of oysters and use of trawls, long haul seines, and swipe nets therefore promoting growth and enhancing survivability of large oysters within the sanctuaries. Large oysters are known to be more viable than their smaller (younger) counterparts. These oysters are assumed to be disease-resistant and have the potential to establish these traits to populations beyond sanctuary boundaries. This in turn could have long-term benefits on a sustainable fishery. Oyster sanctuary reefs not only serve for oyster restoration, but also as artificial habitat for finfish. The location, size, cultch material, and construction methods should be evaluated to achieve maximum ecological benefit both for disease-resistant and brood stock oysters.

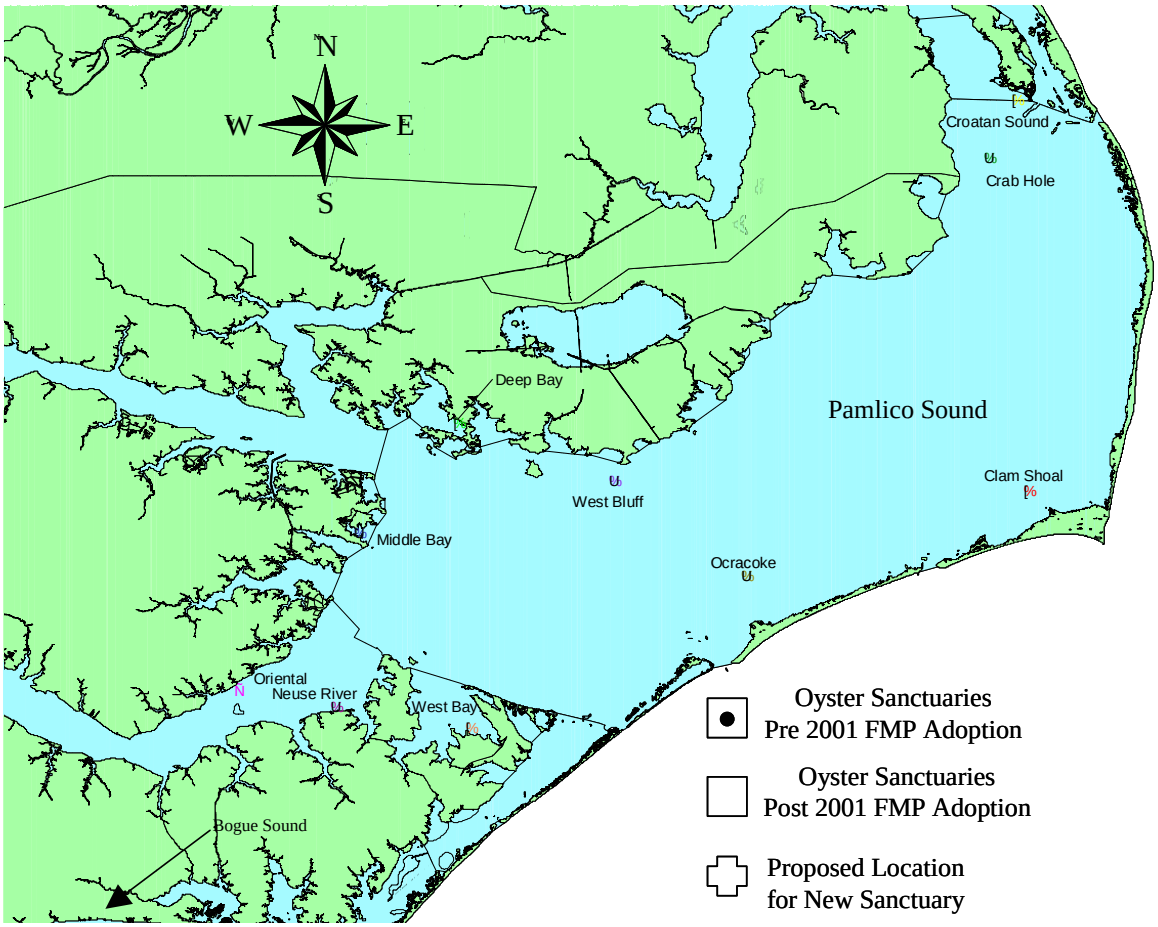


Figure 10.9. North Carolina oyster sanctuary locations.

The North Carolina Division of Marine Fisheries (DMF) has constructed five additional sanctuaries, which will increase the amount of brood stock and help answer some research needs. Currently DMF maintains nine oyster sanctuaries encompassing 5.7 – 58.6 acres

each, totaling 201.9 acres of which approximately 39.6 acres are developed (Table 10.7). These additional sanctuaries are situated in the Neuse River (Turnagain Bay), Middle Bay, West Bluff, Ocracoke, and Crab Hole off Stumpy Point (Figure 10.8). These sanctuaries are constructed of multiple, high profile mounds using mostly Class B Riprap (fossil stone) and the use of shell and seeded shell as part of the research needs. The Nature Conservancy (TNC), the National Marine Fisheries Service (NMFS) Hurricane grant 2001-2006, state appropriations through DMF, and other mitigation sources provided funding. An additional sanctuary is slated for construction (2006-2007) at an existing artificial reef AR-396 in the Neuse River (off Whitehurst Point). Oyster sanctuaries are not recommended in the southern coastal area of North Carolina due to the large amount of oyster habitat already closed to oyster harvest and serve as sanctuaries.

Other states, Virginia and Maryland, have sanctuaries that are a major component of their restoration efforts. With the introduction of additional oyster sanctuaries, traditional fishing grounds could be impacted. Sanctuaries require acres of bottom in order to function properly and although it is unknown how much protected acreage is really needed, scientists in the Chesapeake Bay region have suggested setting aside at least ten percent of traditional oyster reef acreage (50,000 acres) for sanctuaries. Valuable input from commercial watermen is needed in the development of these areas.

Permanent reef sanctuaries can be used to conduct research to address critical unanswered questions of whether the impacts of oyster diseases are functions of stress inflicted by various bottom-disturbing fishing gear. Transplanting large surviving oysters to sanctuaries may encourage the passage of their disease-resistant traits on to future populations. Additionally, sanctuaries could provide protected bottom for stocking disease-free spat from hatcheries to lessen impacts of DERMO. Oyster sanctuary sites may provide important baseline information needed to enhance the understanding of how oyster communities function in North Carolina.

Oyster sanctuaries are currently protected using the rule 15A NCAC 03H .0103 Proclamation Authority of the Fisheries Director. The DMF Director annually issues proclamations to protected oyster sanctuaries from the taking of oysters and clams. Designating the sanctuaries into rule would permanently protect them from harvest.

CURRENT AUTHORITY

North Carolina Marine Fisheries Rules for Coastal Waters (15A NCAC)
03K .0103 Shellfish or Seed Management Areas

DISCUSSION

Current funding of the Oyster Sanctuary program is sufficient to support continued development of existing sanctuaries, but monitoring and research will be hampered with the reduction in federal funding. Learning from other states sanctuary restoration efforts and success is crucial, with limited funding. The potential loss of fishing grounds for sanctuaries

Table 10.7. Summary of oyster sanctuaries in North Carolina.

	Site	Latitude	Longitude	Material type	Acres	Developed acres	Mounds constructed	Average tonnage per mound	Total tons (rip rap)
1	Croatan Sound	35° 48.240' N	75° 38.401' W	Class B Rip Rap	9.5	3.9	16	N/A	1,800
2	Deep Bay	35° 22.857' N	76° 22.260' W	Class B Rip Rap	21.1	5.0	20	N/A	1,200
3	West Bay	34° 58.814' N	76° 21.413' W	Class B Rip Rap	8.0	2.0	15	N/A	1,600
4	Clam Shoal	35° 17.341' N	75° 37.349' W	Class B Rip Rap	58.6	3.4	26	12@100, 14@ 164	4,100
5	Crab Hole	35° 43.595' N	75° 40.628' W	Class B Rip Rap	37.6	10.3	79	150	11,670
6	Ocracoke	35° 10.727' N	75° 59.744' W	Class B Rip Rap	34.5	5.2	40	150	6,640
7	Middle Bay	35° 14.138' N	76° 30.182' W	Class B Rip Rap	5.7	0.4	45	10 to 21.5	2,050
8	Neuse River	35° 00.420' N	76° 32.000' W	Class B Rip Rap	7.0	4.7	36	150	5,350
9	West Bluff	35° 18.200' N	76° 10.300' W	Class B Rip Rap	20.0	4.7	36	150	4,740
				Total	201.9	39.6	313		39,150

needs to be addressed through public meetings. Criteria for the location of oyster sanctuaries should be implemented to lessen the impact to certain fisheries while still allowing brood stock to populate surrounding harvest locations. Sampling is needed to monitor the sanctuaries and establish their ecological importance in the estuary. Reef construction with different cultch material and dimensional qualities should also be researched.

Mortality due to disease is an increasing concern. Relaying large surviving oysters to sanctuaries or planting certified seed oysters with no detectable trace of disease, could promote characteristics needed to suppress the trends in *Perkinsus marinus* (Dermo) mortality. Another strategy for planting oyster seed on sanctuaries would help augment natural reproduction as well as increase biomass. Currently, there are no state operated hatcheries for shellfish restoration in North Carolina. In 2005, recognizing the need for supplementing current restoration efforts, the North Carolina Division of Aquariums was the designated lead agency in planning construction of oyster hatcheries and developing complementary educational programs at each of the North Carolina Aquariums. These interagency efforts were supported with appropriations ($600,000) recurring, from the North Carolina Legislature. Recommendations are detailed in the North Carolina Oyster Hatchery Program final report submitted to the Joint Legislative Commission on Seafood and Aquaculture in February 2007.

Oyster sanctuaries constructed with higher profile mounds will cause navigation hazards to deep drafted vessels and will require constant marking with buoys. Marking will demand increased funding and place additional burden on Marine Patrol to enforce regulations. All buoys should be constructed with radar reflective materials, and documented with the United States Coast Guard for hazards to navigation.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo – continue to develop and monitor existing sanctuaries
+ Some level of habitat protection
+ Some potential for oyster enhancement
+ No additional loss of traditional fishing grounds
+ Used for research to evaluate for the development of new sanctuaries
+ Some level of artificial finfish habitat
- Limited input from fishermen to lessen impacts to fisheries
- Limited understanding of appropriate areas for oyster enhancement
- Increase sampling effort by DMF
- Funds for cultch material used for unharvestable bottom vs. harvestable bottom

B. Expand the number of designated oyster sanctuaries to increase oyster populations

+ Promote long-term growth/increased fecundity and additional brood stocks
+ Promote development of disease-resistant oysters
+ Provide protected habitat for future stocking efforts
+ Reduce bottom-disturbing gear on enhanced bottom
+ Increase the amount of finfish habitat
- Potential loss of traditional fishing grounds
- Increased law enforcement responsibility
- Increase DMF funding for buoy maintenance
- Funds for cultch material used for unharvestable bottom vs. harvestable bottom

C. Include current and future oyster sanctuaries into rule.
+ Long term protection of oyster sanctuaries
+ Long term protection of brood stocks
+ Provide permanent finfish habitat
- Permanently remove potential commercial fishing grounds
- Reduces flexibility to remove sanctuary designation

D. Plant seed oysters on existing oyster/artificial reef sites
+ Quicker grow-out to breeding stock
+ Possible planting of disease-resistant seed to suppress diseases
+ Method supported in other states (MD and VA)
+ Funds requested through recommendations by NC Oyster Hatchery Program
- Increase sampling effort by DMF
- Unknown impacts from predation
- Availability of funding

E. Discontinue existing oyster/artificial reef sanctuary program
+ Increase harvest areas
+ Allow funds for other projects
- No protected area for oyster recovery/brood stocks
- No protected area for potential disease-resistant oysters
- Decrease the potential for increased finfish habitat

MANAGEMENT RECOMMENDATIONS

DMF/AC - Expand and evaluate the number of designated oyster sanctuaries to increase oyster populations
- Include current and future oyster sanctuaries into North Carolina Fisheries Rules For Coastal Waters Subchapter 03R.
- Plant and monitor seed oysters on existing oyster/artificial reef sites

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

- Investigate areas of sanctuary placement (shallow/deep), size, and impacts to the local fishing grounds.
- Determine sanctuary size, profile, and amount of material needed
- Become educated on other states successful sanctuary programs
- Determine the cost of a sanctuary project (private vs. state)
- Investigate larval dispersal and transport.
- Investigate settlement success on different cultch materials
- Determine the hydrodynamics of the areas for sanctuary placement

10.5 ENVIRONMENTAL ISSUES

10.5.1 NON-NATIVE OYSTER INTRODUCTION ISSUE

ISSUE

Consider the introduction of non-native oysters into North Carolina waters as a means of restoring the oyster resource. The issue was raised during public comments in 1999 and continues to be an issue in this review.

BACKGROUND

The International Council for Exploration of the Seas (ICES) defines movement within the natural range of a species as a "transfer" and movements outside the species' natural range as an "introduction" (Carlton 1992). The introduction of foreign oysters has been of concern in North Carolina since at least 1947. The 1947 session of the North Carolina General Assembly passed Senate Bill 236 which authorized the Board of Conservation and Development to adopt rules and regulations to regulate, control, or prohibit the importation of new species of molluscs such as the Pacific oyster, *Ostrea gigas* (now classified as *Crassostrea gigas*). Oyster introductions have revived or expanded oyster fisheries in many parts of the world including France, Australia, the West Coast of the United States and Maine (Shatkin et al. 1997). Other oyster introductions, both intentional and accidental, have failed or caused problems in the host area (Andrews 1980). Unfortunately, many exotic pests have also accompanied oyster introductions (Shatkin 1997).

There have been numerous, mostly anecdotal, accounts of attempts to introduce and establish populations of Pacific oysters (*Crassostrea gigas*) along the southeast Atlantic and Gulf coasts (Hopkins 1946; Dean 1979; Carlton 1992). There were no known breeding populations or pest/parasite problems established by these introductions until it was proven that the oyster parasite *Haplosporidium nelsoni,* which causes MSX disease, was introduced with Pacific oysters (Burreson 1997).

As oyster populations in the mid-Atlantic region have continued to decline, there have been renewed efforts to consider establishing a non-native oyster population (Mann et al. 1991). The ICES Code of Practice calls for a complete assessment of the need for these introductions as well as a thorough review of the biology and life history of the introduced organism and how it will impact native populations and environments. States involved in oyster introduction testing have chosen to follow the ICES guidelines. The necessary ICES

assessments were delayed due to difficulties in anticipating impacts without the use of overboard testing of the oysters. Genetic manipulations to prevent spawning have been used to overcome objections to overboard testing but early attempts proved to be unreliable causing further delays. Improved genetic methods and vigilant monitoring are now allowing overboard tests in North Carolina, Virginia and Maryland. Previous tests have yielded mixed results. One of the species being tested (Pacific oysters) in North Carolina is apparently resistant to the two oyster parasites active in the mid-Atlantic region and appears to be capable of spawning in local environments (Barber 1996). Problems have occurred because the shell of the Pacific oyster is less dense than native oysters and boring worms have inflicted serious damage (Debrosse et al. 1996). Pacific oysters also suffered high mortality at low and medium salinity sites. Less is known about the Suminoe oyster (*Crassostrea ariakensis*) but it is resistant to endemic diseases and in preliminary tests it survived and grew well at all of the sites where native oysters grew normally. Therefore, the Suminoe oyster has become the leading candidate for a non-native oyster introduction. However, questions remained about the ability of this oyster species to survive over the long term since it is suspected it is more susceptible to predation, low dissolved oxygen, and pollutants than native oysters.

Since 2001 there has been increased political and federal involvement in the non-native oyster introduction issue. Maryland changed its position on the issue and now supports use of non-native oysters. Strong industry interest in the use of Suminoe oysters in 2002 led the Chesapeake Bay Foundation, US Environmental Protection Agency, Chesapeake Bay Commission and the US Senate Subcommittee on Veterans Administration, Housing and Urban Development, and Independent Agencies to request that the National Academy of Sciences (NAS) conduct a review of the potential benefits and impacts of a Suminoe oyster introduction. The National Research Council (NRC), under the direction of NAS, produced a comprehensive report on the Suminoe introduction issue in 2004. The NRC recommended that production of Suminoe oysters be limited to caged culture of triploid stock while further research was conducted on the potential effects of extensive triploid-based aquaculture or introduction of reproductive Suminoe populations.

In 2003, legislation was introduced in Virginia and Maryland legislatures to establish breeding populations of Suminoe oysters in Chesapeake Bay if within three years scientists failed to prove that the introduction would be harmful to the Chesapeake Bay ecosystem. This action was taken in response to promising preliminary testing results with Suminoe oysters and fear of a total loss of the oyster industry in the region without a revival of the oyster fishery. The US Fish and Wildlife Service and National Marine Fisheries Service stated their opposition to the proposed diploid introduction and their intention to block it. The US Army Corps of Engineers (USACE) became the middle man in this controversy since they would require permits for the cages used to grow the Suminoe oysters and the fact that escapement of non-native aquaculture species has been ruled a violation of the Clean Water Act. Escaped non-native species are considered to be a biological pollutant.

Later in 2003, Virginia and Maryland requested the USACE develop an environmental impact statement (EIS) to assess the proposed introduction and the impacts of other oyster restoration alternatives. The draft EIS is scheduled to be released in May or June 2007. A

comprehensive ecological risk assessment (ERA) of oyster restoration alternatives will be the major component of the EIS. A major element of the ERA will be the creation of demographic models for both Eastern and Suminoe oysters that will be used to predict population growth of both species under all the alternatives addressed in the EIS. Data to complete the demographic model dominates the 28 research projects being conducted over three years at a cost of $3 million and funded by NOAA to complete the EIS. All of the research topics came from priorities established by the NRC, Chesapeake Bay Scientific and Technical Advisory Committee, and ICES protocols. About 50% of the projects will be completed by June 2007. The items below (VIMS 2007) summarize some of the most important findings from this work as of January 17, 2007.

Taste testing and marketing – In several taste and marketing tests the Suminoe oyster has been well received. Meat texture and taste are very similar to the native oyster and the oyster packing industry reports good acceptance. The Suminoe oyster has a reduced shelf life compared to the native oyster and this may affect its marketability for the half-shell trade.

Growth Rates – Field trials with sterile Suminoe oysters raised under aquaculture conditions (usually in cages suspended above the bottom) have consistently shown that it has a higher growth rate than the native oyster except at low salinity sites, where the two species have similar growth rates. Under some conditions the Suminoe oyster can reach market size in less than one year.

Growth in Natural Habitats – An ongoing study, scheduled for completion by the end of 2007, is evaluating the performance of the Suminoe oyster in more realistic bottom habitats. Preliminary results indicate that the non-native oyster grows and survives better than the native oyster in some, but not all bottom habitats. This and other studies indicate that this oyster species is capable of forming complex reef structures in some bottom habitats.

Disease susceptibility – Research has shown that the Suminoe oyster is resistant to two parasite-induced diseases, MSX and Dermo, which afflict the native oyster. However, juvenile Suminoe oysters are highly susceptible to another parasite, called *Bonamia*, which has caused up to 90% mortality at some locations. To date this parasite has been observed in North Carolina and South Carolina, and its spread to Virginia, if the Suminoe oyster is introduced, seems likely. Several other disease-causing parasites have been identified in this oyster in its native habitats in Asia, including an oyster herpes-like virus. Studies are underway to determine the potential for these diseases to be transmitted to Virginia waters or to our native oyster.

Effects of Predators and Other Organisms – The Suminoe oyster has a thinner shell than the Eastern oyster and research indicates that it is more susceptible to predation by crabs than the native oyster. The Suminoe oyster is also more sensitive to infestations by a small worm, called *Polydora*, which causes “mud blisters” on the inside of the shells and reduces the marketability as a half-shell product.

Tolerance of Low Dissolved Oxygen – Research is still ongoing that indicates the Suminoe oyster is less able to survive in water with low dissolved oxygen levels than our native

oyster. Whether or not this will have important consequences for the long term survival of this species in East Coast waters is not yet clear.

Interactions with the Eastern Oyster – One of the areas of greatest concern regarding an introduction of the Suminoe oyster is whether it will have a positive or negative impact on populations of our native oyster. There is some evidence that the two species will compete for space and/or food and reduce each other's growth rates. The possibilities also exist that the Suminoe oyster will provide new habitat for the native oyster to settle and grow. It is not yet known how disease impacts may vary if the two oyster species co-occur. Several research projects are currently underway investigating these questions and are scheduled to be completed in early 2008. The most significant evidence of potential interactions between species is discussed in the next paragraph.

Reproductive Interference – The Suminoe oyster and the Eastern oyster do not produce viable hybrids. However, research has shown that the sperm of each species can fertilize the eggs of the other, but that the resulting larvae only survive for few days. The effect of this phenomenon, if the two species co-occur and spawn at the same time, would be two reduce the reproductive success of both species.

Also beginning in 2003, UNC-IMS conducted a study aimed to fill voids in the existing knowledge of Suminoe oyster performance in North Carolina by: (1) assessing growth and survival of the non-native oyster under a wide range of environmental conditions and at different times of the year; (2) incorporating rates of growth and mortality into an economic model which assesses the likely economic benefits to be reaped through culture of the Suminoe oyster; and (3) assessing the environmental risk of release of the proposed introduction through a review of published and unpublished literature on the ecology of the Suminoe oyster in its native waters in Asia (Peterson 2005).

With the assistance of 17 local fishermen, Suminoe oysters were cultured at nine sites across North Carolina. Deployments in fall 2003 and spring 2004 were made at two sites within Bogue Sound and one within the Newport River (Carteret County), three sites at Swan Quarter (Hyde County), and sites at Nags Head, Walterslough and Buxton (Dare County). Oysters were deployed using three methods of culture that were developed after some preliminary trials: (1) bottom culture in racks; (2) water-column culture in racks; and (3) water column culture in floating bags.

Growth, mortality and condition of oysters were sampled in the field every eight weeks. Aside from the 70% mortality of Bogue Sound oysters in fall 2003 due to infection with the parasite *Bonamia*, mortality of oysters was consistently low (Bishop and Peterson 2005a). Of the sites at which oysters were deployed, growth was greatest at the high-salinity sites in Bogue Sound (29-32 ppt) and the Newport River (25-30 ppt) and lowest at the low-salinity site, Nags Head (4 ppt; Bishop and Peterson 2005a). The extremely low growth of Suminoe oysters at Nags Head confirms the previous observation that salinities of less than 10 ppt are unsuitable for culture of Suminoe oyster. Over winter, growth of oysters was greater in fixed racks than in floating bags (Bishop and Peterson 2005a). Oysters in floating bags were subject to greater water motion than oysters in fixed bags and appeared to suffer greater rates

of shell abrasion and chipping. Their lesser rate of growth appeared to investment of energy in thickening the shell instead of increasing shell height. Little difference in the growth of oysters on bottom and raised racks was evident (Bishop and Peterson 2005a). A comparison of rates of oyster growth between intertidal and subtidal heights indicate that although in winter intertidal oysters suffer a growth penalty relative to subtidal oysters, in summer they outgrow subtidal oysters because their shells are less fouled by competitors for food (Bishop and Peterson 2005b). Thus, in summer there may be benefit to culturing oysters intertidally. Using the data collected from field trials and consumer surveys, the likely profitability of medium-sized (500,000 oysters on ~3 acre lease) Suminoe oyster culture operations within North Carolina was evaluated (Grabowski et al. 2005). Analyses suggest that winter growout might produce a ~33-36% annual return on the investment at salinities > 10 ppt because at this time of year survivorship is high and shell infestation with value-lowering mud worms does not occur. In contrast, operations in summer will lose revenue (-18-30% annual return on investment) because of greater mortality rates at high salinities and elevated mud worm infestation rates at mid salinities (Grabowski et al. 2005).

Within its native range, the Suminoe oyster must overcome predation by tiger and jade snails however; the natural environment in which the Suminoe oyster has evolved appears characterized by little risk of crab predation. Thus, the Suminoe oyster may grow and mature rapidly at the expense of producing a robust enough shell to invade a system patrolled by a keystone predatory crab. Experiments to evaluate the susceptibility of Suminoe oysters to predatory blue crabs that are common along the mid Atlantic coast were conducted (Bishop and Peterson 2005c). Satiated blue crabs consumed nearly three times as many Suminoe as Eastern oysters of 25-mm and eight times as many of 35-mm shell-height. Despite smaller (30 mm) Suminoe oysters suffering twice the predation rate of simultaneously offered large (40 mm) Suminoe oysters, when 40-mm Suminoe were paired with 30-mm Eastern oysters, seven times as many of the larger Suminoe oysters were consumed. Mechanical trial-and-error rather than prey preference explained the greater susceptibility of the Suminoe oyster to blue crabs. The present importance of blue crab predation in limiting recruitment of native Eastern oysters implies an even greater role in limiting proliferation of introduced Suminoe oysters (Bishop and Peterson 2005c).

Other literature generated from this research project included:

Bishop, M.J. 2005. Culture of oysters in a shallow tidally-flushed system: how provision of ecosystem services can occur without significant ecological cost. Marine Ecology Progress Series.

Bishop, M.J. & P.J. Hooper. 2005. Flow, stocking density and treatment against *Polydora* spp.: Influences on nursery growth and mortality of the oysters *Crassostrea virginica* and *C. ariakensis*. Aquaculture. Vol. 246, pp. 251-261.

Bishop, M.J. & C.H. Peterson. 2005. Consumer ratings of the Suminoe oyster, *Crassostrea ariakensis,* during home cooking. Journal of Shellfish Research.

Burreson, E.M., N.A. Stokes, R.B.Carnegie & M.J. Bishop. 2004. *Bonamia* sp. (Haplosporidia) found in non-native oysters, *Crassostrea ariakensis*, in Bogue Sound, North Carolina. Journal of Aquatic Animal Health. Vol. 16, pp. 1-9.

CURRENT AUTHORITY

North Carolina General Statutes
113-182. Regulation of fishing and fisheries
143B-289.52. Marine Fisheries Commission – powers and duties

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03I .0104 Introduction and Transfer of Marine and Estuarine Organisms

DISCUSSION

ICES protocols require that only quarantined offspring that have been immediately separated from their parents, washed and thoroughly examined be introduced into host waters. There have been no occurrences of an introduced disease or pest associated with an introduction following ICES guidelines since their inception in 1973 (Peterson 1999). Based on oyster introductions in other areas, there are additional concerns and several positive factors to judge in considering the introduction of a non-native oyster.

Additional concerns include competition with remaining native oyster populations. The possibility that non-native oysters could eliminate future recovery of native stocks through their superior physiology is a concern to managers. Non-native oysters introduced successfully in other parts of the world have faster growth rates, better reproductive success, and higher resistance to parasites and diseases than our native oysters. On the other hand, non-native oysters have generally not responded well to the harsh environmental conditions found in the mid-Atlantic area and may compete with native oysters for settlement habitat then suffer heavy mortality prior to full development. This scenario could lead to a situation where there are no harvestable shellfish resources and nuisance non-native shellfish populations. Native and non-native oysters may also spawn at similar temperatures causing cross-fertilization between species. The offspring of these crosses are viable thereby possibly reducing the reproductive potential of both native and non-native oysters.

If state authorities determine there is no hope for reviving native oyster stocks, then the positive aspects of establishing a non-native oyster population should be considered. Since it is possible to select a reef-building oyster for introduction, the ability of that oyster to restore and maintain the habitat services provided by Eastern oysters is vital to maintaining healthy estuaries. A viable non-native oyster population would also provide for the restoration of water filtration capabilities formerly provided by native oysters. Water filtration by oysters decreases suspended sediments and promotes denitrification. Calculated clearance rates indicate Pacific oysters have double the water filtration capacity of native eastern oysters (Peterson 1999). Filtration capacity of Suminoe oysters is expected to be similar to that of Pacific oysters. The reestablishment of a viable oyster fishery would also help preserve a traditional way of life in coastal communities.

This discussion assumes that a complete introduction by establishing a breeding population in the wild is suggested. Public comments were nonspecific on the type or extent of the proposed introduction. Current testing of non-native oysters in NC is being conducted based on aquaculture use only. Recent testing with the Suminoe oyster in the Virginia portion of Chesapeake Bay has been so successful that testing by traditional oyster growers is being conducted. For a complete discussion of the concerns and positive effects relating to the current experiments, see Peterson et al. 1999.

MANAGEMENT OPTIONS/IMPACTS

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

A. Oppose non-native oyster introductions and withdraw support of current non-native testing
+ Maintains direct focus on reestablishing native oysters
+ Requires solving environmental problems affecting native oysters
+ Removes environmental risks associated with use of non-natives
- Provides no options if oyster decline continues

B. Continue current testing for aquaculture use of non-spawning, non-native oysters
+ Provides data on future options for oyster aquaculture
+ May provide data applicable to consideration of an introduction into the wild
+ Adds to the body of knowledge concerning safe non-native testing
- Weakens the focus on native oyster problems
- Introduces some small risk to native populations and environments

C. Expand testing using reproductively competent non-native oysters in wild settings
+ Provides the best data on which to base a decision to introduce the non-native
- Creates an extreme risk for an accidental introduction which may have irreversible negative effects on estuarine habitats and other species

D. Introduce non-native oysters without further testing
+ May provide a rapid end to oyster production problems
- Creates an extreme risk for native oysters
- Requires large scale expenditures with no prediction of results
- Will likely be opposed by other states – legal action
- May have irreversible negative effects on estuarine habitats and other species

E. Review the results of the completed EIS on the proposed introduction of Suminoe oysters in Chesapeake Bay and consult with sister states concerning use of these non-native oysters
+ Provides the most comprehensive review of the possible impacts of an introduction using the most robust methodology

+ Adopts a timeline that coincides with similar decisions in other states
- This issue will probably never be fully resolved

MANAGEMENT RECOMMENDATIONS

DMF - Review the results of the completed USACE EIS on the proposed introduction of Suminoe oysters in Chesapeake Bay and consult with sister states concerning use of these non-native oysters

AC - Oppose non-native oyster introductions and withdraw support of current non-native testing
- All further non-native oyster research must be approved by the MFC Shellfish AC or an oversight committee to ensure there are no biological contamination issues and protocols are created to eliminate any possible impacts to the native oyster stock of North Carolina

MFC Selected Management Strategy – Same as DMF

RESEARCH RECOMMENDATIONS

None

10.5.2 WATER QUALITY DEGRADATION BY BIOLOGICAL CONTAMINATION OF SHELLFISH GROWING WATERS

ISSUE

The increased closures of shellfish waters due to water quality degradation from stormwater runoff.

BACKGROUND

Laws, regulations, and commissions exist to ensure proper balance among all user groups such as fishermen, swimmers, boaters and developers, along with providing adequate protection of the environment. The federal Clean Water Act, enacted by the U.S. Congress in 1972 establishes standards to maintain and restore the integrity of the nation's waters. There are provisions that address pollution of shellfishing waters as well as other water quality issues. One of the most powerful provisions is the protection of the existing uses of public waters in order to prevent further degradation of water quality. Any development permits, dredge and fill permits, or wastewater treatment plant permits issued must comply with these water quality standards. Within the state of North Carolina, there is a set of water quality classifications for both salt water and fresh water determined by the Environmental Management Commission (EMC). These classifications are based on the use that is being protected. Classifications cannot be downgraded if the change eliminates the existing use or the use can be regained.

Class SA Waters. These waters are protected for market purpose shellfishing and have stringent bacteriological standards. Molluscan shellfish, like clams and oysters, are water quality sensitive and are often utilized as environmental indicators because of their sessile lifestyle and ability to concentrate various biological and chemical pollutants up to 1,000 times greater than the concentration of those pollutants found in their surrounding environment. Sewage spills and stormwater runoff into shellfish growing areas may not adversely affect shellfish, but can lead to human illness when shellfish from those areas are consumed. The national standard uses fecal coliform bacteria as an indicator to assess the risk of contracting a human pathogen from consuming raw or partially cooked shellfish. Therefore, fecal coliform bacteria numbers must be low in SA waters.

Class SB Waters. These waters are classified for swimming, skiing and fish propagation. No untreated sewage is allowed into these waters and wastewater treatment plants should have backup systems to insure no untreated sewage is allowed into these waters.

Class SC Waters. These waters are for incidental swimming and fish propagation. These waters are safe for swimming but there is a higher risk of pollution and human illness than in SB waters. Treated sewage is allowed into these waters if it does not affect the use of the waters. Any treated sewage in SC waters must not affect SB or SA waters farther downstream.

Outstanding Resource Waters (ORW). This designation is an addition to the above classifications and provides additional protection for the state's most valuable waters. This classification allows for protection of waters without significant pollution sources and was implemented by North Carolina to carry out federal requirements that exceptionally valuable waters be protected.

Nutrient Sensitive Waters (NSW). This designation is applied in addition to the basic classification and provides limits for nutrient discharge.

High Quality Waters (HQW). This designation includes all SA waters and nursery areas and is applicable to streams with high quality biological and chemical characteristics.

A classification of Use Restoration Waters (URW) was proposed in 1995 by DWQ to address further degradation of closed shellfish harvesting waters. The EMC decided not to use the title as an actual classification, but to establish a program with limited staff assigned to develop the program. Staff have been working with EPA to identify watersheds that have opportunities for restoration and developing Partners and Champions for those watersheds followed by the development of watershed restoration strategies. Although EPA did not have funds for this program, DWQ was able to secure some funds to assist the local interests in developing watershed restoration activities after developing a watershed restoration plan.

The Division of Environmental Health Shellfish Sanitation and Recreational Water Quality Section is responsible for monitoring and classifying coastal waters as to their suitability for shellfish harvesting for human consumption. The Shellfish Sanitation Program is conducted in accordance with the guidelines set by the Interstate Shellfish Sanitation Conference

contained in the National Shellfish Sanitation Program (NSSP) Guide For the Control of Molluscan Shellfish Model Ordinance. The NSSP is administered by the U.S. Food and Drug Administration, is based on public health principles and is designed to prevent human illness associated with the consumption of molluscan shellfish. Sanitary controls are established over all phases of the growing, harvesting, shucking, packing and distribution of fresh and fresh-frozen shellfish. Recommendations are made to the Division of Marine Fisheries to close those waters that have the potential for causing illness and open those waters that are assured of having clean, healthy shellfish. Growing areas are classified based on fecal coliform contamination criteria.

Approved Growing Areas. No contamination with fecal material, pathogenic organisms, poisonous or deleterious substances or marine biotoxins.

Conditionally Approved Open Growing Areas. Sanitary Survey indicates an area can meet approved area criteria for a reasonable period of time and the pollutant event is known and predictable and can be managed by a plan.

Conditionally Approved Closed Growing Areas. Sanitary Survey indicates an area can meet approved area criteria on occasion and the pollutant event is known and predictable and can be managed by a plan.

Restricted Growing Areas. Sanitary Survey indicates limited degree of pollution and the area is not contaminated to the extent that consumption of shellfish can be hazardous after controlled depuration or relaying.

Prohibited Growing Areas. No Sanitary Survey is conducted. Point source discharges and marinas exist in the area. Data do not meet criteria for approved, conditionally approved or restricted classifications.

Waters with the SA designation that are permanently or temporarily closed to shellfish harvest due to high levels of fecal coliform bacteria, but maintain the SA classification are technically not meeting their uses under the federal Clean Water Act. These waters are considered to be “impaired” and are required by federal law to be put on the state’s list of impaired waterbodies. For all waterbodies on the list, the source of pollution must be determined and controlled. If standard management measures cannot control the source, then the federal law requires that North Carolina develop a daily limit for how much of the pollution source causing the impairment is allowed into receiving waters. The Division of Water Quality (DWQ) is tasked with the developing these daily limits. DWQ lists several projects in its draft 2006 list of impaired waters that are aimed at controlling some of the sources of fecal coliform impairment, such as best management practices to reduce stormwater runoff in coastal areas.

The Coastal Zone Management Act was also enacted by the federal government in 1972 to encourage states to develop coastal management programs that balance wise development with protection of natural resources. These programs must meet federal requirements in return for funding and a voice in federal actions affecting their coasts. The North Carolina

Coastal Area Management Act (CAMA), established in 1974, meets these federal requirements and applies to 20 coastal counties. Through this act, Areas of Environmental Concern (AEC) are established along with local land use plans. This ensures balancing environmental preservation with economic growth. AECs are sensitive valuable areas that require special protection. AECs include estuarine waters and public trust areas, estuarine shoreline, coastal wetlands, ocean hazard areas, public water supplies and natural and cultural resource areas. For any development in AECs that requires land or water disturbance, a permit is required from Division of Coastal Management. Exceptions to this permit requirement include some agricultural and forestry activities and maintenance of existing public roads and utilities. Construction of energy facilities and emergency repairs if life or property is in imminent danger are also exempt from CAMA permitting.

One of the findings of a legislative committee formed to study all factors affecting the coastal fishing industry was that management and protection of SA waters was hampered because the responsibility for regulating activities impacting these waters was shared among three state commissions: the EMC, the Marine Fisheries Commission (MFC) and the Coastal Resources Commission (CRC). This finding resulted in the production of the Coastal Habitat Protection Plan (CHPP). The adoption of the CHPP in 2004 brought these commissions together to cooperate in a multi-agency effort to protect and restore both fisheries habitat and water quality. The CHPP identifies threats and management needs for each habitat and recommends administrative, regulatory and non-regulatory steps necessary to protect, restore and enhance fisheries habitat. The implementation of the CHPP involves new activities and revised priorities for existing programs within DENR and other agencies.

At the time of the implementation of the 2001 Oyster FMP and Hard Clam FMP, the CHPP had not been adopted. Recommendations from the 2001 FMPs were to increase use of existing statutory authority (permit comments, CHPP development) and to develop strategies to restore water quality of closed shellfish harvest areas by classifying conditionally approved open shellfish waters as partially supporting; classifying conditionally approved closed shellfish waters as not supporting; adopting standards that limit total impervious cover immediately adjacent to SA waters to 10 percent; and requiring mitigation that results in water quality enhancements in permanently closed areas and recommend specific changes to DWQ and EMC. These recommendations substantially support the strategies laid out in the CHPP; however, all FMPs must now conform to CHPP standards for coastal habitat protection.

CURRENT AUTHORITY

North Carolina General Statutes

143B-279.8. Coastal Habitat Protection Plans

143B-289.52. Marine Fisheries Commission - powers and duties

1130202. New and renewal leases for shellfish culture; termination of leases issue prior to January 1, 1966

DISCUSSION

In spite of all these efforts to protect water quality, population growth has resulted in increased land disturbing activities in the coastal areas. Stormwater runoff is the number one water quality problem in the state and accounts for the majority of shellfish closures. North Carolina's most valuable waters, ORWs have experienced increased closures since the program's inception in October 1989 (Table 10.8). In 2006, Shellfish Sanitation reclassified 1,925 additional acres as Prohibited and 590 acres were reclassified from Conditionally Approved Open to Conditionally Approved Closed (Shellfish Sanitation 2006).

Table 10.8. ORW Acreage Opened and Closed since Oct 1989 (Shellfish Sanitation Data).

ORW	Closure Area	Closed	Acres	Opened	Acres
Masonboro Sd.	Inlet Pt Harbor Marina	6/1998	1		
	Myrtle Grove Sd	5/1999	75		
	Inlet Pt Harbor Marina	5/2004	1		
	Hewletts Crk	12/2006	93		
Topsail/Middle Sd	Howe Crk	12/1991	130		
	Futch Crk	4/1993	50	5/1996	38
	Mill Crk	4/1993	73		
	Old Topsail Crk	4/1993	202		
Stump Sd	Turkey Crk	5/1992	25		
	Galleon Bay	8/1994	25		
	Spicer Bay	8/1995	50		
	ICW Rogers Bay Area			1/1996	20
	Spicer Bay	10/2004	20		
W. Bogue Sd	Archer Crk	7/1995	20		
	Sanders Crk	3/1996	77		
	Deer Crk	5/2000	60		
	Bogue Sd Yacht Club	5/2004	1		
	Hunting Island Crk			10/2004	15
	Sanders Crk			10/2004	30
	Cannonsgate Marina	6/2006	6		
Core/Back Sd	Marinas	7/1990	2		
	Cedar Crk	4/1994	40		
	Glover Crk	4/1994	25		
	Middens Crk	12/2006	5		
	Williston Crk	12/2006	17		
Swanquarter/Juniper Bay	Swanquarter Bay	5/1990	405		
	Juniper Bay	7/1990	155		
	Swanquarter Bay			11/1993	300
	Swanquarter Bay	4/1998	100		
		Total	1658	Total	403

The Division of Water Quality (DWQ) has recently reviewed a number of scientific studies that demonstrate that areas with greater than 10 to 15% impervious surfaces without structural stormwater controls result in some level of water quality degradation. In addition, DWQ has concluded that three coastal stormwater programs adopted in the late 1980s have been ineffective in protecting shellfishing use. The Coastal Stormwater Program, the Shellfishing Waters Programs and the Outstanding Resource Waters Program allow low-density development (with built upon areas of between 25 to 30% impervious surfaces) to be constructed without engineered, or structural, stormwater controls. A review of DWQ's permitting database indicates that since 1988, 72% of impervious surfaces have been built in the 20 Coastal Counties under the low-density provisions of these stormwater programs. However, studies conducted in the southern tidal creeks of North Carolina showed that these stormwater rules were ineffective and closures of SA waters will continue unless changes are made in the low density provisions (Tom Reeder, Division of Water Quality, personal comment).

Based on federal mandates, these findings and an associated review of the scientific literature, DWQ has begun implementation of two new programs. The Phase II Stormwater Rules were passed in July of 2006 and implementation should begin in July of 2007. At present, this federal program affects the southeast counties of Onslow, New Hanover and Brunswick and no other coastal counties. Within these rules, there are two classifications of waters, SA and Shellfish Resource Waters (SR) (Table 10.9).

Table 10.9. Coastal county phase II requirements.

	SR Waters* (SA waters with > 500 ppm chlorides)	SA Waters* (waters classified as shellfishing waters)	Non-SA area
Low Density (impervious surfaces)	12%	24%	24%
High Density (Stormwater Control Amounts)	1-yr, 24-hr storm	Runoff from 1.5" rain	Runoff from 1.5" rain
Density Limits	25% within 575' of SA waters	25% within 575' of SA waters	None
Buffer from waterways	30 ft vegetated buffer	30 ft vegetated buffer	30 ft vegetated buffer
Threshold	1 acre	1 acre	1 acre

* Apply within ½ mile and draining into these waters

The other program is a voluntary program called the Universal Stormwater Management Program (USMP) that went into effect on January 1, 2007 and can be adopted at a local government's discretion. This program removes the high and low density provisions and requires some sort of treatment of all stormwater runoff on a site. The USMP is available to local governments. For those governments located in the 20 coastal counties that adopt the program, it outlines requirements that apply to development and redevelopment activities that disturb 10,000 square feet or more, or disturb less than 10,000 square feet but are part of a

larger common plan of development or sale. Because the USMP is optional, it will only be successful if it is able to gain support at the local level.

Because the Phase II rules only address three coastal counties, DWQ has proposed amendments to the Coastal Stormwater Rules that would implement stormwater controls similar to the Phase II requirements in all the coastal counties. This will affect both SA rules and Non-SA rules and would be uniform across coastal NC (Table 10.10). The MFC resolved to support EMC in incorporating these Phase II requirements and the proposed revision of the Coastal Stormwater Rules for all 20 CAMA Counties.

Table 10.10. Proposed amendments to coastal stormwater rules in SA waters*

	Proposed Rules	Current Rules
Low Density	12%	25%
Buffer from waterways	30 ft vegetated buffer	30 ft vegetated buffer
High Density (Stormwater Control Amounts)	1-yr, 24-hr storm	Runoff from 1.5" rain

* Activities within ½ mile and draining to SA waters

Proposed stormwater rules, along with alternative language being considered include alternatives of 10,000 square feet of land disturbance versus one acre or greater, a 30ft vegetated buffer versus a 50ft vegetated buffer and whether to exclude coastal marsh or all wetlands from impervious surface calculations. These proposed rules and their alternatives would require review by the EMC and public hearings before they can be adopted. The earliest they could become effective would be the summer of 2008.

Vegetated buffers have been used as BMPs since the 1950s and are naturally vegetated transitional zones between land and the land/water interface and function as a barrier/filter for surface water runoff. Vegetated buffers improve water quality by removing sediment, nutrients, chemicals and bacterial/viral agents from the surface water before reaching riparian and coastal waters. The effectiveness of a vegetated buffer in controlling pollutant and sediment removal is a function of its width. A fifty foot buffer will effectively remove 70% or more of sediment and pollutants from stormwater runoff while a thirty five foot buffer will only remove 60% (DCM 2002).

With the increased degradation of shellfishing waters, there are also concerns about closures of shellfish leases due to pollution. Shellfish leases that do not meet certain criteria concerning percentage of days closed to harvest due to pollution cannot be renewed under the existing statutory and rule standards. These statutes also prohibit issuance of new shellfish leases in areas closed to shellfish harvest because of pollution. There are serious concerns related to congregating dangerous food products such as polluted shellfish in high concentrations in marked areas such as leases. Shellfish Sanitation has concerns with lease areas in waters that are closed because of the potential of shellstock from these waters causing a public health risk if harvested illegally. Additional enforcement and patrols of closed waters containing leases might solve their concerns. Other than the recommendation in the Blue Ribbon Advisory Council's report, there has been no action to change the statutory prohibition on shellfish leasing in polluted areas in North Carolina. Eight leases

have been terminated since 1987 with the latest terminations occurring in 2003, when two leases were terminated. Leases in polluted areas that are not up for renewal cannot meet production requirements.

New applicants would apply for shellfish leases in areas currently closed due to pollution because many of these closed areas are adequate growing areas and are near areas offering better opportunities for surveillance and access. Some areas that might be suitable for shellfish leases because of low existing shellfish resources are not sampled sufficiently to allow them to be classified as conditionally approved areas. Currently sampling efforts by DEH are concentrated in areas with high existing resource and high probability for conditional openings. Identification of these areas as URWs may be an option if these waters were located where moderate bacterial contamination and otherwise good habitat are available. Complete restoration to an open harvest status insures access by shellfish harvesters and culturists. Another option would be for DMF and DEH to execute a cooperative agreement where areas found to have suitable shellfish culture conditions, low likelihood of permanent closure, and interest from shellfish culturist would receive the additional sampling necessary to establish a conditionally approved classification. However, the shellfish lease application rate of less than 4 per year does not appear to warrant much additional effort to expand the area available for shellfish leases (DMF Resource Enhancement Section).

DWQ is currently revitalizing the URW program. Funding for this program has become available from EPA's 319 restoration funding and the North Carolina's Clean Water Management Trust Fund. Goals of the URW program include the prioritization of waters for restoration, promotion and support of restoration of impaired waters and to improve documentation of restoration.

Conditionally approved closed waters can be opened to shellfishing on a temporary basis if management plan criteria for those growing waters are met. However, a marina can be permitted in conditionally approved closed waters and even though data indicates the area can open for direct harvest of shellfish on a temporary basis, the area in and around the marina facility must remain closed in accordance with DEH rules. DWQ considers conditionally approved closed waters as not meeting their use and degradation of those waters by permitting additional marinas will not cause any additional "loss of use" of those waters. Therefore, a different designation such as the URW classification by DWQ to restore the best use may help prevent further degradation of these waters. In addition, strategies to protect URWs from further degradation from development activities should also be considered.

Establishing the URW classification for Conditionally Approved Closed Waters where there is good habitat could prevent further degradation of these waters. However, the accumulation of smaller docking facilities could still prevent restoration of closed harvesting areas. Proliferation of smaller docking facilities may be allowed everywhere except along PNA shoreline (reference to recent policy decisions by DCM). In PNAs, docking facilities will be limited to a minimum depth designed to preserve the area's nursery function. So the most expedient alterative would be to designate URWs where there are also PNAs. While no

dredging or trawling are allowed in PNAs, hand harvest methods could be allowed in an area once it has been restored to open status. Currently, URWs are used to identify watersheds with opportunities for restoration and developing partnerships. There is a need to make sure restorable watersheds such as Conditionally Approved Closed Waters are targeted for restoration, and encourage regulatory policy changes regarding development along those waters.

Studies have been conducted indicating actions that can be initiated now which can reduce the extent of some closed harvesting areas, or at least slow or halt the overall increase in closures. By developing an assessment of water quality and shellfish resources in different growing areas, management strategies could be developed to protect the designated uses of each growing area (Robinson and Horzepa, 1988). In order to do this, all available information on water quality and shellfish resources in a growing area must be gathered and evaluated. The results of this assessment would be used to establish management goals and objectives for each growing area. This would insure a consistent and defendable framework for use by the various state agencies as they comment on permit applications that may affect coastal water quality.

Other strategies for coping with shellfish harvesting closures involve acceptance of the fact that closures are going to continue to occur and that different standards could be adopted concerning oyster consumption. The present National Shellfish Sanitation Program standard for bacteriological water quality of shellfish harvest areas assumes that all shellfish could be consumed raw. This assumption requires a very high standard for the waters where shellfish are harvested. In Japan there are standards for cooked consumption and raw consumption. Even though Japan is heavily populated and highly developed in many areas, they are able to utilize almost all of their waters for shellfish production. Most of these waters would be closed to harvest if they occurred in the United States due to higher bacteriological counts.

There has also been discussion of researching different indicator organisms to assess the contamination of shellfish harvest waters. While fecal coliform bacteria are found in the intestinal tract of all warm-blooded animals and indicate the presence of fecal contamination from those animals, they are not specific to the organisms of primary concern to human health, which are viral disease pathogens. More specific indicators of potential human health risks could lead to a reduction in the area of closed shellfishing waters. However, early attempts at locating such an organism have failed and the present system provides a risk adverse approach to protecting human health.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ No additional funds or staff needed to implement
- Continued degradation of water quality and shellfishing closures

B. Continue use of existing statutory authority (permit comments, CHPP development)

+ Makes use of authority to protect water quality
+ Ensures coordination with sister agencies
+ Utilizes existing procedures and information
- Based on a system that has failed in the past
- No defined mechanism for restoration of water quality

C. Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation.

+ Makes use of commenting authority to protect water quality
+ Ensures coordination with sister agencies
+ Utilizes existing procedures and information
- No rules in place now to stop development of projects that are detrimental to water quality

D. Change operational policy and rules to increase shellfish lease use of marginal polluted areas.

+ Allows use of existing prohibited-harvest sites for leases
+ Minimal increase in enforcement burden
+ Maintains minimal risk of poaching of contaminated product
- Allows no additional use of areas closed to shellfish harvest for leasing
- Potential increase in Shellfish Sanitation workload
- Current application rates indicate little need for more lease area

E. Accept closures and develop new standards for shellfish consumption (Recommend changes through the Interstate Shellfish Sanitation Conference)

+ Places little burden on the public
+ Could potentially reopen many areas to shellfish harvest
- Greatly increases potential for water quality problems other than shellfish harvesting closures
- Requires vast modifications to harvesting and marketing rules and enforcement
- Requires a substantial public education effort
- May increase public health risk especially until new consumption habits are learned
- Public health risks would still exist for contaminants other than bacterial
- New indicator for classification of waters would be required
- Interstate Shellfish Dealers would still have to meet the NSSP standard

F. Recommend DWQ to designate Use-Restoration waters in conditionally close waters where moderate contamination and healthy shellfish beds are present and develop strategies to restore and protect those waters.

+ Would help target restoration funds to appropriate watersheds.
+ Would include closed shellfish harvesting areas regardless of their coincidence with PNAs.

- Would not necessarily prevent further degradation of the water from either prop dredging associated with shallow docks or marina development.
- May be harder to designate a more extensive area.
- If development additions counteract restoration activities, there will be no net increase in harvestable waters.
- Would require large amounts of funding and manpower to perform assessments and implement strategies

G. Recommend DWQ designate Use-Restoration waters in PNAs where moderate contamination and healthy oyster beds are present and develop strategies to restore and protect those waters.

+ Would help target restoration funds to appropriate watersheds.
+ Would be easier to designate a smaller area with a history of more stringent protections.
- Ignores closed shellfish beds in non-PNA waterbodies.
- If development additions counteract restoration activities, there will be no net increase in harvestable waters.

H. Recommend DWQ designate Use-Restoration waters in areas where moderate contamination and appropriate shellfish culture conditions are present and develop strategies to restore and protect those waters.

+ Would help target restoration funds to expand shellfish culture.
+ Identifies an additional need for restoration.
- Current application rates indicate little need for more lease area
- Benefits of restoring waters with an existing shellfish resource are much greater

Management option I. below was added after Habitat and Water Quality Committee review on 8/13/07 and has not yet been considered by DMF and the AC in development of management recommendations.

I. Support the establishment of mandatory buffer zones, of scientifically based and effective widths and configurations that protect habitat and water quality, along all streams draining to coastal fish habitat in North Carolina.

+ Provides the broadest coverage of a measure that effectively reduces non-point source pollution
- Requires new rules that may be strongly opposed by traditional economic interests
- DCM has already tried to increase the area of protective buffers with little success

MANAGEMENT RECOMMENDATIONS

DMF/AC - Support DWQ's efforts to improve stormwater rules through permit comments, CHPP implementation and coordination with sister agencies.

- Recommend DWQ to designate Use-Restoration Waters in conditionally closed waters where moderate contamination and healthy shellfish beds are present and develop strategies to restore and protect those waters.
- Recommend DWQ designate Use-Restoration waters in areas where moderate contamination and appropriate shellfish culture conditions are present and develop strategies to restore and protect those waters.
- Recommend to DWQ to lower the stormwater rule threshold level to 10,000 square feet.

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

Continue research on means and methods for reduction of non-point source pollution and mitigation of pollutant effects in the estuary.

10.5.3 EDUCATION ON PUBLIC HEALTH RISKS ON EATING SHELLFISH AND OVERBOARD DISCHARGE OF WASTE

ISSUE

Consumption of raw and partially cooked molluscan shellfish harvested from contaminated waters is known to cause human illness. In the last thirty years, 1,274 illnesses have been traced to overboard discharge of human waste from shellfish harvesting vessels (ISSC 2006). In an effort to prevent further outbreaks, the National Shellfish Sanitation Program (NSSP) has mandated harvester education about overboard discharge. Currently, the Division of Marine Fisheries does not have an educational program for harvesters. The purpose of this issue paper is to describe the compliance requirements and suggests ways of meeting our educational obligations.

BACKGROUND

In the USA, typically 85% of seafood related illnesses are caused by consumption of raw or undercooked molluscan shellfish (Ahmed 1991). Consumption of molluscan shellfish from non-approved waters is the primary cause of illness along with waters contaminated by overboard discharge of human waste. Prevention of illness due to consumption of molluscan shellfish begins with ensuring shellfish are harvested from approved waters, are handled in a sanitary manner, are brought under temperature control quickly, that any further processing is conducted under strict sanitary guidelines and all shellfish are properly tagged and labeled. Perhaps the foremost means of preventing illness is consumer education about the risks involved in consuming raw shellfish and industry education about safe and sanitary means of handling.

Public health controls of shellfish became a national concern in the U.S. in the late 19th and early 20th century when public health authorities noted a large number of illnesses associated with consuming raw oysters, clams, and mussels. During the winter of 1924, a widespread

typhoid fever outbreak occurred, which resulted in a request that the Surgeon General of the United States Public Health Service develop necessary control measures to ensure a safe shellfish supply to the consuming public. This program continues today as the NSSP governed by the Interstate Shellfish Sanitation Conference (ISSC) of which the Division of Environmental Health (DEH) and the Division of Marine Fisheries (DMF) are voting members.

The NSSP is the federal/state cooperative program recognized by the U.S. Food and Drug Administration (FDA) and the ISSC for the sanitary control of shellfish produced and sold for human consumption. The purpose of the NSSP is to promote and improve the sanitation of shellfish (oysters, clams, mussels and scallops in any form, except when the final product form is the adductor muscle only) moving in interstate commerce through federal/state cooperation and uniformity of State shellfish programs. Components of the NSSP include program guidelines, State growing area classification, dealer certification programs, and control of harvesting and FDA evaluation of State program elements. Program requirements and guidelines are contained in the NSSP Model Ordinance. The Food and Drug Administration assesses state compliance to the NSSP by annual state reviews. The FDA has the authority to limit interstate shipment of product found to be out of compliance with the NSSP.

In North Carolina, the DEH, Shellfish Sanitation Program classifies shellfish growing waters and certifies shellfish dealers in accordance with the guidelines of the NSSP Model Ordinance (NSSP 2004). The Division of Marine Fisheries is responsible for licensing shellfish harvesters and dealers and enforcing the Rules of the Marine Fisheries Commission regarding harvest, harvest seasons, size and bag limits and tagging. The DMF Director has proclamation authority to open and close harvesting areas upon recommendation from the DEH.

The ISSC strongly advocates education as one of the foremost means of informing the public of the risks involved in consuming raw shellfish. Furthermore, through the Shellfish Sanitation Program dealer certification process, all shellfish dealers are adequately informed of safe handling and record keeping practices. It is also a requirement of the NSSP Model Ordinance in Chapter VIII, Control of Shellfish Harvesting, that the State shall educate all licensed harvesters and shellstock dealers concerning the public health significance of discharging human sewage overboard (NSSP 2003).

The Division of Marine Fisheries License office has available two informational papers, one identifying where harvesters can purchase tags and the other entitled “Important Message to Shellfish Harvesters” from the DEH. The DEH paper briefly discusses classification of growing areas, hazards from contaminated shellfish and requirements for overboard discharge. It is the decision of the purchaser of the license to obtain these informational papers.

CURRENT AUTHORITY

Division of Environmental Health Rules (15A NCAC 18A)

Section .0300 - .0800 Sanitation of Shellfish
Section .0900 Classification of Shellfish Growing Waters

DISCUSSION

The NSSP Model Ordinance stipulates that shellfish harvesters are educated about the potential problems that can occur with overboard discharge of human waste. In summary, some form of approved waste container must be on board each harvesting vessel. This could be met by having an approved Marine Sanitation Device or a portable toilet on board or simply a bucket with a tight fitting lid.

In Louisiana, as in some other states, oyster harvesting may occur continually over many consecutive days in large vessels. In comparison, shellfish harvesting trips in states like North Carolina generally work just around the low tides on smaller skiffs. For this reason, NC has submitted an issue to the ISSC to waive NC from the requirement for harvest vessels to have a waste container on board.

Whether or not the ISSC waives this requirement for North Carolina is a mute point. DMF should obligate itself to inform harvesters of the significance of dumping any human waste overboard in shellfish harvesting waters. Educational measures could be extended to any vessel operating in approved shellfish harvest waters.

The ISSC has recently produced a brochure and DVD entitled "The Safe Handling of Shellstock, Overboard Discharge and No-Discharge Zones" which is available for states to distribute and use in educational programs. These items could be made available in all license offices, available on our website or used and provided during other training events. The option is also available to have DMF Port Agents distribute the brochure to shellfish harvesters and shellfish dealers during their routine contacts.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo
+ Overboard discharge of waste into shellfish growing waters in NC has not been confirmed as a vector of illness
- NC would be out of compliance with the ISSC regarding mandatory education for harvesters about overboard discharge

B. Provide educational materials to harvesters in license offices and webpage, through other training opportunities and through DMF Port Agent contact with harvesters and dealers.
+ Educational material will advise harvesters on the significance and prevention of overboard waste discharge
+ Maintains NC compliance with NSSP

- May not be read by harvesters

C. Develop "No Discharge Zones" in all approved shellfish growing areas.
+ Would provide enforcement authority for violations of overboard discharge
- Enforcement would be difficult in all areas

MANAGEMENT RECOMMENDATIONS

DMF/AC - Provide educational materials to harvesters in license offices and webpage, through other training opportunities, through DMF Port Agent contact with harvesters and dealers, include other state and federal regulatory agencies to reach all coastal waters users.

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.5.4 WARDS CREEK SHELLFISH MANAGEMENT AREA

ISSUE

The review the management of Shellfish Management Areas (SMAs) in the central portion of the state. The impetus is an action taken in 1995 to protect oyster rocks in Wards Creek, a tributary of North River, from destructive clamming methods. In January of 2007, the Director superseded the 1995 action and allowed oysters and clams to be harvested by hand rakes, tongs or by hand. It is necessary to determine how the SMA should be managed in the future.

BACKGROUND

Complaints by several individuals in 1995 that the oyster rocks in Wards Creek were being destroyed by clam harvesters using rakes and tongs prompted an investigation by the Division of Marine Fisheries (DMF). The area in question was surveyed at low tide in June of 1995 and eight (8) oyster rocks were identified and examined for signs of damage from clamming. Density estimates were made and the sites were videotaped and photographed. Of the eight oyster rocks identified, three were found to exhibit signs of recent damage and the other five showed no such damage. Square meter samples were raked at disturbed and at undisturbed sites on some of the rocks. The Division's investigation resulted in a recommendation by the Resource Enhancement staff to delineate the oyster rocks with signs and prohibit clamming by any means on these rocks. The Director at the time issued a proclamation creating the Wards Creek SMA and prohibiting clam harvest by any means during the hand oyster harvest season. During the hand harvest oyster season, oyster harvest was limited to the use of hands only. This proclamation remained in effect until January of 2007.

In January of 2007, the Director issued a proclamation allowing shellfish in the management area to be harvested in accordance with existing shellfish harvest limits. This allows hand rakes and tongs to be used to take the legal limits of oysters and clams. The proclamation was issued after DMF sampling indicated that legal sized subtidal oysters were present in sufficient quantity to open harvest.

CURRENT AUTHORITY

North Carolina General Statutes
113-207. Taking shellfish from certain areas forbidden; penalty.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0101 Prohibited Shellfish Areas/Activitied
03K .0103 Shellfish or Seed Management Areas
03K .0304 Prohibited Taking

DISCUSSION

The action taken in 1995 by proclamation designated the area from the Highway 70 bridge at Wards Creek downstream to North Leopard Creek as a SMA. The issue to be addressed is how best to manage this Carteret County SMA or any future designations. Clamming was prohibited during oyster season and oysters were harvested using only hands (no rakes or tongs). This action was taken to protect the oyster rocks from destruction by clam rakes and tongs digging through the oyster cultch material and oysters to reach the clams. Hand implements are allowed in the area to harvest clams following the oyster season. The action was taken to respond to a particular, well-documented case of oyster rock destruction by clamming methods. In the southern part of the state, SMAs are routinely managed to allow oyster harvest before clam harvest is allowed to protect the intertidal rocks which support both shellfish. This system works well in that region. In the case of Wards Creek, the area remained closed for 12 years.

From 1995 to the present, there were requests to use rakes and tongs to harvest oysters during the open oyster season in the Wards Creek SMA. These requests usually occurred when the surrounding shellfishing waters had been depleted and the fishermen needed somewhere else to work. Reasons cited include rake and tong harvest being easier and more efficient, those implements would allow harvesters to access oyster rocks in deeper water, clam harvest effort has been reduced in recent years, and questioning the premise or protecting oyster rocks, when the rocks are opened after oyster season ends?

In January of 2007, the Director issued a proclamation allowing oysters and clams to be harvested from the Shellfish Management Area under existing harvest limits and gear restrictions. Fishermen can presently harvest five bushels of oysters and 6,250 clams with hand rakes, tongs and by hand. The decision was made based on the results of sampling the rocks, which revealed an abundance of legal sized, subtidal oysters.

The Southern District has a long history of managing SMAs from New River south by allowing oyster harvest on planted rocks first, and then allowing clam harvest. This protects the oyster rocks from being damaged or destroyed by tongs and rakes digging for clams. The one Carteret County SMA in Wards Creek could be managed in this manner by sampling the rocks to determine if there are enough legal-sized, subtidal oysters to support tong and rake effort and opening by proclamation when there are. When the samples reveal few legal oysters, rakes and tongs would be prohibited.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo – leave current measures in place
+ Requires no regulatory changes
+ Allows SMA to open and close based on abundance of legal oysters
+ Allows easier and more efficient harvest of oysters and more efficiently from deeper waters
- Permits additional destruction of rocks by allowing gear year-round for oysters and clams
- Limits oyster harvest during the hand oyster season by restricting gears

B. Modify proclamation to prohibit hand rakes and tongs year-round
+ Provides protection to the oyster rocks within the SMA
- Eliminates access to clams and oysters by harvesters

C. Rescind the proclamation and designation of Shellfish Management Area
- Situation reverts to allow harvest of oysters and clams in season
- May appear DMF is relaxing a habitat protective measure
- Removing SMA designation eliminates Director's authority to regulate hand clamming methods and possession limits

MANAGEMENT RECOMMENDATIONS

DMF/AC - Status quo – leave current measures in place

MFC Preferred Management Option – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

10.5.5 OYSTER ROCK MANAGEMENT OPTIONS

ISSUE

The management of shellfishing activities on oyster rocks has been an issue since hard clams substantially increased in value during the 1970s. More recently the habitat value of shell bottom, in particular oyster rocks, has been recognized as a major component of healthy estuaries. Fisheries managers are now facing the issue of managing oyster rocks for oyster and clam production versus oyster production only; or totally protecting them to preserve their habitat function.

BACKGROUND

Places where oysters grow are referred to by a variety of terms including beds, rocks, reefs and bars. The most common terminology used in NC is oyster rock or oyster bed. North Carolina Fisheries Rules for Coastal Waters defines an intertidal oyster bed as a formation, regardless of size or shape, formed of shell and live oysters of varying density. Although subtidal oyster beds are not defined, this definition would apply equally as well to those beds.

The effect of harvesting clams by hand methods on and around oyster rocks has been an issue among shellfishermen and the DMF for many years. The perception of many oyster harvesters is that clamming on oyster rocks damages oyster habitat. This has been a problem where oysters and hard clams co-exist, principally around and on oyster rocks from Core Sound south. The competition for these two resources increased with the beginning of a significant market for North Carolina hard clams in the 1970's which put more pressure on these stocks and, as other harvest friendly areas were depleted of clams, harvesters moved to less desirable harvest areas such as oyster rocks. Concurrently, more shellfishing areas, primarily in the southern portion of the state, were closed to harvest because of bacterial contamination in the waters. Additionally, the incidence of *Perkinsus marinus* (Dermo) and its associated mortality has caused significant decrease in oyster harvest in some years. These factors have combined to compress the harvest of these two species of shellfish into smaller and smaller areas and increased the occurrence of clamming in oyster habitat as shellfishermen attempt to maintain their income from these resources. There is no current estimate of the magnitude of the impact of clamming on oyster rocks

Some of the earliest official acts recognizing the negative impact of fishing activities on oyster rocks occurred in the1970s. In 1972 rules were adopted limiting the types of gear that could be used to take clams on live oyster beds and allowed some areas to be closed to shellfish harvest to protect populations of clams, oysters and scallops. Also, in 1977, the NC General Assembly enacted a statute prohibiting the taking of clams by the use of rakes, tongs, or any other device, which will disturb or damage the oysters growing on oyster rocks when the rocks were posted and closed by the Department. The next attempt at regulating competing shellfish harvest on oyster rocks (other than protection of oyster rocks from mechanical clam harvest) occurred in 1980 with adoption of MFC rules granting the Fisheries Director proclamation authority to close and open designated shellfish management areas to the taking of oysters or clams and to designate time, place, character, or dimensions of any method or equipment to be employed.

Until recently, oyster restoration efforts were primarily attempts to revive or even expand the fishery rather than to restore the natural habitat. Scientists conducting research on restoring

lost oyster habitat realized its value as a source of turbidity reduction, nitrogen and phosphorus release, food for filter feeders and predators, substrate for other filter feeders and bacteria, and as a stabilizing force in the sediments of the estuary.

Oyster shell habitat is recognized as essential fish habitat by the South Atlantic Fishery Management Council (1998). Red and black drum, striped bass, sheepshead, weakfish, spotted seatrout, summer and southern flounder, oyster toadfish, and other finfish are cited as users of the food and protection supplied by oyster habitat. Organisms that benefit directly from the habitat structure are clams, mussels, anemones, polychaetes, amphipods, sponges, shrimp, and many species of crabs. In this plan, the section entitled Ecological Relationships also contains information establishing the importance of oyster habitat as a food source and as an important substrate and stabilizing force in the estuary. The MFC has also recognized oyster habitat as one of the fragile estuarine and marine areas that support juvenile and adult populations of economically important seafood species, as well as forage species important in the food chain (North Carolina Fisheries Rules for Coastal Waters).

Coen and Grizzle (2007) prepared a thorough review of the literature concerning the importance of habitat created by molluscan shellfish along the Atlantic coast that points out the value of oyster rock habitat. Lenihan and Peterson (1998) compare the habitat value of oyster reefs to those of coral reefs, sea grass meadows, salt marshes and kelp beds and indicate that oyster beds warrant the same protection. The same level of protection would mean no harvest of the organisms that create the habitat. Lenihan and Peterson (1998) propose that oysters may be more economically valuable for the habitat they provide for other economically valued species than they are for the oyster fishery. The Coastal Habitat Protection Plan (CHPP) contains a recommendation to greatly expand habitat restoration, including creation of subtidal oyster reef, no-take sanctuaries (Street et al. 2005).

CURRENT AUTHORITY

North Carolina General Statutes
113-134. Rules.
113-182. Regulation of fishing and fisheries.
143B-289.52. Marine Fisheries Commission – powers and duties.
113-207. Taking shellfish from certain areas forbidden; penalty.

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0101 Prohibited Shellfish Areas/Activities
03K .0103 Shellfish or Seed Management Areas
03K .0201 Open Season and Possession Limit
03K .0302 Mechanical Harvest Season

DISCUSSION

The rules providing for management of shellfish harvest to protect oyster rocks have been seldom used on natural oyster rocks. In the southern portion of the state where intertidal

oyster reefs are established by cultch planting, DMF manages these areas primarily for oyster harvest. Oysters may be harvested by hand only. The harvest of clams by hand rakes, hand tongs, and by hand is prohibited because those activities can cause mortality of oysters by turning over and burying live oysters. This management is accomplished by designating these sites as Shellfish Management Areas (SMA) through proclamation authority. Occasionally, when oyster populations on these sites are low and more cultch needs to be planted, a proclamation allowing a brief clam harvest is issued.

Field studies by Noble (1996) and Lenihan and Micheli (2000) have confirmed and quantified that both oyster and clam harvest can impact natural oyster rocks. Data collected by Noble resulted in one of the few designations of natural oyster rocks as an SMA when harvest restrictions to protect oyster rocks were implemented in Wards Creek (The Wards Creek issue is discussed in depth in Section 10.4.5.). Even though clam harvest appeared to be causing some damage to the oyster rocks, it happened only in the cold weather months when clammers moved on top of intertidal rocks to avoid cold-water temperatures. Therefore, the harvest restrictions were only in place during the winter months. Lenihan and Micheli (2000) conducted a large-scale field experiment to test what impact clam and oyster harvesting, applied alone and in combination, on intertidal oyster reefs have on the resident shellfish populations. This experiment was conducted to resolve a long-standing conflict between oyster and clam fishermen who contend that the other fishery causes high rates of mortality to their respective species. In summary, it was recommended, "both clamming and oyster harvesting should be permitted on some reefs, but maintaining large populations of oysters and clams on intertidal oyster reefs will require protection of some reefs from both types of harvesting."(Lenihan and Micheli 2000). Their findings also indicate some level of clamming activity on oyster rocks has acceptable impact on the oyster resource.

The statutory provision protecting oyster rocks from damage due to the taking of clams in G.S. 113-207 has not been used since it was adopted according to the collective memory of current DMF staff. The extensive areas of oyster rocks prevalent along most shorelines from Carteret County south would be prohibitively expensive to adequately post and maintain the necessary signs. Enforcement of such an extensive area would also require a substantial increase in resources. No additional funding was received when this statute was enacted. Partial marking of these areas was also considered at one time but the effects of compressing the clam fishery into reduced areas would certainly increase the detrimental effects of clam harvest on the remaining unmarked open oyster rocks. Therefore, DMF has no plans to use the extensive shellfish harvest management provisions of this statute when a more precise management tool exists in SMA rule.

The long term or permanent closure of natural oyster rocks to all shellfish harvesting methods to preserve their habitat value would be a major policy change in North Carolina. Implementation of these closures even on a small scale would create considerable concern among shellfish harvesters already contending with increasing harvest closures due to pollution, disease effects on oysters and soft markets. When first considering establishing constructed shellfish sanctuaries in NC, the southern coast was not a high priority area because of the sizeable amount of oysters in areas closed to harvest by reason of pollution and lesser problems with reduced spatfall and disease mortality in the area. Constructed

oyster sanctuaries have been recommended primarily to provide improved production of larvae and an environment where oysters could develop disease resistance. However, they also provide the habitat benefits found on natural oyster rocks and are constructed to mimic healthy, undisturbed oyster habitat.

In the Pamlico Sound region there are currently nine constructed sanctuary sites but few closed harvest areas to act as sanctuaries. The construction of the sanctuaries in this area has been criticized for taking away fishable bottom in the past. Fishermen would also likely be concerned about designating natural rocks as sanctuaries because the oyster resource in the area rarely provides a full season's work with all available area open to harvest.

Another tact at approaching management of oyster rocks would be to adopt the BRACO recommendation for establishing an extensive, user-friendly shellfish lease program and produce oysters for market through culture rather than off valuable natural habitat. North Carolina has always had, by many accounts, thousands of acres of potentially productive oyster bottom (Winslow 1889; Chestnut 1955). Many believe with State support and relaxation of the shellfish lease standards that a productive oyster culture industry could exist here.

Another factor to consider is the recent initiation of State programs to fund continued sanctuary construction and support positions and sanctuary construction through contributions from environmental groups. These sources have the potential to consistently and, in the long term, significantly increase oyster rock habitat. Increased funding from environmental groups could be expected if some mechanism for long-term dedication of the enhanced areas exclusively for habitat use could be obtained. Currently, DMF and MFC could close these areas to any potentially damaging harvest practice through proclamation or rule however, these authorities are subject to change within 48 hours for proclamations and within approximately six to eight months through rule making. Environmental groups would like more assurance that their investment would have more long-term effect. Questions arise as to what legal mechanism to use and what is the proper authority to make such a recommendation. Other states have used a shellfish lease type of mechanism while some have utilized conservation easements (Beck et al. 2004; Udelhoven et al. 2005).

As stated earlier, DMF's current sanctuaries are constructed primarily as oyster spawning reserves and for breeding oyster disease resistance. They also secondarily function as oyster rock habitat. The situation with sanctuaries constructed by environmental groups is subtly different in that it is more accurately described as the reverse of DMF sanctuaries. They are primarily constructing oyster habitat and value the oysters more for water filtration and substrate benefits than as an advantage for restoring fishery production. Another possibility to consider is the future inclusion of other types of estuarine habitat in non-governmental restoration plans. This raises the question whether a shellfish lease based system would work for those areas or would it be best to create a new lease mechanism involving all the responsible agencies and establish these dedicated areas under authority of the CHPP.

MANAGEMENT OPTIONS/IMPACTS

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

A. Status quo (Harvest of oysters and clams allowed except on designated areas)
+ No changes in management or impacts to fishing practices
+ SMA designation can be used to protect sensitive areas
+ No data on oyster rock habitat changes through time to determine optimum area or configuration of harvest closures
+ Private and State programs are in place to create oyster rock habitat
- Oyster rock habitat should be protected similar to other estuarine habitats
- Appears that fisheries concerns may outweigh habitat concerns

B. Eliminate clam harvest on all designated oyster rocks
+ Removes a potentially harmful harvest practice from oyster rock habitat
- Prohibitively expensive to mark and maintain without increased funding
- May unnecessarily restrict clam harvest in some areas (Most clams are near but not under oyster rocks)
- Will further reduce limited shellfish resources for harvesters
- Enforcement of small irregular areas is very difficult so larger areas will likely be designated

C. Eliminate all shellfish harvest from oyster rock habitat (assumes all bottom disturbing gear as well)
+ Recognizes oyster rock value and gives it the highest level of fisheries protection
- Prohibitively expensive to mark and maintain without increased funding
- May unnecessarily restrict clam harvest in some areas (Most clams are near but not under oyster rocks)
- Will virtually eliminate wild oyster harvest and place more pressure on clams and other fisheries
- Enforcement of small irregular areas is very difficult so larger areas will likely be designated

D. Eliminate all shellfish harvest from oyster rock habitat and replace production Through oyster culture
+ Recognizes oyster rock value and gives it the highest level of fisheries protection
+ Additional shellfish habitat benefits will be obtained from culture sites
- Many areas have strong feelings against shellfish leases and shellfish leases are prohibited in some waterbodies
- Many current fishermen are not equipped or trained to conduct shellfish culture
- Current restrictions on shellfish leases are not conducive to extensive oyster culture
- Support services and materials are not available to support a sudden increase in leaseholders

E. Recommend repeal of G.S. 113-207 (a) and (b)

+ The statue is impossible to implement without additional funding and personnel
+ There are other less extensive mechanisms for protecting oysters and their habitat

F. Recommend that conservation leasing for constructed oyster rock habitat be studied by DENR counsel for development of a proper mechanism and to develop siting criteria

+ Properly places this level of activity at the Department level where it can be addressed as issue
+ Keeps the FMP process properly focused on management issues for the subject species
+ Rules, proclamation authority, and shellfish lease contracts will not have to be modified to accommodate this function
- Conservation leasing will have to be developed and initiated

MANAGEMENT RECOMMENDATIONS

DMF/AC - Status quo (harvest of oysters and clams allowed except in designated areas)
- Recommend repeal of G.S. 113-207 (a) and (b)
- Recommend that conservation leasing for constructed oyster rock habitat be studied by DENR counsel for development of a proper mechanism and to develop siting criteria

MFC Selected Management Strategy – Same as DMF/AC

RESEARCH RECOMMENDATIONS

None

11.0 SELECTED MANAGEMENT PROGRAM AND RESEARCH NEEDS

11.1 SUSTAINABLE HARVEST STRATEGY

Although there is insufficient data to calculate sustainable harvest levels for the oyster fishery, the available indicators show that harvest is not excessive (see Section 6.2). The MFC chose to keep harvest strategies consistent with recent years except for lowering daily limits in the portions of Pamlico Sound bays open to mechanical harvest to 10 bushels per day. It is also recommended to increase shellfish sampling programs to determine triggers for closing the harvest season.

11.2 MANAGEMENT STRATEGIES

MFC SELECTED MANAGEMENT STRATEGIES OYSTER FMP AMENDMENT II
11.2.1 HARVEST ISSUES
Recommend no change to the open shellfish harvest license
Recommend a 15 bushel hand/mechanical harvest limit in Pamlico Sound mechanical harvest areas outside the bays, 10 bushel hand/mechanical harvest limit in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound.
Define recreational shellfish gear
Allow no sale of weekend shellfish harvest except from leases
Propose repeal of G.S. 113-169.2 license exemption.
Set recreational limits in rule and proclamation
Require all shellfish to be tagged at the dealer level
Adopt a new rule limiting mechanical harvest of other shellfish to areas where and season when mechanical harvest gear for shellfish is allowed in existing fisheries
10 bushel mechanical gear harvest limit in the Pamlico Sound bays with a six week (mid November through December) season (until triggers are established)
Collect more data comparing the effects of 50 and 100 pound dredges prior to making a decision on this issue
Change existing rule to set the latest season closure date at March 31
11.2.2 PRIVATE CULTURE ISSUES
Leave regulations as is for depuration facilities.
Utilize user coordination plans for shellfish lease issuance coast wide
Support private oyster larvae monitoring programs
Support construction of an integrated system of shellfish hatcheries and remote-setting sites
Develop a subsidized, fee-for-service disease diagnosis program.
Update seed oyster management in statutes and rule.
Monitor seeded oyster sanctuaries for cownose ray predation.
Propose an exemption from G.S. 113-168.4(b)(1) when the sale is to lease, UDOC permit, or Aquaculture Operations Permit holders for further rearing
Require an examination with a passing score based on pertinent information in the training package irrespective of whether the applicant has obtained instruction voluntarily or is reviewing the information independently
Request that appropriate agencies such as the Oyster Hatcheries and N.C. Sea Grant conduct shellfish lease training as part of their educational and outreach activities
Modify G.S. 113–201 to include a requirement of an examination with a passing score for persons acquiring shellfish leases by lawful transfers unless they have a shellfish lease that is currently meeting production requirements
Encourage harvesters to take volunteer time and temperature control measures on their product.

Change the current rule specifying a three year running production average to a five year production average and change the statutory provision for a ten year lease contract to a five year contract
Limit acreage per shellfish lease application 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 Lat./Long. 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 or family holdings
No change to rules affecting the issuance of permits for culturing shellfish in closed harvest areas
11.2.3 INSUFFICIENT DATA
Recommend no change (status quo) to collect information on recreational harvest of shellfish through a license
11.2.4 ENHANCEMENT ACTIVITIES
Expand and evaluate the number of designated oyster sanctuaries to increase oyster populations
Include current and future oyster sanctuaries into North Carolina Fisheries Rules For Coastal Waters Subchapter 03R.
Plant and monitor seed oysters on existing oyster sanctuary/artificial reef sites.
11.2.5 ENVIRONMENTAL ISSUES
Review the results of the completed USACE EIS on the proposed introduction of Suminoe oysters in Chesapeake Bay and consult with sister states concerning use of these non-native oysters
Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation and co-ordinate with sister agencies
Recommend DWQ to designate Use-Restoration waters in conditionally closed waters where moderate contamination and healthy shellfish beds are present and develop strategies to restore and protect those waters
Recommend DWQ designate Use-restoration waters in areas where moderate contamination and appropriate shellfish culture conditions are present and develop strategies to restore and protect those waters
Recommend to the DWQ to accept a lower threshold of 10,000 square feet to coastal stormwater rules
Recommend a naturally vegetative riparian buffer width of 50 feet
Recommend the exclusion of all wetlands (coastal and non-coastal), from the built-upon area calculations

Provide educational materials to harvesters in license offices and on DMF webpage, through other training opportunities, and through DMF Port Agent contact with harvesters and dealers and include other state and federal regulatory agencies to reach all coastal waters users
Leave current management practices in place for Ward Creek
Recommend repeal of G.S. 113-207 (a) and (b) to end the requirement that all oyster rocks must be posted by the Department
Recommend that conservation leasing for constructed oyster rock habitat be studied by DENR counsel for development of a proper mechanism and to develop siting criteria

11.3 RESEARCH NEEDS SUMMARY

- Develop peer reviewed, standardized monitoring metrics and methodologies for oyster restoration and stock status assessments
- Conduct studies on the impacts of current oyster dredging practices on oyster habitat
- Conduct studies on the effects of oyster dredge weight and size on habitat disturbance and oyster catches
- Determine a protocol and triggers for closures of oyster harvesting areas
- Conduct stock assessments of oysters located within polluted areas to determine feasibility of depuration operations
- Review current DEH rules to update to current depuration technologies.
- Explore new technologies for off-bottom oyster culturing methods
- Develop new types of biomarkers that can be used to select more effectively for disease-resistant genetic oyster stock
- Develop disease-resistant or fast-growing strains of oysters
- Establish an oyster brood stock development program
- Develop methods to determine resistance of shellfish stocks to various diseases
- Assess survival and productivity of relayed oysters vs. natural recruitment on planted cultch
- Investigate timing of oyster spatfall, larval dispersal and transport
- Determine the hydrodynamics of areas for oyster restoration, culture activities and sanctuaries
- Collect population information on cownose rays
- Explore uses of cownose rays for food in the pet food industry and the human food industry
- Explore uses of cownose rays as a source of chondroitin/glucosamine or oil for pet and human supplements
- Investigate markets for cownose rays
- Investigate areas of sanctuary placement (shallow/deep), size, and impacts to the local fishing grounds.
- Determine sanctuary size, profile, and amount of material needed
- Determine the cost of an oyster sanctuary project (private vs. state)
- Investigate larval oyster dispersal and transport.
- Investigate oyster spat settlement success on different cultch materials

- Continue research on means and methods for reduction of non-point source pollution and mitigation of pollutant effects in the estuary.
- Determine the effect of shellfish filtering capacities on water quality parameters, such as bacteria, nutrients and sediments.
- Support collaborative research to more efficiently track bacterial sources for land-based protection and restoration efforts.
- Quantify the impact of current fishing practices on oyster habitat suitability in North Carolina.
- Determine the impact of docks siting practices and bottom disturbing activities on nearby habitats and on the shifting boundaries of habitat itself so that protective buffer distances can be established.
- Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units (i.e., docks, bulkhead sections)

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13.0 APPENDICES

13.1 RULES NECESSARY TO IMPLEMENT NC OYSTER FMP AMENDMENT II SELECTED MANAGEMENT STRATEGIES CHOSEN BY THE MFC

Issue No: **10.1.3** Issue: **Recreational and Weekend Shellfish Harvest**

15A NCAC 03I .0101is proposed for amendment as follows:

.0101 DEFINITIONS (Partial)

(C)(3)(E) Hand operated rakes no more than 12 inches wide and weighing no more than 6 pounds and hand operated tongs. ~~and taking shellfish without the use of harvest tools.~~

*The strike through phrase above was objected to by the Rules Review Commission (RRC) during August, 2008 after the MFC passed the proposed rule. Staff chose to remove the phrase and did not argue against the objection. The RRC argued that the rule was intended to identify non-commercial fishing **gear and equipment** and therefore fishing without the use of tools (equipment, gear, implements, etc.) was not properly included in this rule. Taking shellfish by hands, feet, etc. could be a method but not a tool. No attempt was made to include a new rule on methods because G.S. 113-168 defines a commercial fishing operation in a manner that limits a*

*commercial fishing operation to commercial fishing **equipment or gear [not hand]** or by any means if the purpose of the taking is to obtain fish for sale. Therefore hand harvesting or treading shellfish is already only commercial if the catch is sold.*

15A NCAC 03K .0101 is proposed for amendment as follows:

.0101 PROHIBITED SHELLFISH AREAS/ACTIVITIES

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

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

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

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

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

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

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

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

(B) The date of harvest.

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

(D) Type and quantity of shellfish.

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

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

15A NCAC 03K .0105 is proposed for amendment as follows:

.0105 RECREATIONAL HARVEST OF ~~CRABS AND~~ SHELLFISH

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

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

~~(c)~~ (a) It is unlawful to take oysters or clams from public bottoms on Sundays, and scallops from public bottoms on Saturdays and Sundays except:

(1) during open seasons, and

(2) ~~in accordance with limits outlined in G.S. 113-169.2.~~ for recreational purposes.

(b) It is unlawful to possess, for recreational purposes, more than:

(1) ten conchs or whelks per person per day, not to exceed 20 conchs or whelks per vessel per day, and

(2) 100 mussels per person per day, not to exceed 200 mussels per vessel per day, and

(3) 100 clams per person per day, not to exceed 200 clams per vessel per day.

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

15A NCAC 03K .0106 is proposed for amendment as follows:

.0106 TAKING OR UNLOADING OYSTERS AND CLAMS ON SUNDAY OR AT NIGHT

(a) It is unlawful to take oysters or clams between the hours of sunset and sunrise on any day.

(b) It is unlawful to unload oysters or clams from any vessel or remove any vessel containing oysters or clams from the water on Sunday or between sunset and sunrise on any day except that in New Hanover, Pender and Brunswick Counties, oysters and clams may be unloaded until two hours after sunset. Oysters and clams taken on Sunday from public bottom under the provisions of 15A NCAC 03K .0105 or from shellfish leases and franchises pursuant to G.S. 113-208 are exempt from the Sunday unloading prohibition.

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

15A NCAC 03K .0201 is proposed for amendment as follows:

.0201 OPEN SEASON AND POSSESSION LIMIT

It is unlawful to ~~take, buy, sell~~, take or possess ~~any~~ oysters from public bottoms except ~~during the open season~~ from October 15 through May 15. ~~During any open season that may be allowed within the time periods stated herein, the~~ The Fisheries Director may, by proclamation, close and open the season within the time period stated herein or close and open any of the various waters to the taking of oysters depending on the need to protect small oysters and their habitat, the amount of saleable oysters available for harvest, the number of days harvest is prevented due to unsatisfactory bacteriological samples and weather conditions, and the need to prevent loss of oysters due to parasitic infections and thereby reduce the transmission of parasites to uninfected oysters or other variable conditions and may impose any or all of the following ~~restrictions:~~ restrictions on commercial and recreational oyster harvest:

(1) Specify days of the week harvesting will be allowed;

(2) Specify areas;

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

(4) Specify time period;

(5) Specify the quantity, but shall not exceed possession of more than 50 bushels ~~aboard a vessel;~~ in a commercial fishing operation; and

(6) Specify the minimum size limit by shell length, but not less than 2 1/2 inches.

History Note: *Authority G.S. 113-134; 113-182; 113-201; 113-221; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. March 1, 1996; September 1, 1991.

15A NCAC 03L .0209 is proposed for adoption as follows:

.0209 RECREATIONAL HARVEST OF CRABS
It is unlawful to possess more than 50 blue crabs per person per day, not to exceed 100 blue crabs per vessel per day, for recreational purposes.

History Note: *Authority G.S. 113-134; 113-182; 143B-289.52;*
Eff. ????????????;

Issue No: **10.1.4** Issue: **Require out of state shellfish to be tagged**

15A NCAC 03K .0101 is proposed for amendment as follows:

.0101 PROHIBITED SHELLFISH AREAS/ACTIVITIES
(a) It is unlawful to possess, sell, or take oysters, clams or mussels from areas which have been designated as prohibited (polluted) by proclamation by the Fisheries Director except as provided in 15A NCAC 03K .0103, .0104, .0107, and .0401. The Fisheries Director shall issue such proclamations upon notice by the Division of Environmental Health that duly adopted criteria for approved shellfish harvest areas have not been met. The Fisheries Director may reopen any such closed area upon notification from the Division of Environmental Health that duly adopted criteria for approved shellfish harvest areas have been met. Copies of these proclamations and maps of these areas are available upon request at the Division of Marine Fisheries, 3441 Arendell St., Morehead City, NC 28557; (252) 726-7021.
(b) The Fisheries Director may, by proclamation, close areas to the taking of oysters, clams, scallops and mussels in order to protect the shellfish populations for management purposes or for public health purposes not specified in Paragraph (a) of this Rule.
(c) It is unlawful to possess or sell oysters, clams, or mussels taken from polluted waters outside North Carolina.
~~(d) It is unlawful to possess or sell oysters, clams, or mussels taken from the waters of North Carolina except as provided in G. S. 113-169.2 (i) without a harvest tag affixed to each container of oysters, clams or mussels. Harvest tags shall be affixed by the harvester and shall meet the following criteria:~~
- ~~(1) Tags shall be identified as harvest tags. They shall be durable for at least 90 days, water resistant, and a minimum of two and five-eighths inches by five and one-fourth inches in size.~~
- ~~(2) Tags shall be securely fastened to the outside of each container in which shellstock is transported. Bulk shipments in one container and from the same source may have one tag with all required information attached. Harvesters who are also certified shellfish dealers may use only their dealers tag if it contains the required information. The required information shall be included on all lots of shellfish subdivided or combined into market grades or market quantities by a harvester or a certified shellfish dealer.~~
- ~~(3) Tags shall contain legible information arranged in the specific order as follows:~~
  - ~~(A) The harvester's name, address and shellfish license or standard or retired standard commercial fishing license with shellfish endorsement number.~~
  - ~~(B) The date of harvest.~~
  - ~~(C) The most precise description of the harvest location as is practicable (e.g., Long Bay, Rose Bay) that can be easily located by maps and charts.~~
  - ~~(D) Type and quantity of shellfish.~~
  - ~~(E) The following statement in bold, capitalized type: "THIS TAG IS REQUIRED TO BE ATTACHED UNTIL CONTAINER IS EMPTY AND THEREAFTER KEPT ON FILE FOR 90 DAYS".~~

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

15A NCAC 03K .0109 is proposed for adoption as follows:

.0109 SHELLFISH HARVESTER AND DEALER TAGS

It is unlawful to possess or sell oysters, clams, or mussels in a commercial fishing operation without a harvest tag affixed to each container of oysters, clams or mussels. Tags shall be affixed by the harvester or dealer and shall meet the following criteria:

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

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

(c) Tags shall be attached to all shellfish stored at a dealer location.

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

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

(2) The date of harvest.

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

(4) Type and quantity of shellfish.

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

History Note: *Authority G.S. 113-134; 113-168.5; 113-169.2; 113-182; 113-221; 143B-289.52;*
Eff.???

In order to track the changes made to the rule, the following example is provided:

3K .0109 SHELLFISH HARVESTER AND DEALER TAG [not for rule making]

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

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

(b)~~(2)~~ Tags shall be securely fastened to the outside of each container in which shellstock is transported. A harvester or dealer tag shall be securely fastened to the outside of each container at a dealer location except, ~~Bulk shipments in one container and from the same source may have one tag with all required information attached.~~ bulk shipments of shellfish in one container and from the same source may have one tag with all required information attached. Harvesters who are also certified shellfish dealers may use only their dealers tag if it contains the required information. The required information shall be included on all lots of

shellfish subdivided or combined into market grades or market quantities by a harvester or a certified shellfish dealer.

(c)~~(3)~~ Tags shall be attached to all shellfish stored at a dealer location.

(d)~~(4)~~ Tags shall contain legible information arranged in the specific order as follows:

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

(2)~~(B)~~ The date of harvest.

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

(4)~~(D)~~ Type and quantity of shellfish.

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

Issue No: **10.1.5** Issue: **Mechanical harvest of other shellfish**

15A NCAC 03K .0108 is proposed for adoption as follows:

.0108 DREDGES/MECHANICAL METHODS PROHIBITED

(a) It unlawful to use mechanical methods, except those defined in 15A NCAC 03I .0101 (12), (13) and (14), to take shellfish.

(b) It is unlawful to use mechanical methods for oystering or clamming to take shellfish not subject to the restrictions in 15A NCAC 03K .0201, .0204, .0302, 0304, .0404, .0501, and .0503:

(1) within any established bed of submerged aquatic vegetation as defined in 15A NCAC 03I .0101 or salt water cordgrass (Spartina alterniflora);

(2) in areas designated in 15A NCAC 03R .0108, except on shellfish leases and franchises with a Permit to Use Mechanical Methods for Oysters and Clams on Shellfish Leases and Franchises;

(3) in areas designated in 15A NCAC 03K .0204 and 03R .0103; and

(4) except following restrictions for the use of mechanical methods specified pursuant to 15A NCAC 03J .0303 and 03K .0201, .0209, .0302, .0404, .0501, and .0503.

History Note: Authority G.S. 113-134; 113-201; 143B-289.52;
Eff. ?????????.

Issue No: **10.1.7** Issue: **Change dates for oyster season**

15A NCAC 03I .0101is proposed for amendment as follows:

.0101 DEFINITIONS [Partial]

(a) (7) Regular Closed Oyster Season. ~~May 15~~ March 31 through October 15, unless amended by the Fisheries Director through proclamation authority.

15A NCAC 03K .0201 is proposed for amendment as follows:

.0201 OPEN SEASON AND POSSESSION LIMIT

It is unlawful to take, buy, sell, or possess any oysters from public bottoms except during the open season from October 15 through ~~May 15~~ March 31. During any open season that may be allowed within the time periods stated herein, the Fisheries Director may, by proclamation, close and open the season or close and open any of the various waters to the taking of oysters depending on the need to protect small oysters and their habitat, the amount of saleable oysters available for harvest, the number of days harvest is prevented due to unsatisfactory bacteriological samples and weather conditions, and the need to prevent loss of oysters due to parasitic infections and thereby reduce the transmission of parasites to uninfected oysters or other variable conditions and may impose any or all of the following restrictions:

(1) Specify days of the week harvesting will be allowed;
(2) Specify areas;
(3) Specify means and methods which may be employed in the taking;
(4) Specify time period;
(5) Specify the quantity, but shall not exceed possession of more than 50 bushels aboard a vessel; and
(6) Specify the minimum size limit by shell length, but not less than 2 1/2 inches.

History Note: *Authority G.S. 113-134; 113-182; 113-201; 113-221; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. March 1, 1996; September 1, 1991.

Issue No: **10.2.4** Issue: **Seed oyster management areas**

15A NCAC 03I .0101 is proposed for amendment as follows:

.0101 DEFINITIONS

(a)(8) Seed Oyster Management Area. An open harvest area that, by reason of poor growth characteristics, predation rates, overcrowding or other factors, experiences poor utilization of oyster populations for direct harvest and sale to licensed dealers and is designated by the Marine Fisheries Commission as a source of seed for public and private oyster culture.

15A NCAC 03K .0103 IS PROPOSED FOR AMENDMENT AS FOLLOWS:

.0103 SHELLFISH ~~OR SEED~~ MANAGEMENT AREAS
(a) The Fisheries Director may, by proclamation, designate Shellfish Management Areas which meet any of the following criteria. The area has:
(1) conditions of bottom type, salinity, currents, cover or cultch necessary for shellfish growth;
(2) shellfish populations or shellfish enhancement projects that may:
(A) produce commercial quantities of shellfish at ten bushels or more per acre;
(B) produce shellfish suitable for transplanting as seed or for relaying from prohibited (polluted) areas; or
(C) serve as sanctuaries to increase spawning and disease resistance or to prevent predation.
(b) It is unlawful to use a trawl net, long haul seine, or swipe net in any designated Shellfish or Seed Management area. These areas shall be marked with signs or buoys. Unmarked and undesignated tributaries shall be the same designation as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the designation of any such body of water or portion thereof, nor shall any such unauthorized removal or relocation or the absence of any marker affect the applicability of any rule pertaining to any such body of water or portion thereof.
(c) It is unlawful to take shellfish from any Shellfish Management Area which has been closed and posted, except that the Fisheries Director may, by proclamation, open specific areas to allow the taking of shellfish and may designate time, place, character, or dimensions of any method or equipment that may be employed.
~~(d) It is unlawful to take oysters from Seed Management Areas for planting on shellfish leases or franchises without first obtaining a Permit to Transplant Oysters from Seed Management Areas from the Fisheries Director. The procedures and requirements for obtaining permits are found in 15A NCAC 03O .0500.~~

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

15A NCAC 03K .0208 is proposed for adoption as follows:

.0208 SEED OYSTER MANAGEMENT AREAS

(a) It is unlawful to take oysters from Seed Oyster Management Areas designated in 15A NCAC 03R .0115? for planting on shellfish leases or franchises without first obtaining a Permit to Transplant Oysters from Seed Oyster Management Areas from the Fisheries Director. The procedures and requirements for obtaining permits are found in 15A NCAC 03O .0500 et seq.

(b) It is unlawful to use a trawl net, long haul seine, or swipe net in any designated Seed Oyster Management Area.

History Note: *Authority G.S. 113-134; 113-182; 113-203; 113-221; 143B-289.52;*
Eff. ???????;

15A NCAC 03R .0116 is proposed for adoption as follows:

.0116 DESIGNATED SEED OYSTER MANAGEMENT AREAS

The Seed Oyster Management Areas referenced in 15A NCAC 03K .0208 are delineated in the following coastal water areas:

(1) Croatan Sound and tributaries: Cedar Bush Bay Seed Oyster Management Area, within the area described by a line beginning at a point 35° 50.0383' N - 75° 40.0712' W; running easterly to a point 35° 50.2328' N - 75° 39.4930' W; running southeasterly to a point 35° 49.3831' N - 75° 39.1521' W; running southwesterly to a point 35° 48.8000' N - 75° 39.5000' W; running westerly to a point 35° 48.6333' N - 75° 40.7000' W; running northerly to a point 35° 49.7000' N - 75° 40.6333' W; running northeasterly back to the point of beginning;

(2) Croatan and Roanoke sounds and tributaries: Wanchese Marshes Seed Oyster Management Area, within an area described by a line beginning at a point 35° 49.0000' N - 75° 38.3000' W; running northerly to a point 35° 49.2243' N - 75° 38.3000' W; running easterly to a point 35° 49.0806' N - 75° 37.5293' W; running easterly to a point 35° 49.2893' N - 75° 37.0335' W; running northeasterly to point 35° 49.5541' N - 75° 36.9715' W; running southerly to a point 35° 49.0000' N - 75° 36.5500' W; running southwesterly to a point 35° 48.1500' N - 75° 36.9500' W; running westerly to a point 35° 48.1000' N - 75° 37.6333' W; running northwesterly to the point of beginning;

(3) Pamlico Sound and tributaries: Bay River Seed Oyster Management Area, within an area described by a line beginning at a point 35º 10.7670' N - 76º 36.7000' W off Spencer Point; running southeasterly to a point 35º 10.5330' N - 76º 36.4670' W; running westerly to a point 35º 10.4670' N - 76º 36.6500' W; running northwesterly to a point 35º 10.8000' N - 76º 36.9170' W, running easterly to the point of beginning;

(4) White Oak River: White Oak River Seed Oyster Management Area, within an area described by a line beginning at a point 34º 43.0774' N - 77º 06.8610' W on the White Oak River/Stevens Creek polluted area line; running northeasterly to a point 34º 43.4006' N - 77º 06.1293' W on the east shore; running southerly along the shoreline to a point 34º 43.0755' N - 77º 06.1187' W; running southwesterly to a point 34º 42.8800' N - 77º 06.7975' W on the White Oak River/Stevens Creek polluted area line; running northerly to the point of beginning;

(5) Topsail Sound and tributaries:

(a) Virginia Creek Seed Oyster Management Area, within an area described by a line beginning at a point 34º 25.4620' N - 77º 36.0074' W on the north shore; running southerly to a point 34º 25.1346' N - 77º 36.0640' W on the south shore; running easterly and southerly along the shoreline to a point 34º 24.9438' N - 77º 35.5325' W on Sloop Point; running northeasterly to a point 34º 25.0988' N - 77º 35.2920' W on the north shore; running northwesterly along the shoreline to the point of beginning;

(b) Topsail Sound Seed Oyster Management Area, within an area described by a line beginning at a point 34º 24.6555' N - 77º 35.6012' W across the IWW from Sloop

Point; running southeasterly to a point 34º 24.3677' N - 77º 35.2015' W; running northeasterly to a point 34º 24.5260' N - 77º 35.1070' W; running northwesterly to a point 34º 24.8690' N - 77º 35.2872' W; running southwesterly to the point of beginning.

Issue No: **10.2.7** Issue: **Leaseholder education training**

15A NCAC 03O .0202 is proposed for adoption as follows:

.0202 SHELLFISH BOTTOM AND WATER COLUMN LEASE APPLICATIONS

(a) Application forms are available from the Division's office headquarters at 3441 Arendell Street, Morehead City, NC 28557 for persons desiring to apply for shellfish bottom and water column leases. Each application shall be accompanied by a map or diagram prepared at the applicant's expense including an inset vicinity map showing the location of the proposed lease with detail sufficient to permit on-site identification and must meet the information requirements pursuant to G.S. 113-202(d).

(b) As a part of the application, the applicant shall submit a management plan for the area to be leased on a form provided by the Division which meets the following standards:

(1) States the methods through which the applicant will cultivate and produce shellfish consistent with the minimum requirements set forth in 15A NCAC 03O .0201;
(2) States the time intervals during which various phases of the cultivation and production plan will be achieved;
(3) States the materials and techniques that will be utilized in management of the lease;
(4) Forecasts the results expected to be achieved by the management activities; and
(5) Describes the productivity of any other leases or franchises held by the applicant.

(c) The completed application, map or diagram, and management plan for the requested lease shall be accompanied by the non-refundable filing fee set forth in G.S. 113-202(d1). An incomplete application shall be returned and not considered further until re-submitted complete with all required information.

(d) Applicants and transferees not currently holding a shellfish cultivation lease, and applicants and transferees holding one or more shellfish cultivation leases which are not meeting production requirements, shall complete and submit an examination, with a minimum of 70 percent correct answers, based on an educational package provided by the Division of Marine Fisheries. The examination demonstrates the applicant's knowledge of:

(1) the shellfish lease application process;
(2) shellfish lease planting and production requirements;
(3) lease marking requirements;
(4) lease fees;
(5) shellfish harvest area closures due to pollution;
(6) safe handling practices;
(7) lease contracts and renewals;
(8) lease termination criteria; and
(9) shellfish cultivation techniques.

(~~d~~e) Immediately after an application is deemed to have met all requirements and is accepted by the Division, the applicant shall identify the area for which a lease is requested with stakes at each corner in accordance with 15A NCAC 03O .0204(a)(1)(A). The applicant shall attach to each stake a sign, provided by the Division containing the name of the applicant, the date the application was filed, and the estimated acres.

History Note: *Authority G.S. 113-134; 113-201; 113-202; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. September 1, 2005; May 1, 1997; September 1, 1991.

15A NCAC 03O .0209 IS PROPOSED FOR ADOPTION AS FOLLOWS:

.0209 TRANSFER OF INTEREST

(a) Within 30 days after transfer of ownership of all or any portion of interest in a shellfish lease or franchise, the new owner shall notify the Division, and provide the number of the lease or franchise and the county in which it is located. Such notification shall be accompanied by a management plan prepared by the new owner in accordance with 15A NCAC 3O .0202(b).
(b) If the new owner obtains a portion of an existing shellfish bottom lease or franchise, it shall not contain less than one-half acre and the required notification to the Division shall be accompanied by a survey prepared in accordance with the standards in 15A NCAC 3O .0203(d).
(c) Water column leases are not transferable except when the Secretary approves such transfer in accordance with G.S. 113-202.1(f) and G.S. 113-202.2(f).
(d) In the event the transferee involved in a lease is a nonresident, the Secretary must initiate termination proceedings.
(e) Within six months after transfer of ownership, the transferee shall complete shellfish cultivation lease training as specified in 15A NCAC 03O .0202(d).

History Note: *Authority G.S. 113-134; 113-182; 113-201; 113-202; 113-202.1; 113-202.2; 113-205; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. March 1, 1994; September 1, 1991.

Note: Adoption of 15A NCAC 03O .0209 requires the amendment of **G.S. 113-201 Legislative findings and declaration of policy; authority of Marine Fisheries Commission.** to include a requirement for training for persons acquiring shellfish leases by lawful transfers. Persons acquiring leases through transfer account for a substantial portion of current leaseholders and many are not familiar with shellfish cultivation.

Issue No: 10.2.9 Issue: Modify shellfish lease provisions

15A NCAC 03O .0201 is proposed for amendment as follows:

.0201 STANDARDS FOR SHELLFISH BOTTOM AND WATER COLUMN LEASES
(a) All areas of the public bottoms underlying coastal fishing waters shall meet the following standards in addition to the standards in G.S. 113-202 in order to be deemed suitable for leasing for shellfish cultivation purposes:

(1) The lease area must not contain a natural shellfish bed which is defined as 10 bushels or more of shellfish per acre.
(2) The lease area must not be closer than 100 feet to a developed shoreline. In an area bordered by undeveloped shoreline, no minimum setback is required. When the area to be leased borders the applicant's property or borders the property of riparian owners who have consented in a notarized statement, the Secretary may reduce the distance from shore required by this Rule.
(3) Unless the applicant can affirmatively establish a necessity for greater acreage through the management plan that is attached to the application and other evidence submitted to the Secretary, the lease area shall not be less than one-half acre and shall not exceed:
    (A) 10 acres for oyster culture;
    (B) 5 acres for clam culture; or
    (C) 5 acres for any other species.
    This Subparagraph shall not be applied to reduce any holdings as of July 1, 1983.

(b) Franchises recognized pursuant to G.S. 113-206 and shellfish bottom leases shall meet the following standards in addition to the standards in G.S. 113-202. In order to avoid termination, franchises and shellfish bottom leases shall:

(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.

(c) The following standards shall be applied to determine compliance with Subparagraphs (1) and (2) of Paragraph (b) of this Rule:

(1) Only shellfish planted, produced or marketed according to the definitions in 15A NCAC 03I .0101 (26), (27) and (28) shall be submitted on production/utilization forms for shellfish leases and franchises.

(2) If more than one shellfish lease or franchise is used in the production of shellfish, one of the leases or franchises used in the production of the shellfish must be designated as the producing lease or franchise for those shellfish. Each bushel of shellfish may be produced by only one shellfish lease or franchise. Shellfish transplanted between leases or franchises may be credited as planting effort on only one lease or franchise.

(3) Production and marketing information and planting effort information shall be compiled and averaged separately to assess compliance with the standards. The lease or franchise must meet the production requirement and the planting effort requirement within the dates set forth to be judged in compliance with these standards.

(4) In determining production and marketing averages and planting effort averages for information not reported in bushel measurements, the following conversion factors shall be used:

(A) 300 oysters, 400 clams, or 400 scallops equal one bushel; and

(B) 40 pounds of scallop shell, 60 pounds of oyster shell, 75 pounds of clam shell and 90 pounds of fossil stone equal one bushel.

(5) In the event that a portion of an existing lease or franchise is obtained by a new owner, the production history for the portion obtained shall be a percentage of the originating lease or franchise production equal to the percentage of the area of lease or franchise site obtained to the area of the originating lease or franchise.

(6) These production and marketing rates shall be averaged:

(A) over the ~~most recent three year period~~ consecutive full calendar years remaining on the lease contract after ~~January 1~~ December 31 following the second anniversary of initial bottom leases and ~~franchises~~ franchises. ~~and throughout the terms of renewal leases.~~

(B) over the consecutive full calendar years beginning January 1 of the final year of the previous lease term and ending December 31 of the final year of the current lease contract for renewal leases.

~~(C)~~ ~~For water column leases, these production and marketing rates shall be averaged~~ over the first five year period for initial water column leases and over the most recent ~~three~~ five year period thereafter for renewal water column leases.

~~Three year averages for production~~ Production and marketing ~~rates~~ rate averages shall be computed irrespective of transfer of the shellfish lease or franchise.

(7) All bushel measurements shall be in U.S. Standard Bushels.

(d) Water columns superjacent to leased bottoms shall meet the standards in G.S. 113-202.1 in order to be deemed suitable for leasing for aquaculture purposes.

(e) Water columns superjacent to franchises recognized pursuant to G.S. 113-206 shall meet the standards in G.S. 113-202.2 in order to be deemed suitable for leasing for aquaculture purposes.

(f) Water column leases must produce and market 40 bushels of shellfish per acre per year to meet the minimum commercial production requirement or plant 100 bushels of cultch or seed shellfish per acre per year to meet commercial production by planting effort. The standards for determining production and marketing averages and planting effort averages shall be the same for water column leases as for bottom leases and franchises set forth in Paragraph (c) of this Rule except that either the produce and market requirement or the planting requirement must be met.

History Note: *Authority G.S. 113-134; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. May 1, 1997; March 1, 1995; March 1, 1994; September1,1991;
Temporary Amendment Eff. October 1, 2001
Amendedt Eff. April 1, 2003.

15A NCAC 03O .0201 is proposed for amendment as follows:

.0201 STANDARDS FOR SHELLFISH BOTTOM AND WATER COLUMN LEASES

(a) All areas of the public bottoms underlying coastal fishing waters shall meet the following standards in addition to the standards in G.S. 113-202 in order to be deemed suitable for leasing for shellfish cultivation purposes:

(1) The lease area must not contain a natural shellfish bed which is defined as 10 bushels or more of shellfish per acre.

(2) The lease area must not be closer than 100 feet to a developed shoreline. In an area bordered by undeveloped shoreline, no minimum setback is required. When the area to be leased borders the applicant's property or borders the property of riparian owners who have consented in a notarized statement, the Secretary may reduce the distance from shore required by this Rule.

(3) ~~Unless the applicant can affirmatively establish a necessity for greater acreage through the management plan that is attached to the application and other evidence submitted to the Secretary, the~~ The proposed lease area shall not be less than one-half acre and shall not ~~exceed~~: exceed 5 acres for all areas except those areas open to the mechanical harvest of oysters where proposed lease area shall not exceed 10 acres.

~~(A) 10 acres for oyster culture;~~

~~(B) 5 acres for clam culture; or~~

~~(C) 5 acres for any other species.;~~

This Subparagraph shall not be applied to reduce any holdings as of July 1, 1983.

(b) Franchises recognized pursuant to G.S. 113-206 and shellfish bottom leases shall meet the following standards in addition to the standards in G.S. 113-202. In order to avoid termination, franchises and shellfish bottom leases shall:

(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.

(c) The following standards shall be applied to determine compliance with Subparagraphs (1) and (2) of Paragraph (b) of this Rule:

(1) Only shellfish planted, produced or marketed according to the definitions in 15A NCAC 03I .0101 (26), (27) and (28) shall be submitted on production/utilization forms for shellfish leases and franchises.

(2) If more than one shellfish lease or franchise is used in the production of shellfish, one of the leases or franchises used in the production of the shellfish must be designated as the producing lease or franchise for those shellfish. Each bushel of shellfish may be produced by only one shellfish lease or franchise. Shellfish transplanted between leases or franchises may be credited as planting effort on only one lease or franchise.

(3) Production and marketing information and planting effort information shall be compiled and averaged separately to assess compliance with the standards. The lease or franchise must meet the production requirement and the planting effort requirement within the dates set forth to be judged in compliance with these standards.

(4) In determining production and marketing averages and planting effort averages for information not reported in bushel measurements, the following conversion factors shall be used:

(A) 300 oysters, 400 clams, or 400 scallops equal one bushel; and

(B) 40 pounds of scallop shell, 60 pounds of oyster shell, 75 pounds of clam shell and 90 pounds of fossil stone equal one bushel.

(5) In the event that a portion of an existing lease or franchise is obtained by a new owner, the production history for the portion obtained shall be a percentage of the originating lease or franchise production equal to the percentage of the area of lease or franchise site obtained to the area of the originating lease or franchise.

(6) The production and marketing rates shall be averaged over the most recent three-year period after January 1 following the second anniversary of initial bottom leases and franchises and

throughout the terms of renewal leases. For water column leases, these production and marketing rates shall be averaged over the first five year period for initial leases and over the most recent three year period thereafter. Three year averages for production and marketing rates shall be computed irrespective of transfer of the shellfish lease or franchise.

(7) All bushel measurements shall be in U.S. Standard Bushels.

(d) Water columns superjacent to leased bottoms shall meet the standards in G.S. 113-202.1 in order to be deemed suitable for leasing for aquaculture purposes.

(e) Water columns superjacent to franchises recognized pursuant to G.S. 113-206 shall meet the standards in G.S. 113-202.2 in order to be deemed suitable for leasing for aquaculture purposes.

(f) Water column leases must produce and market 40 bushels of shellfish per acre per year to meet the minimum commercial production requirement or plant 100 bushels of cultch or seed shellfish per acre per year to meet commercial production by planting effort. The standards for determining production and marketing averages and planting effort averages shall be the same for water column leases as for bottom leases and franchises set forth in Paragraph (c) of this Rule except that either the produce and market requirement or the planting requirement must be met.

History Note: *Authority G.S. 113-134; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. May 1, 1997; March 1, 1995; March 1, 1994; September1, 1991;
Temporary Amendment Eff. October 1, 2001.
Amended Eff. April 1, 2003.

15A NCAC 03O .0201 is proposed for amendment as follows:

.0201 STANDARDS FOR SHELLFISH BOTTOM AND WATER COLUMN LEASES

(a) All areas of the public bottoms underlying coastal fishing waters shall meet the following standards in addition to the standards in G.S. 113-202 in order to be deemed suitable for leasing for shellfish <u>cultivation</u> purposes:

(1) The lease area must not contain a natural shellfish bed which is defined as 10 bushels or more of shellfish per acre.

(2) The lease area must not be closer than 100 feet to a developed shoreline. In an area bordered by undeveloped shoreline, no minimum setback is required. When the area to be leased borders the applicant's property or borders the property of riparian owners who have consented in a notarized statement, the Secretary may reduce the distance from shore required by this Rule.

(3) Unless the applicant can affirmatively establish a necessity for greater acreage through the management plan that is attached to the application and other evidence submitted to the Secretary, the lease area shall not be less than one-half acre and shall not exceed:

(A) 10 acres for oyster culture;

(B) 5 acres for clam culture; or

(C) 5 acres for any other species.

This Subparagraph shall not be applied to reduce any holdings as of July 1, 1983.

<u>(b) Persons holding 5 or more acres under shellfish lease or franchise shall meet the standards established in Paragraph (c) of this Rule prior to acceptance of applications for additional shellfish lease acreage.</u>

~~(b)~~ <u>(c)</u> Franchises recognized pursuant to G.S. 113-206 and shellfish bottom leases shall meet the following standards in addition to the standards in G.S. 113-202. In order to avoid termination, franchises and shellfish bottom leases shall:

(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.

~~(c)~~ <u>(d)</u> The following standards shall be applied to determine compliance with Subparagraphs (1) and (2) of Paragraph ~~(b)~~ <u>(c)</u> of this Rule:

(1) Only shellfish planted, produced or marketed according to the definitions in 15A NCAC 03I .0101 (26), (27) and (28) shall be submitted on production/utilization forms for shellfish leases and franchises.

(2) If more than one shellfish lease or franchise is used in the production of shellfish, one of the leases or franchises used in the production of the shellfish must be designated as the producing lease or franchise for those shellfish. Each bushel of shellfish may be produced by only one shellfish lease or franchise. Shellfish transplanted between leases or franchises may be credited as planting effort on only one lease or franchise.

(3) Production and marketing information and planting effort information shall be compiled and averaged separately to assess compliance with the standards. The lease or franchise must meet the production requirement and the planting effort requirement within the dates set forth to be judged in compliance with these standards.

(4) In determining production and marketing averages and planting effort averages for information not reported in bushel measurements, the following conversion factors shall be used:

(A) 300 oysters, 400 clams, or 400 scallops equal one bushel; and

(B) 40 pounds of scallop shell, 60 pounds of oyster shell, 75 pounds of clam shell and 90 pounds of fossil stone equal one bushel.

(5) In the event that a portion of an existing lease or franchise is obtained by a new owner, the production history for the portion obtained shall be a percentage of the originating lease or franchise production equal to the percentage of the area of lease or franchise site obtained to the area of the originating lease or franchise.

(6) The production and marketing rates shall be averaged over the most recent three-year period after January 1 following the second anniversary of initial bottom leases and franchises and throughout the terms of renewal leases. For water column leases, these production and marketing rates shall be averaged over the first five year period for initial leases and over the most recent three year period thereafter. Three year averages for production and marketing rates shall be computed irrespective of transfer of the shellfish lease or franchise.

(7) All bushel measurements shall be in U.S. Standard Bushels.

~~(d)~~ (e) Water columns superjacent to leased bottoms shall meet the standards in G.S. 113-202.1 in order to be deemed suitable for leasing for aquaculture purposes.

~~(e)~~ (f) Water columns superjacent to franchises recognized pursuant to G.S. 113-206 shall meet the standards in G.S. 113-202.2 in order to be deemed suitable for leasing for aquaculture purposes.

~~(f)~~ (g) Water column leases must produce and market 40 bushels of shellfish per acre per year to meet the minimum commercial production requirement or plant 100 bushels of cultch or seed shellfish per acre per year to meet commercial production by planting effort. The standards for determining production and marketing averages and planting effort averages shall be the same for water column leases as for bottom leases and franchises set forth in Paragraph ~~(c)~~ (d) of this Rule except that either the produce and market requirement or the planting requirement must be met.

History Note: *Authority G.S. 113-134; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. May 1, 1997; March 1, 1995; March 1, 1994; September 1, 1991;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2003.

15A NCAC 03O .0210 IS PROPOSED FOR AMENDMENT AS FOLLOWS:

.0210 SHELLFISH FRANCHISES

(a) The resolution of claims filed under G.S. 113-205 is governed by standards in Departmental Rules 15A NCAC 01G .0200 and .0300. Following receipt of notification that a claim has a valid chain of title, the owner shall provide to the Division within 90 days a survey prepared in accordance with the standards in 15A NCAC

03O .0203(d). Failure to provide the required survey within the time period specified will result in denial of the claim.

(b) Acceptable management plans, prepared in accordance with the standards in 15A NCAC 03O .0202(b), shall be provided to the Division within 30 days following formal recognition of a valid chain of title and at ten-year intervals thereafter.

(c) The survey and management plan requirements in Paragraphs (a) and (b) of this Rule, and all other requirements and conditions of this Section affecting management of franchises, shall apply to all valid shellfish franchises recognized prior to September 1, 1989.

(d) Commercial production requirements for franchises shall be identical to that required for leases in 15A NCAC 03O .0201~~(a)(2)~~ (c) averaged over the most recent three-year period after January 1 following the second anniversary of the dates of recognition of claims as valid shellfish franchises and continuing throughout the term of management plans required in Paragraph (b) of this Rule. Annual reporting of commercial production shall be submitted upon receipt of forms provided by the Division for that purpose.

History Note: *Authority G.S. 113-134; 113-201; 113-202; 113-205; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. September 1, 1991.

15A NCAC 03O .0203 is proposed for amendment as follows:

.0203 SHELLFISH LEASE APPLICATION PROCESSING

(a) Upon acceptance of a completed application, the proposed lease area shall be inspected within a reasonable time by agents of the Division. Proposed lease areas inconsistent with applicable standards contained or referenced in 15A NCAC 3O .0201 shall result in the return of applications for amendment to remove the inconsistencies. If the boundaries of the proposed lease area are modified, the stakes identifying such areas shall be relocated accordingly by the applicant. The failure of applicants to amend applications or modify lease area identification, when required, shall result in denial of such applications.

(b) If the initial or amended lease application is deemed consistent with all applicable requirements, the Secretary or his designee shall notify the applicant and publish notices of intention to lease in accordance with standards in G.S. 113-202(f).

(c) The Secretary shall consider the lease application, the Division's proposed lease area analysis, and public comments, and may in his discretion lease or decline to lease the proposed lease area or any part thereof. Special conditions may be imposed so that leases may be issued which would otherwise be denied. Should an applicant decide not to accept any special condition imposed on the lease by the Secretary, the application shall be considered denied.

(d) Upon approval of leases by the Secretary, applicants shall mark the shellfish bottom leases in accordance with 15A NCAC 3O .0204(a)(1), water column leases in accordance with 15A NCAC 3O .0204(a)(2), and shall within 90 days submit to the Division acceptable surveys of the areas approved for leasing except that a water column lease which entirely covers a shellfish bottom lease or franchise with an accepted survey on file does not require another survey. Such surveys shall be made at the expense of applicants and must meet the following standards:

(1) Surveys and maps shall meet all the requirements of 21 NCAC 56 .1600, Standards of Practice for Land Surveying in North Carolina, which is hereby incorporated by reference including subsequent amendments and editions. This material is available for inspection and copies may be obtained from the Marine Fisheries Division, Marine Fisheries Building, 3441 Arendell St., P.O. Box 769, Morehead City, North Carolina 28557, at no cost.

(2) Maps shall bear the certificate:
"I _____ certify that this map was (drawn by me) (drawn under my supervision) from (an actual survey made by me) (an actual survey made under my supervision); that the error of closure as calculated by latitudes and departures is 1: _____, that the area is _____ acres. Witness my hand and seal this _____ day of _____ AD _____."

_____
Surveyor or Engineer

(3) The phrase "other appropriate natural monuments or landmarks" in 21 NCAC 56 .1604(e)(9) shall include bridges, roads, highways, intersections, publicly maintained aids to navigation, houses and other permanent buildings, radio, telephone, TV, and water towers; docks; piers, and bulkheads; but does not include stakes marking the boundaries of adjoining leases, points of marsh, junctions of streams, or other landmarks which are particularly subject to change through natural processes, storms, or the effect of man.

(4) A written description of the survey suitable for official documents shall be provided with the survey.

(5) Locations of all corner markers in latitude and longitude shall be provided with the survey and presented in an eight digit format. The relative accuracy of the corner marker locations shall be equal to or less than 2 meters. Information on the method of measurement, make and model of equipment, and coordinate system used to determine the latitude and longitude shall be included.

(e) Proposed shellfish bottom lease areas remain public bottom until a formal lease has been executed by the Secretary.

(f) Proposed water column lease areas superjacent to shellfish bottom leases and recognized perpetual franchises remain public water until a formal lease has been executed by the Secretary.

History Note: *Authority G.S. 113-134; 113-182; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. March 1, 1994; September 1, 1991.

Issue No: **10.4.1** Issue: **Oyster sanctuary development**

15A NCAC 03K .0209 is proposed for adoption as follows:

03K .0209 OYSTER SANCTUARIES

(a) It is unlawful to use a trawl net, long haul seine, or swipe net in Oyster Sanctuaries designated in 15A NCAC 03R .0117. These areas shall be marked with signs or buoys. Unmarked and undesignated tributaries shall be the same designation as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the designation of any such body of water or portion thereof, nor shall any such unauthorized removal or relocation or the absence of any marker affect the applicability of any rule pertaining to any such body of water or portion thereof.

(b) It is unlawful to use mechanical methods for oystering or clamming in, or to take oysters or clams from, Oyster Sanctuaries designated in 15A NCAC 03R .0116?.

History Note: *Authority G.S. 113-134; 113-182; 113-201; 113-204; 143B-289.52;*
Eff. ???????;

15A NCAC 03R .0117 is proposed for adoption as follows:

03R .0117 OYSTER SANCTUARIES

The Oyster Sanctuaries referenced in 15A NCAC 03K .0209 are delineated in the following coastal water areas:

(1) Croatan Sound area: within the area described by a line beginning at a point 35° 48.2842‘N - 75° 38.4575’W; running westerly to a point 35° 48.2842‘N - 75° 38.3360’W; running southerly to a point 35° 48.1918‘N - 75° 38.3360’W; running easterly to a point 35° 48.1918‘N - 75° 38.4575’W; running northerly to the point of beginning.

(2) Pamlico Sound area:

(a) Crab Hole: within the area described by a line beginning at a point 35° 43.6833‘N - 75° 40.7500’W; running westerly to a point 35° 43.6833‘N - 75° 40.5083’W; running southerly to a point 35° 43.5000‘N - 75° 40.5083’W; running easterly to a point 35° 43.5000‘N - 75° 40.7500’W; running northerly to the point of beginning.

(b) Deep Bay: within the area described by a line beginning at a point 35° 22.9126‘N - 75° 22.1612’W; running westerly to a point 35° 22.9126‘N - 75° 22.3377’W; running southerly to a point 35° 22.7717‘N - 75° 22.1612’W; running easterly to a point 35° 22.7717‘N - 75° 22.3377’W; running northerly to the point of beginning.

(c) Bluff Point: within the area described by a line beginning at a point 35° 18.3000‘N - 76° 10.2760’W; running westerly to a point 35° 18.3000‘N - 76° 10.0890’W; running southerly to a point 35° 18.1460‘N - 76° 10.0890’W; running easterly to a point 35° 18.1460‘N - 76° 10.2760’W; running northerly to the point of beginning.

(d) Clam Shoal: within the area described by a line beginning at a point 35° 17.4784‘N - 75° 37.4173’W; running westerly to a point 35° 17.4800‘N - 75° 37.1800’W; running southerly to a point 35° 17.1873‘N - 75° 37.1826’W; running easterly to a point 35° 17.1873‘N - 75° 37.4173’W; running northerly to the point of beginning.

(e) Middle Bay: within the area described by a line beginning at a point 35° 14.1580‘N - 76° 30.3320’W; running westerly to a point 35° 14.1580‘N - 76° 30.1780’W; running southerly to a point 35° 14.1150‘N - 76° 30.1780’W; running easterly to a point 35° 14.1150‘N - 76° 30.3320’W; running northerly to the point of beginning.

(f) Ocracoke area: within the area described by a line beginning at a point 35° 10.8150‘N - 75° 59.8530’W; running westerly to a point 35° 10.8150‘N - 75° 59.6320’W; running southerly to a point 35° 10.6320‘N - 75° 59.6320’W; running easterly to a point 35° 10.6320‘N - 75° 59.8530’W; running northerly to the point of beginning.

(g) West Bay: within the area described by a line beginning at a point 34° 58.8517‘N - 76° 21.4735’W; running westerly to a point 34° 58.8517‘N - 76° 21.3632’W; running southerly to a point 34° 58.7661‘N - 76° 21.3632’W; running easterly to a point 34° 58.7661‘N - 76° 21.4735’W; running northerly to the point of beginning.

(3) Neuse River: within the area described by a line beginning at a point 35° 00.4742‘N - 76° 32.0550’W; running westerly to a point 35° 00.4742‘N - 76° 31.9550’W; running southerly to a point 35° 00.3920‘N - 76° 31.9550’W; running easterly to a point 35° 00.3920‘N - 76° 32.0550’W; running northerly to the point of beginning.

History Note: *Authority G.S. 113-134; 113-182; 113-201; 113-204; 143B-289.52; Eff. ???????;*

13.2 STATUTE CHANGES NECESSARY TO IMPLEMENT NC OYSTER FMP AMENDMENT II PREFERRED MANAGEMENT OPTIONS SELECTED BY THE MFC

Issue No: **10.1.2** Issue: **Recreational and Weekend Shellfish Harvest**

Amend G.S. 113-169.2. Shellfish license for North Carolina residents without a SCFL. by repealing subsection (i) and replacing “quantities greater than the personal use limits set forth in subsection (i) of this section” with “a commercial fishing operation” elsewhere in the statute. G.S. 113-168 and 113-168.4 more broadly define the commercial sale and license requirements for all types of fish, including shellfish, and obviate the need to make the license exemptions based on quantity found in G.S. 113-169.2. Recreational catch limits for shellfish are set in rule and proclamation under authority of the Marine Fisheries Commission.

Issue No: **10.2.4** Issue: **Seed oyster management areas**

Amend G.S. 113-203. Transplanting of oysters and clams. by expanding the authority to designate natural and managed public beds as seed oyster areas, change the name of these areas to seed oyster management areas, and remove the role of the county commissioners in the designation process. The MFC has a deliberative fishery management plan process and an extensive committee structure to obtain public input on fisheries management actions that make county commissioner's involvement unnecessary. The other changes will allow DMF to fully develop suitable sites and standardize terminology between statutes and rules.

Issue No: **10.2.6** Issue: **Status of pre-dealer seed shellfish sales**

Amend G.S. 113-168.4. Sale of fish. to 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, Under Dock Oyster Culture Permit, or a shellfish cultivation lease holder for further grow out. The provisions of G.S. 113-168.4 (b) ensure sale of fish to licensed dealers and that data on the amount of fish harvested and sold to consumers is collected. Shellfish hatcheries and aquaculture operations often sell undersize oysters and clams to others conducting aquaculture operations for further grow out. The proposed exemption will prevent the use of erroneous data in management decisions.

Issue No: **10.2.7** Issue: **Leaseholder education training**

Amend G.S. 113-202. New and renewal leases for shellfish cultivation; termination of leases issued prior to January 1, 1966. to include a requirement for training for persons acquiring shellfish leases by lawful transfers. Persons acquiring leases through transfer account for a substantial portion of current leaseholders and many are not familiar with shellfish cultivation.

Issue No: **10.2.9** Issue: **Modify shellfish lease provisions**

Amend G.S. 113-202. New and renewal leases for shellfish cultivation; termination of leases issued prior to January 1, 1966. to change the shellfish bottom lease term to 5 years instead of 10 years so that it coincides with the proposed five year interval on shellfish lease production requirements in rule and to give the Marine Fisheries Commission authority to establish caps on shellfish lease acreage by area.

Also amend G.S. 113-202 to include in the amount of shellfish lease acreage a person may hold the amount held by corporations where the leaseholder holds an interest. The MFC will also need authority to require information on individual interest in corporations similar to license requirements in G. S. 143B-289.52 (b) (3) or fishing piers in G.S. 113-169.4 to monitor these holdings. Statutory changes are also recommended to discourage corporations from holding shellfish leases and to limit corporate holdings as described above.

Issue No: **10.5.5** Issue: **Oyster rock management measures**

It is recommended that G.S. 113-207 (a) and (b) be repealed because the provisions have never been used to manage shellfish and the MFC has created rules to address clamming on oyster rocks on a case-by-case basis.

It is also recommended that stakeholders and legal counsel investigate conservation leasing where environmental groups could lease coastal submerged lands and utilize portions of the water column for long term habitat creation or enhancement projects and that their recommendations be implemented as appropriate.

13.3. Active and Complete NC Oyster FMP Management Issues

Table 13.1. Active and complete NC Oyster and Hard Clam FMP management issues.

	Management Issue	FMP*	Initial FMP	Amend I	Amend II	Amend I Status	Amend II Status **
1	Management Measures (hand harvest areas)	O	2001			Active	Remove; Update in section.
2	Restrict Clam Harvest in Oyster Habitat	B	2001			Active	Active, Combine with Posting on oyster rock and Habitat vs. Production issues #35 and #3
3	Habitat vs. Production	O	2001			Active	Active, Combine with Posting Over Oyster Rocks issue and Restrict clam harvest, #35 and #2
4	Oyster Sanctuary Development/Construction	O	2001			Active	Active, Update
5	Criteria for Transfers	B	2001			Active	Complete; Update in section.
6	Non-Native Oyster Introduction Issue	O	2001			Active	Active, Update
7	Allocation of Areas for Shellfish Leases (Human Use Mapping and Coordination Plans)	B	2001			Active	Active, Update
8	Lease Activities vs. Public Trust	B	2001			Active	Complete
9	Review Shellfish Lease Program	B	2001			Active	Complete; Update in section.
10	No Data on Recreational Harvest of Shellfish	B	2001			Active	Active, Update
11	Effects of an Open Harvest License on Shellfish Fisheries	B	2001			Active	Active, Update
12	Aquaculture Agency ID Problem	B	2001			Active	Complete
13	Shellfish Depuration Plants	B	2001			Active	Active, Update
14	Oyster Enhancement Activities	O	2001			Active	Complete; Update in section.
15	Harvest Management Options for Oysters	O	2001			Active	Active, Combined with and updated in

							#50
16	Oyster Gear Restrictions	O	2001			Active	Complete; new more specific issue in #46
17	Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	B	2001			Active	Active, Update and combine with URW and Polluted Lease Areas issue papers, #30 and #25
18	Permits	B	2001			Active	Complete
19	Unload After Dark	B	2001			Active	Complete
20	Audit Recommendations	B	2001			Active	Complete
21	Clam Relay During Closures	C	2001			Active	Complete; Update in section
22	Manage Mech. Clam Harvest	C	2001			Active	Complete; Update in section.
23	Rotation of Southeast Pamlico Sound and Core Sound	C	2001			Active	Active, Update
24	Effects of Mech. Clam Harvest	C	2001			Active	Active, Update and combine with #42
25	Allow Leases in Polluted Areas	B	2001			Active	Complete -- Add to WQ issue paper #17as a URW issue
26	Modify Lease Production Units	C	2001			Active	Complete
27	Enhancing Clam Production	C	2001			Active	Active, Update
28	Technical Support for Shellfish Leaseholders	B	2001			Active	Active, Update
29	Amend Designation of Oyster Harvest Methods	O		2003		New	Complete
30	Seed Oyster Management Areas	O			2008		New
31	Use Restoration Waters Initiative	B			2008		New but combine with Water Quality issue #17
32	Recreational and Weekend Shellfish Harvest Provisions	B			2008		New
33	Require all Shellfish (out-of-state) at Dealer Level to be Tagged	B			2008		New
34	Education on Shellfish Health Risks and Overboard Discharge of Waste	B			2008		New
35	Statute 113-207 - Posting Oyster Rocks	B			2008		New, Combine with #2 and #3
36	Mechanical Harvest of Other Shellfish	B			2008		New
37	Ward Creek Shellfish Management Area	B			2008		New
38	Cownose ray interaction and their effects on clam and oyster populations	B			2008		New
39	Mechanical Harvest in No-Trawl Areas	C			2008		New, Combine with Effects of Mech.

							Clam Harvest issue #42
40	Ocean Open Area for Harvest of Clams	C			2008		New
41	Status of Pre-Dealer Seed Clam Sales	B			2008		New
42	Effects of Mechanical Clam Harvest on Fish Habitat	C			2008		New, Combine with #24
43	Leaseholder education training	B			2008		New
44	Increased Dredging Restrictions in Pamlico Sound Bays	O			2008		New
45	Change of Dates for Oyster Season	O			2008		New
46	Oyster Rock Management Options	B			2008		New/Update
47	Education on Shellfish Health Risks	B			2008		New
48	Modify shellfish lease provisions	B			2008		New
49	Movement of Seed Shellfish from Polluted Waters	C			2008		New
50	Mechanical vs. Hand Harvest Trip Limit Differences	O			2008		New, Addition to #15
	* O = Oyster C = Clam B = Both						**2008 Issues or Updates in Section**
							28 total
	** Several 2001 issues will be added to historical sections in the FMP. They are no longer considered issues. Other issues are complete and will be removed from the plan. This table indicates issue status for 2008 FMP Amendments. The FMPs will also add information on the UDOC and Recycling Programs, shellfish mapping and sanctuary work, and progress in planning for the state hatchery .						6-Oyster
							6-Clam
							16-Both