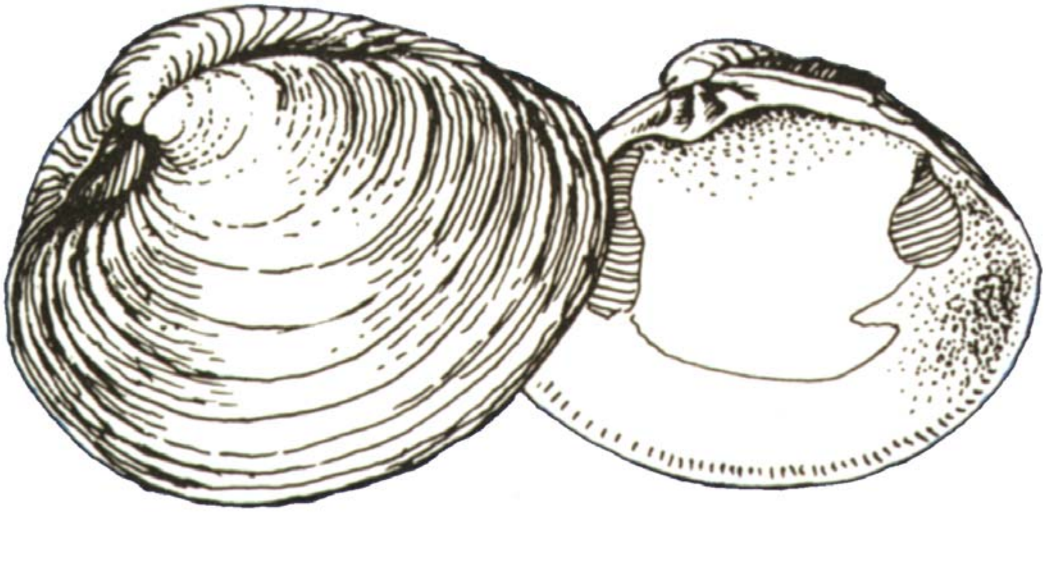
North Carolina
Fishery Management Plan

Hard Clam



June 2008

North Carolina
Hard Clam
Fishery Management Plan

AMENDMENT 1

By

North Carolina Division of Marine Fisheries

North Carolina Department of Environment and Natural Resources
Division of Marine Fisheries
3441 Arendell Street
P. O. Box 769
Morehead City, NC 28557

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 options after public comments
November 2007	Revised with DENR comments
November 2007	Presented to the JLCSA
January 2008	Draft rules accepted for public comment
June 2008	Final adoption by the MFC

1.0 ACKNOWLEDGEMENTS

The 2008 North Carolina Hard Clam Fishery Management Plan (FMP) was developed by the North Carolina Department of Environment and Natural Resources Division of Marine Fisheries (DMF) under the direction of the North Carolina Marine Fisheries Commission (MFC) with advice from the Oyster and Hard Clam Advisory Committee, the Plan Development Team (PDT), and the Rules Subcommittee who contributed their time and knowledge to this document.

Oyster and Hard Clam Advisory Committee

William T. (Rusty) Russ, Co-chair
John Leutze, Co-chair
Troy Alphin
Bob Austin
Elaine Davis
Paul Dunn
Chris Elkins
Larry Gill
Raymond Graham
Nelson Lee
Jim Swartzenberg
Edward (Ted) S. Wilgis

Oyster and Hard Clam Plan Development Team

Greg Allen
Christine Burgess
Clay Caroon
Rich Carpenter
Scott Chappell
Brian Conrad
Scott Crosson
Patti Fowler
Joanne Harcke
Craig Hardy
Don Hesselman
Harold Knudson
Mike Marshall
Sean McKenna
Sara Mirabilio
Wayne Mobley
Tina Moore
Trish Murphey
Stopher Slade
Helen Takade
David Taylor
Stephen Taylor
Marc Turano

2.0 TABLE OF AMENDMENTS

MANAGEMENT STRATEGIES	Issue/Section	OBJECTIVES	REQUIRED ACTION
INSUFFICIENT DATA			
1. Recommend no change (status quo) to collect information on recreational harvest of shellfish	No Data on Recreational Harvest of Shellfish	7	No action required
MANAGEMENT			
1. Rescind the proclamation but keep authority to open the designated area for the mechanical harvest of clams if and when necessary	Ocean Open Area for Harvest of Clams	1, 4 and 8	Existing proclamation authority
2. Define recreational shellfish gear	Recreational and Weekend Shellfish Harvest Provisions	1 and 4	Rule change to 15A NCAC 03I .0101
3. Allow no sale of weekend shellfish harvest except from leases	Recreational and Weekend Shellfish Harvest Provisions	1 and 8	Rule change to 15A NCAC 03K .0106
4. Propose repeal of G.S. 113-169.2 license exemption.	Recreational and Weekend Shellfish Harvest Provisions	1	Statute G.S. 113-169.2 change and Rule 15A NCAC 03K .0105 change
5. Set recreational limits in rule and proclamation	Recreational and Weekend Shellfish Harvest Provisions	1 and 8	Rule change for 15A NCAC 03K .0105 and existing proclamation authority
6. 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	Mechanical Harvest of Other Shellfish	6	Rule change to 15A NCAC 03K .0108
7. Recommend no change to the open shellfish harvest license	Effects of an Open Harvest License on Shellfish Fisheries	1, 3, 7, and 8	No action required
8. Require all shellfish to be tagged at the dealer level	Require all Shellfish (out-of-state) at Dealer Level to be Tagged	1 and 3	Rule change
9. Discontinue rotation of Pamlico Sound with northern Core Sound.	Rotation of Southeast Pamlico Sound with Core Sound	1, 4, 5, 6, 7, and 8	Existing proclamation authority
10. Institute a resting period within the mechanical clam harvest area in the northern part of Core Sound	Rotation of Southeast Pamlico Sound with Core Sound	1, 4, 5, 6, 7, and 8	Existing proclamation authority
PRIVATE CULTURE			
1. Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species	Enhancing Clam Production	2 and 8	No action required
2. If clam seed grow out is initiated then the hatchery facility should work with the MFC Shellfish AC and DMF to determine management criteria for the uses of the clam seed stock	Enhancing Clam Production	1, 2, 3, 5, and 8	No action required

MANAGEMENT STRATEGIES	Issue/Section	OBJECTIVES	REQUIRED ACTION
PRIVATE CULTURE			
3. 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	Status of Pre-Dealer Seed Shellfish Sales	1 and 7	Statute change to G.S. 113-168.4(b)(1)
4. Leave regulations in place as is for depuration facilities.	Shellfish Depuration Plants	7 and 8	No action required
5. Utilize user coordination plans for shellfish lease issuance coast wide	Allocation of Areas for Shellfish Leases	1, 3, 5, 7, and 8	No action required
6. Develop an independent education package in coordination with the Oyster Hatchery Program, N. C. Sea Grant, and other state agencies, and organizations to be presented at seminars with a mandatory attendance for all new leaseholders, and a mandatory completion of an examination with a passing score to meet education requirements for both new leaseholders and leaseholder transferees	Leaseholder Educational Training	2, 6, and 8	Amend statute G.S. 113-202 and rule changes to 15A NCAC 03O .0202 and 15A NCAC 03O .0209
7. 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	Leaseholder Educational Training	1 and 4	Amend statute G.S. 113-202 and change rule 15A NCAC 03O .0202
8. 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	Leaseholder Educational Training	8	No action required
9. 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	Leaseholder Educational Training	3 and 8	Amend G.S. 113-201
10. Support private oyster larvae monitoring programs	Technical Support for Shellfish Leaseholders	1, 2, 3, 5, and 7	No action required
11. Support construction of an integrated system of shellfish hatcheries and remote-setting sites	Technical Support for Shellfish Leaseholders	1, 2, 5, 7, and 8	No action required
12. Develop a subsidized, fee-for-service disease diagnosis program.	Technical Support for Shellfish Leaseholders	2 and 5	No action required
13. Recommend status quo on the movement of seed shellfish from polluted waters	Movement of Seed Shellfish from Polluted Waters	2 and 7	No action required
14. 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	Modify Shellfish Lease Provisions	1 and 5	Amend Amend G.S. 113-202 and changes to rule 15A NCAC 03O .0201

MANAGEMENT STRATEGIES	Issue/Section	OBJECTIVES	REQUIRED ACTION
PRIVATE CULTURE			
15. Limit acreage per shellfish lease application to 5 acres	Modify Shellfish Lease Provisions	1 and 5	Rule change to 15A NCAC 03O .0201
16. 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	Modify Shellfish Lease Provisions	1 and 7	Amend G.S. 113-202 and rule changes to 15A NCAC 03O .0201and 15A NCAC 03O .0210
17. Require Lat./Long. coordinates on lease corner locations as part of the requirement of a registered land survey	Modify Shellfish Lease Provisions	3	Amend G.S. 113-202 and rule changes to 15A NCAC 03O .0203
18. Develop regional lease acreage caps based on established use of water bodies	Modify Shellfish Lease Provisions	1, 3, 5, 7, and 8	Amend G.S. 113-202
19. 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	Modify Shellfish Lease Provisions	1, 5, and 7	Amend G.S. 113-202
20. Monitor seeded oyster sanctuaries for cownose ray predation.	Cownose Ray Interaction and Their Effect on Clam and Oyster Populations	2	No action required
21. Provide bilingual (English and Spanish) educational materials to consumers, leaseholders, UDOC permit holders, shellfish dealers, and other DENR state regulatory agencies	Education on Shellfish Health Risks	7 and 8	No action required
22. Encourage harvesters to take volunteer time and temperature control measures on their product.	Education on Shellfish Health Risks	2, 5, and 8	No action required
HABITAT AND WATER QUALITY CONCERNS			
1. Identify and delineate Strategic Habitat Areas that will enhance protection of clam habitats; research physical factors influencing clam abundance predictably	Habitat Section	6	Existing authority through the CHPP implementation plan
2. Coordinate SHAs with land-based conservation and restoration activities such as One North Carolina Naturally and DENR's green infrastructure planning	Habitat Section	6	Existing authority through the CHPP implementation plan
3. Ensure oyster and SAV habitat definitions are consistent across regulating agencies	Habitat Section	6	Existing authority through the CHPP implementation plan
4. Completely map all structured habitat (i.e., shell bottom, SAV) in North Carolina, including the deep, subtidal rocks on Pamlico Sound	Habitat Section	2 and 6	Existing authority through the CHPP implementation plan
5. Remap structured habitats to assess changes in distribution and abundance over time	Habitat Section	2 and 6	Existing authority through the CHPP implementation plan

MANAGEMENT STRATEGIES	Issue/Section	OBJECTIVES	REQUIRED ACTION
HABITAT AND WATER QUALITY CONCERNS			
6. Restore historical distribution and acreage of oysters and SAV where possible; coordinate with land-based protection and restoration efforts	Habitat Section	2 and 6	Existing authority through the CHPP implementation plan
7. Balance protection of oyster beds and SAV (as habitat) with harvest provisions and expand oyster sanctuary planting and designation	Habitat Section	2 and 6	Existing authority
8. Monitor biological/ecological condition and effectiveness of oyster sanctuaries and restored SAV beds	Habitat Section	2 and 6	No action required
9. Cooperate with University researchers on oyster larvae distribution and oyster recruitment studies to aid in restoration planning	Habitat Section	2 and 6	No action required
10. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to oyster and SAV habitat	Habitat Section	6	Existing authority through the CHPP implementation plan
11. Develop permit application survey protocols for shellfish and SAV habitats for CAMA applicants	Habitat Section	6	Existing authority
12. Evaluate and adjust as necessary dredging and trawling boundaries to protect and enhance oyster and SAV habitat	Habitat Section	4 and 6	Existing proclamation authority
13. Seek additional resources to enhance enforcement of and compliance with expanded bottom disturbing fishing gear restrictions that protect oyster and SAV habitat	Habitat Section	4 and 6	No action required
14. Evaluate making conservation leasing available to non-government organizations for the purpose of oyster restoration and sanctuary development	Habitat Section	6	No action required
15. Work with NOAA and DWQ to determine appropriate levels of TSS, turbidity, chlorophyll a, and other water clarity parameters to achieve adequate water quality conditions for SAV growth and clam production	Water Quality Section	6	Existing authority through the CHPP implementation plan
16. Seek 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	Water Quality Section	6	Existing authority through the CHPP implementation plan
17. Target productive shellfish resources in conditionally approved closed areas for land-based protection and restoration efforts. This could include designation as Strategic Habitat Are or Use-Restoration Water	Water Quality Section	6	Existing authority through the CHPP implementation plan
18. Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information	Effects of Mechanical Clam Harvest on Fish Habitat	4 and 6	Existing proclamation authority

MANAGEMENT STRATEGIES	Issue/Section	OBJECTIVES	REQUIRED ACTION
HABITAT AND WATER QUALITY CONCERNS			
19. 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	Education on Public Health Risks of Eating Shellfish and Overboard Discharge of Waste	8	No action required
20. Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation and co-ordinate with sister agencies	Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	6	Existing authority through the CHPP implementation plan
21. 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	Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	6	Existing authority through the CHPP implementation plan
22. 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	Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	6	Existing authority through the CHPP implementation plan
23. Recommend to the DWQ to accept a lower threshold of 10,000 square feet to coastal stormwater rules	Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	6	Existing authority through the CHPP implementation plan
24. Recommend a naturally vegetative riparian buffer width of 50 feet	Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	6	Existing authority through the CHPP implementation plan
25. Recommend the exclusion of all wetlands (coastal and non-coastal), from the built-upon area calculations	Water Quality Degradation by Biological Contamination of Shellfish Growing Waters	6	Existing authority through the CHPP implementation plan
26. Recommend repeal of G.S. 113-207 (a) and (b) to end the requirement that all oyster rocks must be posted by the Department	Oyster Rock Management Options	3	Repeal G.S. 113-207 (a) and (b)
27. 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	Oyster Rock Management Options	2 and 6	No action required
28. Leave current management practices in place for Ward Creek	Ward Creek Shellfish Management Area	1 and 7	Existing proclamation authority

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3.1 LIST OF TABLES

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3.3 LIST OF ACRONYMS

AC – Advisory Committee

AEC – Areas of Environmental Concern

AOP – Aquaculture Operation Permit

ASMFC – Atlantic States Marine Fisheries Commission

BMP – Best Management Practice

BRACO – Blue Ribbon Advisory Committee on Oysters

CAMA – Coastal Area Management Act

CEIP – Coastal Energy Impact Program

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

DOT – North Carolina Department of Transportation

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

ICW – Intracoastal Waterway

ISSC – Interstate Shellfish Sanitation Conference

JLCSA – Joint Legislative Commission for Seafood and Aquaculture

MAFMC – Mid Atlantic Fisheries Management Council

MFC – North Carolina Marine Fisheries Commission

MRFSS- Marine Recreational Fisheries Statistical Survey

MSC – Moratorium Steering Committee

MSX – Multinucleated Sphere X

NCOHP – North Carolina Oyster Hatchery Program

NCSU – North Carolina State University

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

QPX – Quahog Parasite Unknown

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

TTP – North Carolina Division of Marine Fisheries Trip Ticket Program

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

VIMS – Virginia Institute of Marine Science

VMPB – Virginia Marine Products Board

WRC – North Carolina Wildlife Resources Commission

WS – Water Supply

4.0 EXECUTIVE SUMMARY

Hard Clam Stock Status: The status of the hard clam stock in North Carolina is currently listed as unknown. A stock assessment cannot be completed at this time due to data limitations.

Problem Areas: (A) Insufficient Data – (1) Inability to conduct a stock assessment; (B) Management – (1) Increase application of rule authority (2) Evaluate rotational mechanical clam harvest in northern Core Sound; (C) Private Culture – (1) Insufficient industry support (2) Improve lease administration (3) Educate leaseholders (4) Support hatchery establishment and associated programs; (D) Habitat and Water Quality Concerns – (1) Support CHPP implementation plan (2) Habitat value higher than harvest value (3) Increase efforts to restore water quality.

Sustainable Harvest: Data limitations prevent DMF from conducting a hard clam stock assessment and calculating sustainable harvest. While landings records will reflect population abundance to some extent, the relationship is confounded by changes in effort, gear technology, regulations, and market demand. Based on the best available indicators harvest levels in most areas appeared relatively constant. It is also recommended to increase hard clam sampling programs to collect information necessary for the completion of a stock assessment.

Public Fishery Aspects: Since 1991 annual hard clams landings from public bottoms have been in decline which may be attributed to less market demand, higher harvesting costs, weather events, and increasing polluted area closures.

Private Fishery Aspects: Hard clams are the principal species produced on leased bottom in North Carolina where unique environmental conditions enable development of various hard clam culture methods. Today the majority of shellfish leases are held by commercial fishermen to supplement their income from public harvest areas by holding shellfish to improve the meat condition and/or sell during better market conditions. Private bottom acreage has fluctuated very little over time while number of leases has shown a gradual increase indicating leases are getting slightly smaller

Recreational Fishery: The amount and extent of recreational harvest of hard clams is unknown at this time. Collection of recreational harvest information would provide a better estimate of fishing mortality and estimate of relative abundance of hard clams.

Economic Status: In real dollar (inflation-adjusted) terms, 2005 had the least-valued landings since the mid-1970s. Prices for some grades of clams have dropped in recent years in real-dollar terms, but this decline in total value is largely driven by a decline in catch. Clams are, however, important to the shellfishermen that harvest them, supplementing their income when other fisheries are slow.

Habitat and Water Quality: Section 9.0 and issues in Section 10.0 address habitat and water quality concerns specific to hard clams. Adequate habitat and suitable water quality are imperative to support the hard clam population. All information and recommendations from Section 9.0 are derived directly from the CHPP.

Management Options: Section 10.0 provides background and discussion of the 22 issues considered by the MFC in selecting their management and research recommendations. The MFC recommends maintaining current catch limits until changes in catch rates occur. It is also recommended to discontinue the rotational management regime in the mechanical clam harvest area in Pamlico Sound and instead incorporate a resting period of one year on and one year off to the mechanical clam harvest area in the northern part of Core Sound.

4.1 GOALS AND OBJECTIVES

The goal of the 2008 North Carolina Hard Clam FMP is to manage hard clam stocks in a manner that achieves sustainable harvest and protects its ecological value. To achieve this goal, it is recommended that the following objectives be met:

1. Protect the hard clam stock from overfishing, while maintaining levels of harvest at sustained production, providing sufficient opportunity for both recreational and commercial hard clamming, and aquaculture.

2. Identify, develop, and promote research to improve the understanding of hard clam biology, ecology, population dynamics, and aquaculture practices.

3. Initiate, enhance, and continue studies to collect and analyze economic, social, and fisheries data needed to effectively monitor and manage the hard clam fishery.

4. Identify, develop and promote efficient hard clam harvesting practices while protecting habitat.

5. Investigate stock and bottom enhancement measures for both wild stock and cultured hard clams.

6. Promote the protection, restoration, and enhancement of habitats and water quality so that the production of hard clams is optimized.

7. Consider the socioeconomic concerns of all user groups.

8. Promote public awareness regarding the status and management of the North Carolina hard clam stock.

4.2 MARINE FISHERIES COMMISSION SELECTED MANAGEMENT OPTIONS

MANAGEMENT STRATEGIES	OBJECTIVES	REQUIRED ACTION
INSUFFICIENT DATA		
1. Recommend no change (status quo) to collect information on recreational harvest of shellfish	7	No action required
MANAGEMENT		
1. Rescind the proclamation but keep authority to open the designated area for the mechanical harvest of clams if and when necessary	1, 4 and 8	Existing proclamation authority
2. Define recreational shellfish gear	1 and 4	Rule change to 15A NCAC 03I .0101
3. Allow no sale of weekend shellfish harvest except from leases	1 and 8	Rule change to 15A NCAC 03K .0106
4. Propose repeal of G.S. 113-169.2 license exemption.	1	Statute G.S. 113-169.2 change and Rule 15A NCAC 03K .0105 change
5. Set recreational limits in rule and proclamation	1 and 8	Rule change for 15A NCAC 03K .0105 and existing proclamation authority
6. 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	6	Rule change to 15A NCAC 03K .0108
7. Recommend no change to the open shellfish harvest license	1, 3, 7, and 8	No action required
8. Require all shellfish to be tagged at the dealer level	1 and 3	Rule change to 15A NCAC 03K .0101
9. Discontinue rotation of Pamlico Sound with northern Core Sound.	1, 4, 5, 6, 7, and 8	Existing proclamation authority
10. Institute a resting period within the mechanical clam harvest area in the northern part of Core Sound	1, 4, 5, 6, 7, and 8	Existing proclamation authority
PRIVATE CULTURE		
1. Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species	2 and 8	No action required
2. If clam seed grow out is initiated then the hatchery facility should work with the MFC Shellfish AC and DMF to determine management criteria for the uses of the clam seed stock	1, 2, 3, 5, and 8	No action required
3. 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	1 and 7	Statute change to G.S. 113-168.4(b)(1)
4. Leave regulations in place as is for depuration facilities.	7 and 8	No action required
5. Utilize user coordination plans for shellfish lease issuance coast wide	1, 3, 5, 7, and 8	No action required
6. Develop an independent education package in coordination with the Oyster Hatchery Program, N. C. Sea Grant, and other state agencies, and organizations to be presented at seminars with a mandatory attendance for all new leaseholders, and a mandatory completion of an examination with a passing score to meet education requirements for both new leaseholders and leaseholder transferees	2, 6, and 8	Amend statute G.S. 113-202 and rule changes to 15A NCAC 03O .0202 and 15A NCAC 03O .0209
7. 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	1 and 4	Amend statute G.S. 113-202 and change rule 15A NCAC 03O .0202
8. 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	8	No action required

MARINE FISHERIES COMMISSION PREFERRED MANAGEMENT OPTIONS

MANAGEMENT STRATEGIES	OBJECTIVES	REQUIRED ACTION
PRIVATE CULTURE		
9. 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	3 and 8	Amend G.S. 113-201
10. Support private oyster larvae monitoring programs	1, 2, 3, 5, and 7	No action required
11. Support construction of an integrated system of shellfish hatcheries and remote-setting sites	1, 2, 5, 7, and 8	No action required
12. Develop a subsidized, fee-for-service disease diagnosis program	2 and 5	No action required
13. Recommend status quo on the movement of seed shellfish from polluted waters	2 and 7	No action required
14. 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	1 and 5	Amend Amend G.S. 113-202 and changes to rule 15A NCAC 03O .0201
15. Limit acreage per shellfish lease application to 5 acres	1 and 5	Rule change to 15A NCAC 03O .0201
16. 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	1 and 7	Amend G.S. 113-202 and rule changes to 15A NCAC 03O .0201and 15A NCAC 03O .0210
17. Require Lat./Long. coordinates on lease corner locations as part of the requirement of a registered land survey	3	Amend G.S. 113-202 and rule changes to 15A NCAC 03O .0203
18. Develop regional lease acreage caps based on established use of water bodies	1, 3, 5, 7, and 8	Amend G.S. 113-202
19. 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	1, 5, and 7	Amend G.S. 113-202
20. Monitor seeded oyster sanctuaries for cownose ray predation.	2	No action required
21. Provide bilingual (English and Spanish) educational materials to consumers, leaseholders, UDOC permit holders, shellfish dealers, and other DENR state regulatory agencies	7 and 8	No action required
22. Encourage harvesters to take volunteer time and temperature control measures on their product.	2, 5, and 8	No action required
HABITAT AND WATER QUALITY CONCERNS		
1. Identify and delineate Strategic Habitat Areas that will enhance protection of clam habitats; research physical factors influencing clam abundance predictably	6	Existing authority through the CHPP implementation plan
2. Coordinate SHAs with land-based conservation and restoration activities such as One North Carolina Naturally and DENR’s green infrastructure planning	6	Existing authority through the CHPP implementation plan
3. Ensure oyster and SAV habitat definitions are consistent across regulating agencies	6	Existing authority through the CHPP implementation plan
4. Completely map all structured habitat (i.e., shell bottom, SAV) in North Carolina, including the deep, subtidal rocks on Pamlico Sound	2 and 6	Existing authority through the CHPP implementation plan
5. Remap structured habitats to assess changes in distribution and abundance over time	2 and 6	Existing authority through the CHPP implementation plan

MARINE FISHERIES COMMISSION PREFERRED MANAGEMENT OPTIONS

MANAGEMENT STRATEGIES	OBJECTIVES	REQUIRED ACTION
HABITAT AND WATER QUALITY CONCERNS		
6. Restore historical distribution and acreage of oysters and SAV where possible; coordinate with land-based protection and restoration efforts	2 and 6	Existing authority through the CHPP implementation plan
7. Balance protection of oyster beds and SAV (as habitat) with harvest provisions and expand oyster sanctuary planting and designation	2 and 6	Existing authority
8. Monitor biological/ecological condition and effectiveness of oyster sanctuaries and restored SAV beds	2 and 6	No action required
9. Cooperate with University researchers on oyster larvae distribution and oyster recruitment studies to aid in restoration planning	2 and 6	No action required
10. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to oyster and SAV habitat	6	Existing authority through the CHPP implementation plan
11. Develop permit application survey protocols for shellfish and SAV habitats for CAMA applicants	6	Existing authority
12. Evaluate and adjust as necessary dredging and trawling boundaries to protect and enhance oyster and SAV habitat	4 and 6	Existing proclamation authority
13. Seek additional resources to enhance enforcement of and compliance with expanded bottom disturbing fishing gear restrictions that protect oyster and SAV habitat	4 and 6	No action required
14. Evaluate making conservation leasing available to non-government organizations for the purpose of oyster restoration and sanctuary development	6	No action required
15. Work with NOAA and DWQ to determine appropriate levels of TSS, turbidity, chlorophyll a, and other water clarity parameters to achieve adequate water quality conditions for SAV growth and clam production	6	Existing authority through the CHPP implementation plan
16. Seek 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	6	Existing authority through the CHPP implementation plan
17. Target productive shellfish resources in conditionally approved closed areas for land-based protection and restoration efforts. This could include designation as Strategic Habitat Are or Use-Restoration Water	6	Existing authority through the CHPP implementation plan
18. Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information	4 and 6	Existing proclamation authority

MARINE FISHERIES COMMISSION PREFERRED MANAGEMENT OPTIONS

MANAGEMENT STRATEGIES	OBJECTIVES	REQUIRED ACTION
HABITAT AND WATER QUALITY CONCERNS		
19. 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	8	No action required
20. Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation and co-ordinate with sister agencies	6	Existing authority through the CHPP implementation plan
21. 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	6	Existing authority through the CHPP implementation plan
22. 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	6	Existing authority through the CHPP implementation plan
23. Recommend to the DWQ to accept a lower threshold of 10,000 square feet to coastal stormwater rules	6	Existing authority through the CHPP implementation plan
24. Recommend a naturally vegetative riparian buffer width of 50 feet	6	Existing authority through the CHPP implementation plan
25. Recommend the exclusion of all wetlands (coastal and non-coastal), from the built-upon area calculations	6	Existing authority through the CHPP implementation plan
26. Recommend repeal of G.S. 113-207 (a) and (b) to end the requirement that all oyster rocks must be posted by the Department	3	Repeal G.S. 113-207 (a) and (b)
27. 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	2 and 6	No action required
28. Leave current management practices in place for Ward Creek	1 and 7	Existing proclamation authority

4.3 SUSTAINABLE HARVEST STRATEGY

Data limitations prevent DMF from conducting a hard clam stock assessment and calculating sustainable harvest. Based on the best available indicators harvest levels in most areas appeared relatively constant. Refer to Subsections 6.2 and 6.3, Present Stock Status and Sustainable Harvest Strategies, for an overview of the methods used to provide stock indicators although there are data limitations with these methods. It is recommended that the hard clam fishery continue to harvest at current daily harvest limits, eliminate the mechanical clam harvest rotation in Pamlico Sound, and institute a resting period in the northern Core Sound mechanical clam harvest area. It is also recommended to increase hard clam sampling programs to collect information necessary for the completion of a stock assessment.

5.0 INTRODUCTION

5.1 MANAGEMENT AUTHORITY

All authority for management of North Carolina's hard clam (*Mercenaria mercenaria*) fishery is vested in the State of North Carolina. Management of the hard clam fishery includes all activities associated with maintenance, improvement, and utilization of the hard clam population and their habitats in the coastal area, including research, development, regulation, enhancement, and enforcement. Hard clam harvest occurs from coastal waters and is under rules of the North Carolina Marine Fisheries Commission (MFC). However, the North Carolina Department of Environment and Natural Resources (DENR) is the agency directed by North Carolina General Statute 113-182.1 (G.S. 113-182.1) to prepare Fishery Management Plans (FMPs) for all commercially or recreationally significant species or fisheries that comprise State marine or estuarine resources. These plans must be approved and adopted by the MFC.

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

The Fisheries Reform Act of 1997 (FRA) establishes a process for preparation of coastal FMPs in North Carolina (G.S. 113-182). The FRA was amended in 1998 and again in 2004. In 1998 the FRA was amended with several changes, that; 1) determine limited entry authority in Federal quota-based fisheries; 2) authorized that FMPs and management measures from FMPs be reviewed by the regional advisory committees; 3) authorized that MFC meetings must have a super quorum; 4) clarified definitions; and 5) clarified licensing provisions for standard commercial fishing licenses (SCFL) and recreational commercial gear licenses (RCGL). The amendment of the Act in 2004 required FMPs to achieve sustainable harvest rather than optimal yield and to specify a time period not to exceed 10 years for ending overfishing and rebuilding a fishery. The FRA states that "the goal of the plans shall be to ensure the long-term viability of the State's commercially and recreationally significant species or fisheries. Each plan shall be designed to reflect harvest practices so that one plan may apply to a specific fishery, while other plans may be based on gear or geographic areas. Each plan shall:

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

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

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

d. Specify a time period, not to exceed 10 years from the date of adoption of the plan, for ending overfishing and achieving a sustainable harvest. This subdivision shall only apply to a plan for a fishery that is overfished. This subdivision shall not apply to a plan for a fishery where the biology of the fish or environmental conditions make ending overfishing and achieving a sustainable harvest within 10 years impracticable (G.S. 113-129(12d)).

Sustainable harvest is defined in the FRA as "The amount of fish that can be taken from a fishery on a continuing basis without reducing the stock biomass of the fishery or causing the fishery to become overfished" (G.S. 113-129(14a)). Overfished is defined as "the condition of a fishery that occurs when the spawning stock biomass of the fishery is below the level that is adequate for the recruitment class of a fishery to replace the spawning class of the fishery" (G.S. 113-129(12c)). Overfishing is defined as "fishing that causes a level of mortality that prevents a fishery from producing a sustainable harvest" (G.S.113-129(12d)).

The Eastern oyster (*Crassostrea virginica*) was considered a priority species for the development of an FMP because the 1998 DMF Stock Status Report (SSR) designated the stock as depressed. The DMF changed the stock status designation in 1999 and determine eastern oyster as concern. The MFC decided the Hard Clam FMP would be written in conjunction with the Oyster FMP because of coincident fisheries, shared habitats and similar fishing practices.

5.2 GENERAL PROBLEM STATEMENT

Issues that will be addressed in the Hard Clam FMP fall into 4 general problem statements. The categories include: 1) insufficient data; 2) management; 3) private culture; and 4) habitat and water quality. The only historical data available for the hard clam are commercial landings and various short-term surveys. Fishery dependent and independent sampling programs were initiated in 1999. These programs are currently small in scale and concentrate around the hard clam population only in Core Sound.

5.2.1 INSUFFICIENT DATA

Data limitations prevent DMF from conducting a hard clam stock assessment and calculating sustainable harvest. Prior to 1994, hard clam data for North Carolina were limited to landings from the commercial fishery and a number of short-term surveys. **The statutory obligation to manage hard clams according to sustainable harvest cannot be met until the appropriate data are collected.** While landings records reflect population abundance to some extent, the relationship is confounded by changes in harvest effort and efficiency. The trip ticket program, initiated in 1994, provides commercial landings as well as individual trip information. Fishery-dependent and independent monitoring program were initiated in 1999 to collect biological data to complement trip ticket landings information in Core Sound. Unfortunately, no data are collected for the recreational harvest of hard clams. Socioeconomic surveys of recreational participants need to be performed to determine specific characteristics of the user group, which issues are important to them, attitudes toward management of the fishery, as well as general demographic information.

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

5.2.2 MANAGEMENT

The hard clam fishery has been managed through harvest and size limits. Mechanical harvest also has gear, season, and area restrictions, and a relay program where clams are moved from certain polluted areas and placed on leases for depuration. Rotational two year openings for mechanical harvest between an area in the southeast Pamlico Sound with Core Sound has occurred since 2001with lower bag limits to 20 bags per day in both areas. White Oak River, the Intracoastal Waterway (ICW) of Onslow and Pender counties (Marker 65 to the BC Marker at Banks Channel), and New River are rotated on a yearly basis. The status of the hard clam is still listed as unknown. The management program needs to be re-assessed and modified as data become available. Other issues of concern include: predator impacts on the population, clarification of rules, rotational mechanical harvest areas, and gear conflicts.

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

5.2.3 PRIVATE CULTURE

The current shellfish lease system in North Carolina needs to be evaluated and changes implemented in order to make the system more productive. Improved allocation of lease areas may reduce conflict between culturists and other user groups, while better monitoring of leases and enforcement of lease requirements would greatly improve acceptance of the program by commercial fishermen. Leaseholder needs for technical support will also be assessed as a means of improving production through private culture. Other issues of concern include: education of leaseholders, clarification of rules, production enhancement, and depuration.

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

5.2.4 HABITAT AND WATER QUALITY CONCERNS

Adequate habitat and suitable water quality are imperative to the hard clam population. Support of the Coastal Habitat Protection Plan (CHPP) is essential in collaborating with other agencies such as, the Coastal Resources Commission (CRC) and the Environmental Management Commission (EMC) to improve habitat and water quality coastwide. The MFC and DMF will continue to comment on permit applications involving shoreline development that may impact shellfish areas. These recommendations should include ways to prevent or minimize potential negative impacts to shellfish growing waters. Other habitat issues include effects of mechanical harvest on fish habitat, shellfish polluted areas, and education on public health risks.

Specific issues, options, and potential actions are outlined in Sections 9.0, 10.0, and 11.0.

5.3 DEFINITION OF THE MANAGEMENT UNIT

The management unit includes the hard clam (*Mercenaria mercenaria*) and its fisheries in all waters of coastal North Carolina.

5.4 EXISTING PLANS, STATUTES, AND RULES OF NORTH CAROLINA

5.4.1 PLANS

There are no federal or interstate FMPs regulating hard clams in North Carolina. A state hard clam FMP was written in 1997 but was never finalized and did not address private culture issues.

In August 2001 a state FMP for hard clams was approved for North Carolina (see Appendix 13.1 for a summary of actions taken). The Hard Clam FMP is reviewed and updated at least every five years. This document is a review and Amendment (1) of the 2001 FMP.

5.4.2 STATUTES

North Carolina G.S. 113-134, 113-182, and 143B-289.54 allow the MFC broad authority to promulgate rules for the management of marine and estuarine resources, including clams, in coastal fishing waters (MFC 2007). 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 from public grounds and private beds. Propagation of shellfish by the DENR both for public or private beds is authorized under G.S. 113-204.

Aquaculture, including the aquaculture of estuarine shellfish, is under the jurisdiction of the North Carolina Department of Agriculture. That department and its Aquaculture Advisory Board are charged with reviewing and making recommendations on policies, laws, and regulations to facilitate aquaculture development. The powers and duties associated with this charge are contained in North Carolina General Statutes 106-756 through 106-760.
The MFC has jurisdiction, as provided in G.S. 113-132, over all activities connected with the conservation and regulation of marine and estuarine resources, including the regulation of aquaculture facilities (as defined in G.S. 106-758) which cultivate or rear marine and estuarine resources.

Other North Carolina General Statutes that address specific items relating to the hard clam fishery as referred from the North Carolina Fisheries Rules for Coastal Waters 2007 (MFC 2007) and are listed as follows:

G.S. 113-168.2 Standard Commercial Fishing License

This is 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

This is 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	Licenses for fish dealers
	This establishes a license requirement and a $50.00 fee for dealing in clams. Dealer licenses are restricted to North Carolina residents.
G.S. 113-182.1	Fishery Management Plans (FMP)
	This requires the Department to prepare and the MFC to adopt FMPs for all commercially or recreationally significant species.
G.S. 113-187	Penalties for violations
	Penalties for shellfishing in an area closed because of suspected pollution is guilty of a class A1 misdemeanor
G.S. 113-201.1	Definitions
	This 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
	This allows shellfish leases meeting certain standards to be granted in coastal fishing waters except in Brunswick County and Core Sound.
G.S. 113-202.1	Water column leases for aquaculture
	This 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
	This 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
	Establishes rules for transplanting shellfish to private beds.
G.S. 113-206	Chart of grants, leases and fishery rights; overlapping leases and right; contest or condemnation of claims; damages for taking of property.

This provides for resolution of submerged lands conflicts.

G.S. 113-207 Taking shellfish from certain areas forbidden; penalty

It is unlawful to take clams from posted oyster rocks by use of rakes or tongs. It is unlawful to take any shellfish from within 150 feet of a publicly owned pier in which the DMF has deposited cultch material. A violation is a class 3 misdemeanor.

G.S. 113-208 Protection of private shellfish rights

This establishes a maximum $5,000 fine for theft from a shellfish lease.

G.S. 113-209 Taking polluted shellfish at night or with prior convictions forbidden; penalty

This establishes a Class I felony with a minimum $2,500 fine for repeat offenders taking shellfish from polluted areas or at night.

G.S. 113-269 Robbing or injuring hatcheries and other aquaculture operations

This defines fines and punishment for robbing or injuring aquaculture operations.

G.S. 143B-279.8 Coastal Habitat Protection Plans

This 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

5.4.3.1 GENERAL

- Dredge is defined as a device towed by engine power consisting of a frame, tooth bar or smooth bar, and catchbag used in the harvest of oysters, clams, crabs, scallops, or conchs (15A NCAC 03I .0101(b)(12)).
- Mechanical methods of clamming is defined as including but not limited to dredges, hydraulic clam dredges, stick rakes and other rakes when towed by engine power, patent tongs, kicking with propellers or deflector plates with or without trawls, and any other method that utilizes mechanical means to harvest clams (15A NCAC 03I .0101(b)(13)).
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- Depuration is defined as the purification or the removal of adulteration from live oysters, clams and mussels by any natural or artificially controlled means (15A NCAC 03I .0101(b)(15)).
- Aquaculture operation is defined as an operation that produces artificially propagated stocks of marine or estuarine resources or obtains such stocks from authorized sources for the purpose of rearing in a controlled environment (15A NCAC 03I .0101(b)(19)).
- Shellfish producing habitats are those areas in which shellfish, such as clams , whether historically or currently, reproduce and survive because of such favorable conditions as bottom type, salinity, currents, cover, and cultch. Included are those shellfish producing areas closed to shellfish harvest due to pollution (15A NCAC 03I .0101(b)(20)(B)).
- Intertidal Oyster Bed is defined as a formation of shell and live oysters of varying density (15A NCAC 03I .0101(b)(21)).
- Shellfish production on leases and franchises is defined as the culture of clams on shellfish leases on leases and franchises from a sublegal harvest size to a marketable size. And also the transplanting (relay) of clams from designated areas closed due to pollution to shellfish leases and franchises in open waters abd the natural cleansing of those shellfish. (15A NCAC 03I .0101(b)(26)(A)(B)).
- Shellfish marketing from leases and franchises is defined as the harvest of clams from privately held shellfish bottoms and lawful sale of those shellfish to the public at large or to a licensed shellfish dealer (15A NCAC 03I .0101(b)(27)).
- Shellfish planting effort on leases and franchises. The process of obtaining authorized cultch materials, seed shellfish, and polluted shellfish stocks and the placement of those materials on privately held shellfish bottoms for increased shellfish production (15A NCAC 03I .0101(b)(28)).
- It is unlawful to introduce, transfer, hold, or maintain any live aquatic animals or plants not native to the state without first obtaining a permit from the Fisheries Director (15A NCAC 03I .0104 (a)(1)(2)(3)(b)(c)).

5.4.3.2 SHELLFISH GENERAL

- It is unlawful to possess, sell, or take oysters, clams or mussels from prohibited (polluted) areas in or out of North Carolina. The Fisheries Director may close areas to the taking of oysters, clams, scallops and mussels in order to protect shellfish populations for management purposes or for public health purposes (15A NCAC 03K .0101 (a)(b)(c)).
- It is unlawful to possess or sell oysters, clams, or mussels without a harvest tag affixed to each container. Tags should be durable for at least 90 days, and should be securely fastened to the outside of each container. Tags should have legible information including the harvester’s name, address, and license number, harvest date, harvest location, type, and quantity (15A NCAC 03K .0101 (d)).

- It is unlawful to use a rakes more than 12 inches wide or weighing more than six pounds to take clams in any live oyster bed, in any established bed of submerged aquatic vegetation, or in any established bed of saltwater cordgrass (Spartina alterniflora) (15A NCAC 03K. 0102(b)).
- The Fisheries Director may designate Shellfish or Seed Management Areas based on certain criteria such as bottom type, salinity, cover, and the ability to produce commercial shellfish populations or shellfish enhancement projects (15A NCAC 03K .0103 (a)(1)(2)(3)).
- It is unlawful to use a trawl net, long haul seine, or swipe net in a Shellfish/Seed Management area. It is unlawful to take oysters or clams from a closed Shellfish/Seed Management area. A permit is required to take oysters or clams from a Seed Management area for planting on private bottom (15A NCAC 03K .0103 (b)(c)).
- Relaying of clams from polluted public bottom may only occur between April 1 through May 15 and only with a permit (15A NCAC 03K .0104 (a)(b)).
- The season does not apply in 15A NCAC 03K .0104 (b) for areas designated by the Fisheries Director as sites where shellfish would otherwise be destroyed in maintenance dredging operations (15A NCAC 03K .0104 (c)).
- The Fisheries Director shall close and reopen any private shellfish bed for which the owner has obtained a permit to relay oysters and clams from polluted public bottom (15A NCAC 03K .0104 (d)).
- The recreational harvest limit for clams is one hundred clams per person per day, not to exceed two hundred clams per vessel per day (15A NCAC 03K .0105 (b)).
- It is unlawful to take clams on Sundays except in recreational quantities (15A NCAC 03K .0105 (c)(1)(2)).
- It is unlawful to take oysters or clams, unload oysters or clams, or remove any vessel containing oysters or clams between the hours of sunset and sunrise on any day. Oysters and clams taken in New Hanover, Pender and Brunswick Counties may be unloaded until two hours after sunset (15A NCAC 03K .0106 (a) (b)).
- It is unlawful to take clams, oysters, or mussels from polluted waters for depuration except when the harvest utilizes shellfish that would be destroyed in maintenance dredging operations. The Fisheries Director may impose restrictions on harvest. A permit is required to harvest clams, oysters or mussels from polluted waters for depuration (15A NCAC 03K .0107 (a) (b)(1)(2)(3)(4)(5)(6)(7)(c)(1)(2)(3)).
- Oysters, clams, or mussels harvested from polluted areas for depuration within or outside of the state of North Carolina shall be transported under the supervision of the Division of Marine Fisheries or the Division of Environmental Health (15A NCAC 03K .0107 (d) (1) (2) (e)).

5.4.3.3 HARD CLAMS

- It is unlawful to take, land, or possess aboard a vessel more than 6,250 clams per fishing operation from public bottom in internal waters. It is unlawful to take, possess, sell or purchase any clams less than one inch thick, except for hatchery/aquaculture clams (15A NCAC 03K .0301 (a) (b) (1) (2)(3)).
- It is unlawful to take buy, sell, or possess any clams taken by mechanical methods from public bottom except when the Fisheries Director may open and close the season in the ocean at any time and between December 1 through March 31 in internal waters. Areas that may be open are Core and Bogue Sounds, Newport, North, White Oak and New Rivers, the Intracoastal Waterway north of the “BC” Marker at Topsail Beach, and a specified area in Pamlico Sound (15A NCAC 03K .0302 (a)(1)(2)(3)(4)(5)(b)).
- Permits are required to harvest hard clams by mechanical methods from private bottom (15A NCAC 3K .0303 (a)(b)).
- It is unlawful to take clams by any method, other than by hand tongs, hand rakes. It is unlawful to take clams by hand tongs in any established bed of submerged aquatic vegetation or salt water cordgrass (15A NCAC 03K .0304 (a)).
- It is unlawful to have mechanical harvest gear aboard a vessel at any time except during mechanical harvest season (15A NCAC 03K .0304 (b)).
- Possession and sale of hatchery/aquaculture clams are exempted from bag and size limits (15A NCAC 03K .0305).

5.4.3.4 NURSERY AREAS

- It is unlawful to use mechanical methods for the harvest of clams in a primary nursery area (15A NCAC 03N .0104).

5.4.3.5 LEASES AND FRANCHISES

- All areas of public bottoms must meet certain criteria in order to be deemed suitable for leasing for shellfish purposes (15A NCAC 03O .0201 (a)(1)(2)(3)(A)(B)(C)).
- All leases must produce 10 bushels of clams per acre per year or plant 25 bushels of cultch or seed clams per acre per year (15A NCAC 03O .0201 (b)(1)(2)).
- Compliance requirements to the production and marketing of the leases for shellfish purposes (15A NCAC 03O .0201 (c)).
- Water columns must meet certain criteria in order to be deemed suitable for leasing for aquaculture purposes (15A NCAC 03O .0201 (d)(e)).
- All water column leases must produce and market 40 bushels of clams per acre per year or plant 100 bushels of cultch or seed clams per acre per year (15A NCAC 03O .0201(d)).

- Applications for leases are available from Division of Marine Fisheries and must be submitted along with a management plan, map or diagram of proposed lease area and a filing fee of one hundred dollars (15A NCAC 03O .0202(a)(b)(1)(2)(3)(4)(5)(c)(d)).
- Agents of the Division shall inspect accepted applications of a proposed lease area. After the proposed lease is deemed consistent with applicable requirements, the applicant will be notified and notices of intention published. The Secretary shall consider the lease application, the Division's lease area analysis and public comment and may lease or decline to lease all or any part of the proposed lease. The Secretary may also impose special conditions so that leases may be issued (15A NCAC 03O .0203(a)(b)(c)).
- A formal survey is required in the areas approved for leasing (15A NCAC 03O .0203(d)(1)(2)(3)(4)(e)(f)).
- Marking requirement for approved bottom and water column leases (15A NCAC 03O .0204 (a)(1)(A)(B)(C)(2)(b)(c)(d)).
- It is unlawful to exclude or attempt to exclude the public from allowable public trust use of navigable waters on shellfish leases and franchises (15A NCAC 03O .0204(e)).
- Shellfish bottom lease renewals shall be provided in January of the year of expiration and water column lease renewals shall be provided at least 90 days prior to expiration. Lease renewals shall be accompanied by management plans. Fifty dollars is required with renewal application of bottom leases (15A NCAC 03O .0205 (a)(1)(2)(b)).
- A survey for renewals shall be required when the Division determines the area leased is inconsistent with the survey on file. When it is determined that the lessee has not complied with requirements or is inconsistent, the Secretary may decline to renew any shellfish bottom or water column lease. The Secretary is not authorized to recommend approval of renewal of a lease in an area closed to shellfishing because of pollution (15A NCAC 03O .0205 (c)(d)(e)).
- Any member of the public has the right to protest issuance of a leaser and shall be allowed an opportunity to comment on any lease application (15A NCAC 03O .0206(a)(b)).
- Owners of shellfish leases and franchises shall provide annual production reports to the Division. Failure to furnish production reports can constitute grounds for termination (15A NCAC 03NO .0207 (a)(b)).
- The Secretary shall begin action to terminate leases and franchises for failure to produce and market shellfish, or for failure to maintain a planting effort at 25 bushels per acre per year on bottom leases and 100 bushels per acre per year for water column leases (15A NCAC 03N .0208(a)(b)(c)(d)(e)).
- A new owner must notify the Division and must provide the number of the lease, location, and a management plan prepared by the new owner within 30 days of transfer of ownership of all or part of a shellfish lease or franchise (15A NCAC 03O .0209(a)(b)).
- Water column leases are not transferable except when the Secretary approves a transfer (15A NCAC 03O .0209(c)).

- It is unlawful to use any bottom disturbing fishing gear on any shellfish lease or franchise unless it has been duly authorized by the Fisheries Director (15A NCAC 03O .0211).

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 crustacea. The Division of Environmental Health, Shellfish Sanitation Section is responsible for North Carolina's compliance with the National Shellfish Sanitation Program (NSSP) of the US Food and Drug Administration (FDA). Based on data from the Shellfish Sanitation Section, the State Health Director recommends closures of coastal waters to shellfish harvest; the DMF implements closures by proclamation, and enforcement of those closures is conducted by DMF Marine Patrol officers. The DMF and the 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 Services (NMFS) enforces the Lacey Act, which prohibits import, export, and the interstate transport of illegally taken fish and wildlife, which includes illegally- possessed clams.

The ASMFC approved a plan in 1989 to control the transfer and introduction of shellfish, although it has no authority over shellfish in the states (ASMFC 1989). The plan supports state regulation. A key provision of the plan 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 LIFE HISTORY

6.1.1 DISTRIBUTION

The hard clam is distributed from the Gulf of St. Lawrence, Canada to Texas and has been transplanted successfully in California and areas in Europe (Eversole et al. 1987). Common names for *M. mercenaria* include quahog, quahaug, northern quahog, littleneck clam, and cherrystone clam. A sister species, *M. campechiensis* is present in ocean waters off North Carolina and occurs mainly from North Carolina to Florida (Hadley and Coen 2006). Hard clams occur throughout the south Atlantic region in estuaries from the intertidal zone to depths exceeding 15m (Abbott 1974; Eversole et al. 1987). In North Carolina hard clams are most abundant in higher salinity waters inside the barrier islands from Ocracoke southward to the North Carolina/South Carolina border (DMF shellfish bottom mapping data unpublished). They also have been harvested by hand methods in the immediate vicinity of

Oregon Inlet, and trawlers occasionally take a few while trawling for shrimp or oyster dredging in western Pamlico Sound.
Localized adult population densities vary considerably and are dependent on many environmental factors. Population densities appear to be similar in the northeast and southeast United States and areas where they have been introduced (Fegley 2001). Experimental studies have shown that areas with multiple substrates (those with shell and seagrass present) often support more clams than homogeneous substrates because indirectly they protect smaller clams from predation (Peterson et al. 1984; Peterson 1986b).

6.1.2 HABITAT TOLERANCES AND PREFERENCES

Hard clams occupy mostly shallow estuarine environments but can be found in deeper water areas. The hard clam occurs in groups ranging from small patches to extensive beds at intertidal and subtidal water depths, from sand to muddy sediments, from bare substrates to seagrass beds, and shelly bottom habitat near oyster beds (Harte 2001).

Hard clams have wide temperature and salinity tolerances, which probably contributes to the extensive range in the species. Growth rates of hard clams are most favorable at water temperatures around 20 ^{o}C and ceases at 9 ^{o}C and 31 ^{o}C (Ansell 1968; Eversole et al. 1986). Adult hard clams can survive below freezing temperatures but have a higher survival rate when covered by water or sediment than those exposed in the intertidal areas (Eversole et al. 1987). Adult hard clams have been found in waters with salinity ranges from 4 to 35 parts per thousand (ppt). Growth is optimal at salinities between 24 and 28 ppt (Chestnut 1951a). Hard clams cease pumping in water that is below 15 ppt and above 40 ppt, and they will close their shells tightly during periods of stress and respire anaerobically to reduce mortality.

Adequate water circulation is essential for good growth and recruitment of hard clams. Water currents move food, maintain water quality, removes wastes, and transport eggs and larvae in the water column (Eversole et al. 1986). Hard clams obtain food by filtering suspended particulate matter and absorbing dissolved organics directly from the water. Larvae and adult hard clams are able to select their food and regulate the quality and quantity of food they consume. Hard clams adapt well to a changing food supply, but they are sensitive to the presence or absence of particular algal species that can affect growth (Eversole et al. 1986; Eversole et al. 1987). More detailed habitat and water quality information is available in Section 9.0: Environmental Factors.

6.1.3 REPRODUCTIVE BIOLOGY

The gametogenic and spawning cycle of the hard clam varies with latitude (Eversole et al. 1984; Eversole et al. 1987). Spawning occurs in North Carolina from spring through fall, when water temperatures reach 20 ^{o}C (68 ^{o}F) (Loosanoff and Davis 1950; Porter 1964). Spawning clams release eggs and sperm through the exhalent siphon into the water where fertilization occurs and rapid development begins. The first larval stage is the trochophore stage that lasts about a day, followed by several veliger/pediveliger stages that last approximately 20 days. Juvenile clams (spat) settle along edges of sandbars and channels where varying water currents occur (Carriker 1959). Hard clams will also settle in substrates with shell and subtidal vegetation. These substrates appear to have better conditions for spat survival than unstructured substrates because they offer protection from predators (Kerswill 1941; Wells 1957; MacKenzie 1977; Peterson 1982).

Precursors to both male and female sex cells are found in the gonads of juveniles (Eversole 2001). During the juvenile stage, gonad cells differentiate and clams develop predominately as males. As adults, many clams transform into females. The sex ratio of adult clams is approximately 1:1 across its geographical range (Eversole 2001).

Sexual maturity in hard clams tends to be a function of size not age, therefore maturity is dependent on growth. Sexual maturity is usually reached during the second to third year at a shell length of 1.3 inches (33 mm), but faster growing clams may mature at an earlier age (Eversole et al. 1987). The legally harvestable size of one inch thick (25.4 mm) is typically reached by age two to five with three as a reasonable average expectation in North Carolina (C. Peterson, UNC Institute of Marine Science, personal communication).

Although estimates vary, fecundity depends on size and condition (Ansell and Loosmore 1963). Several studies have found that fecundity increased with shell length (Bricelj and Malouf 1980; Peterson 1983; Eversole et al. 1984; Peterson 1986a). Hard clams occur in aggregations over a wide area, and close proximity of adults is important for successful reproduction to occur in organisms that spawn in the water column (Peterson 2002). Because clams have limited mobility, spawning efficiency could be reduced in areas where harvest has caused a significant decrease in number and size of clams within these aggregations. Reduced spawning efficiency could affect future recruitment in hard clam populations (Fegley 2001; Peterson 2002).

6.1.4 AGE, SIZE STRUCTURE, AND GROWTH

Hard clam populations show a wide size range of individuals (Fegley 2001). A fishery independent sampling program in North Carolina began in 1999 to look at hard clams in Core sound (Figure 6.1). Samples were taken in areas open and closed to harvest and all clams captured were measured for shell thickness and length (mm). Shell thickness across multiple years of sampling varied from 14 mm to 100 mm, with 73 percent of the hard clams between the 50 and 80 mm size range. Growth rates of hard clams are highly variable and depend on water temperature, habitat, food availability, and genetics (Ansell 1968; Pratt and Campbell 1956; Chanley 1958; Peterson et al. 1983; Peterson et al. 1985; Arnold et al. 1991). Shell growth is greatest during the first year after which growth decreases as age increases (Eversole et al. 1986; Eversole et al. 1987). Shell growth is fastest in the spring and fall, slower in the winter, and the slowest in the summer months when water temperatures exceed 30 ^{o}C (Eversole et al. 1987).

The age of clams can be determined by direct examination of annual growth lines within the shell. Age frequency distributions show a lot of difference among sites within and between regions (Fegley 2001). There is also a lot of variation in age of similar-sized clams even within the same habitat (Peterson et al. 1984; Rice et al. 1989; Fegley 2001). Maximum age was determined to be 46 years old in North Carolina (Peterson 1986a). Shell growth patterns vary by latitude. North Carolina shell growth follows a southern growth pattern where a light band forms in the middle layer of the shell during the winter months and dark band forms during the late summer to fall months resulting in annual banding patterns (Peterson et al. 1983; Arnold et al. 1991). The opposite shell pattern growth is observed in northern latitudes (i.e., Connecticut to Massachusetts and England) where a dark band forms during the colder winter months, and a light band forms during the warmer months in the middle layer. At the middle part of the geographical range (i.e., New Jersey) shell pattern banding follows the northern banding pattern during the first several years of growth and then takes on a more "southern" banding pattern as they age (Fritz 2001).

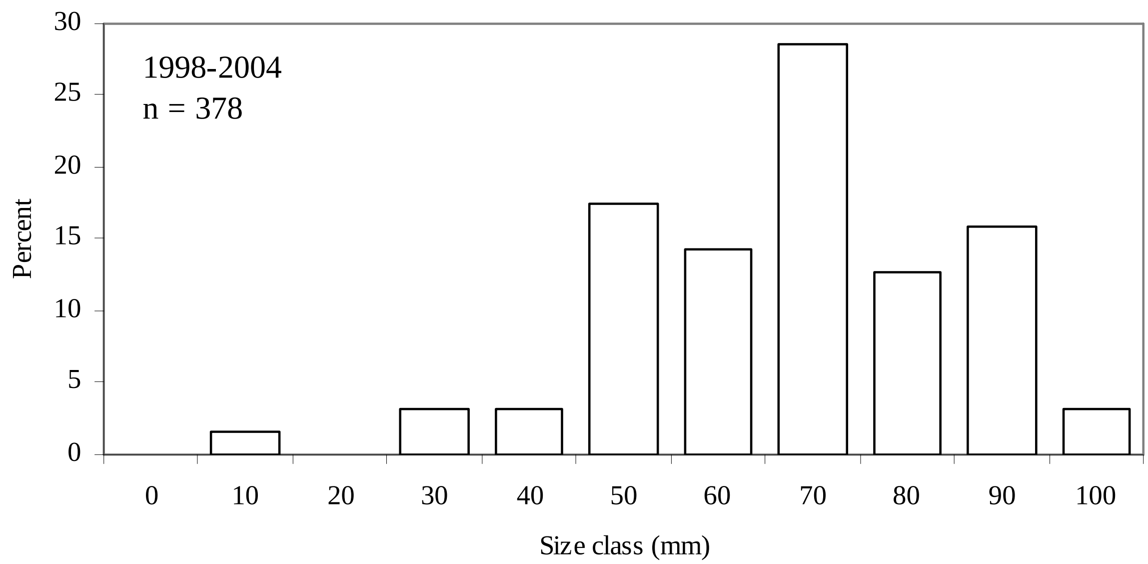


Figure 6.1. Shell thickness (mm) frequency distribution of hard clams from a pilot fishery independent sampling program in Bogue and Core sounds, 1998-2004. DMF biological database.

6.1.5 PREDATORS AND DISEASE

Little data is available on the direct predation rates on larval hard clams (Kraeuter 2001). High natural mortality in the larval stages suggests that predation is probably high during this life stage of the hard clam. Newly set or juvenile hard clams (<1 mm shell length) are vulnerable to a large number of predators. Primary predators of juvenile hard clams are the snapping shrimp *(Alpheus heterochaelis)*, mud crabs (*Neopanope sayi*), and blue crabs (*Callinectes sapidus)* (Beal 1983; Kraeuter 2001). Several types of snails (*Urosalpinx* sp., *Polinices* sp.), whelks, (*Busycon* sp.), cownose rays (*Rhinoptera bonasus*), and various birds feed on adult hard clams (Kraeuter and Castagna 1980; Kraeuter 2001). As hard clams grow the collection of potential predators is reduced (Kraeuter 2001). Hard clam survival from predation can be affected by sediment characteristics such as presence of shell fragments and seagrasses, and presence of other prey species (Peterson 1982; Peterson 1986b; Kraeuter 2001).

Infectious diseases can result in devastating losses of wild populations of some mollusks. Hard clams appear to be relatively disease free and a number of studies of captive populations show that non-predation losses are typically only 5-10% per year (Eldridge and Eversole 1982; Eversole et al. 1987; Bower et al. 1994). Many of the large-scale hard clam mortalities along the northeastern United States and Canada are related to air exposure during extreme cold events and negative impacts from stress associated with parasites (Smolowitz et al. 1998). Diseases in larval and juvenile hard clams held in culture conditions are often caused by bacteria, fungi, and viruses that are common in the cultured bivalves and are associated with opportunistic invaders of animals under stress in high-density culture situations (Ford 2001).

6.2 PRESENT STOCK STATUS

The status of the hard clam stock in North Carolina is currently listed as unknown because there are only limited data available to assess the population (DMF 2007a). A monitoring program is currently underway in Core Sound to provide baseline data on hard clam abundance, and gather quantitative environmental parameters. In the future it may be possible to expand this sampling into other areas to evaluate the population and estimate sustainable harvest levels for the hard clam fishery. Landings data have been recorded since the 1880s. A fishery-dependent sampling program was initiated in the Central District in 1999 to collect information on hard clam harvest at the trip level. Information collected includes effort by gear type, catch composition, and size distribution of hard clams by market grade. While landings records will reflect population abundance to some extent, the relationship is confounded by changes in effort, gear technology, regulations, and market demand. The fishery-dependent sampling program should be expanded to the southern district to monitor changes in the fishery from Ocracoke to the South Carolina line where the majority of hard clams landings occur.

The apparent sustainability of current harvest levels in a given water body may be detected by examining trends in landings and effort data from the trip ticket program. Only landings from public bottoms were examined because planting of seed clams, grow-out availability, and market demand often artificially drives landings from private leases. Additionally, localized trends in mechanical or hand harvest were analyzed separately due to regulatory differences to assess whether trends are likely to be gear specific or extend to the entire water body.

The average catch per trip from 1994 to 2005 was calculated by year for both hand harvest and mechanical harvest from public bottom in each of the major water bodies from which clams are harvested. Hand harvest occurs year-round and is summarized by calendar year. The majority of mechanical harvest occurs from December through March with some harvest occasionally allowed during other times of the year; therefore, mechanical harvest is summarized by fishing year (December through November). In order to compare water bodies, the mean catch per trip was expressed as a percentage of the trip limit. In other words, if the average catch of a trip was 3,125 clams and the trip limit was 6,250 clams, then the average catch was 50% of the trip limit. Individual trip limits were determined for each month and combined to get an average yearly limit for each area. By looking at catch per trip instead of just landings, the problem of varying closure periods and trip limits among years and waterbodies is avoided. Since the confounding effect of variable effort per trip cannot be avoided, it is assumed that effort per trip remained consistent over the time period.

Based on examination of trip ticket data, the percent of the limit landed per trip remained constant for most water bodies in North Carolina. Hand harvest of clams appeared to be particularly stable (Figure 6.2). Hand harvesters are limited to a trip limit of 6,250 clams in all water bodies and typically land 5-15% (300-1,000 clams) of the limit.

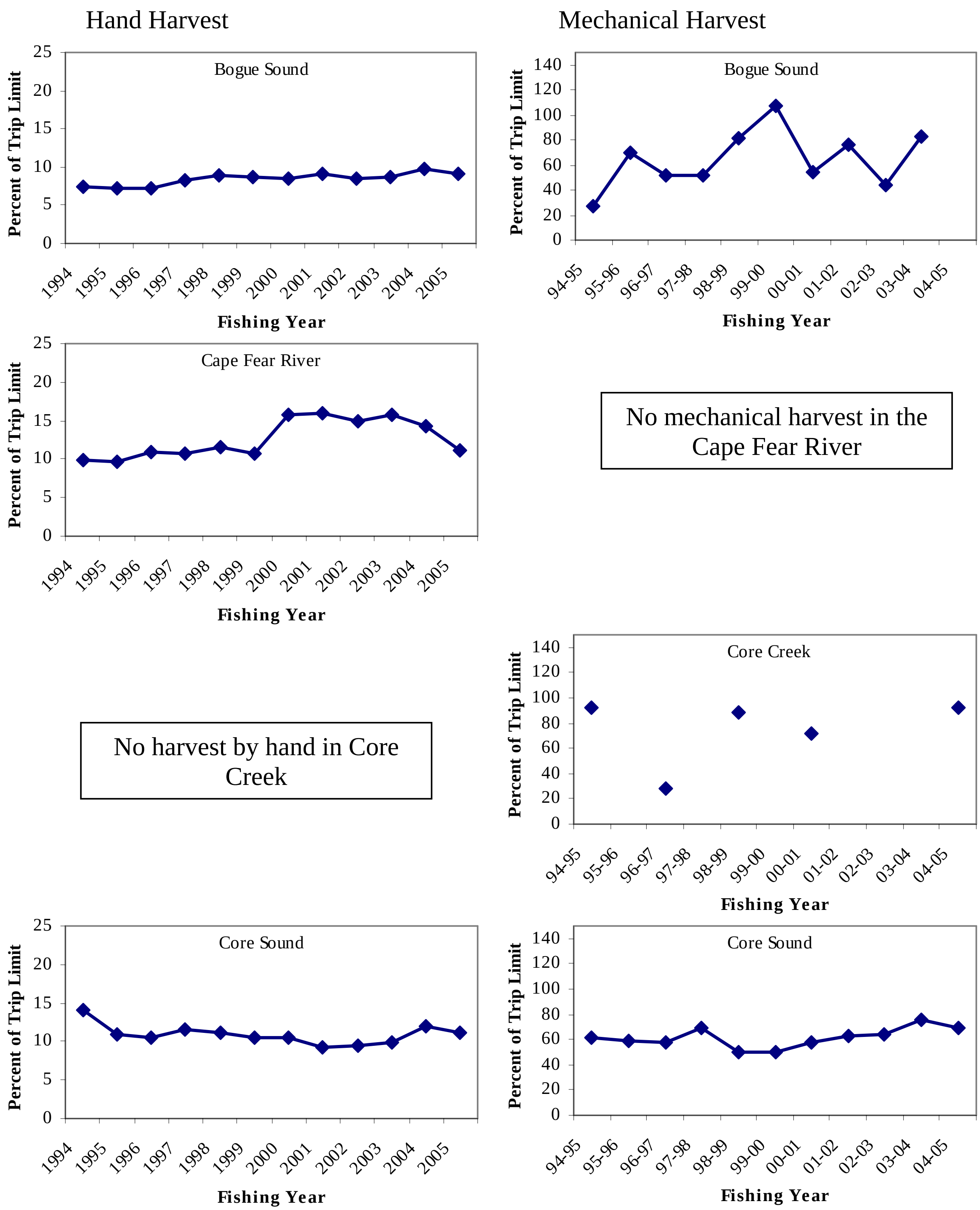
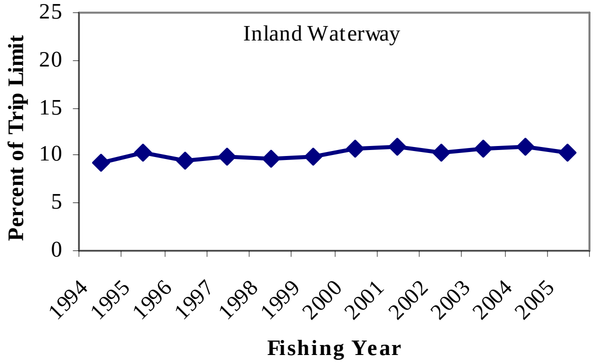
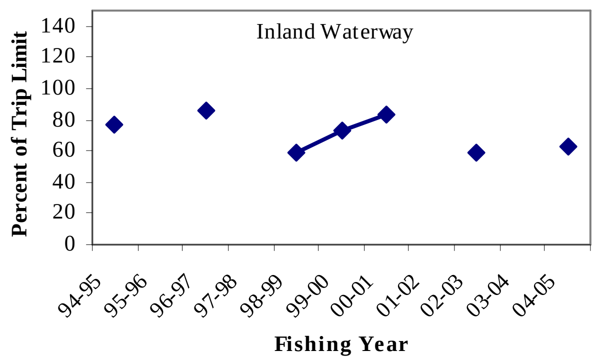


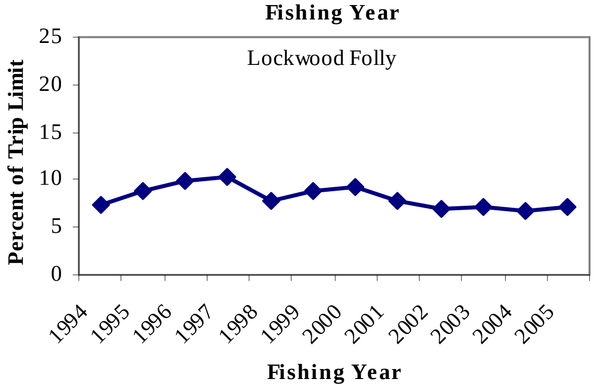
Figure 6.2. Percent of hard clam trip limit for hand (calendar year, Jan-Dec) and mechanical harvest (fishing year, Dec-Nov) landed from public bottom. DMF Trip Ticket Program.

Hand Harvest

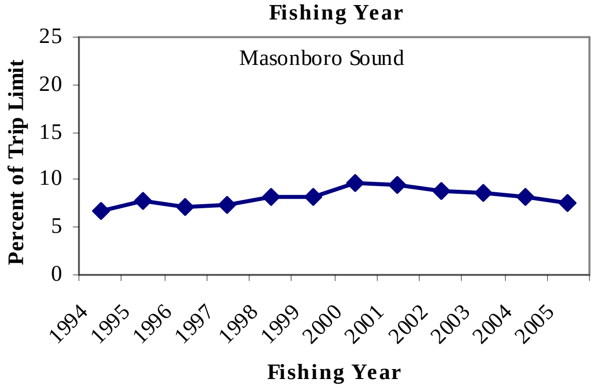
Mechanical Harvest



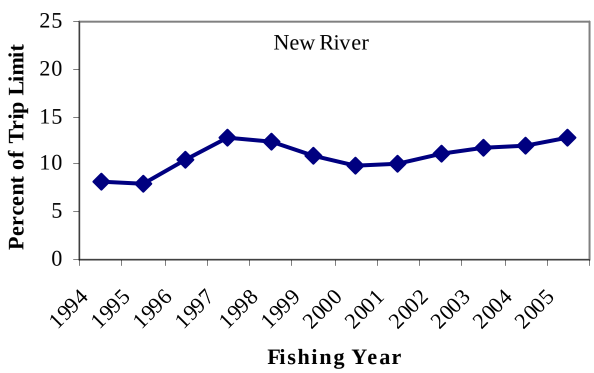




No mechanical harvest in Lockwood Folly



No mechanical harvest in Masonboro Sound



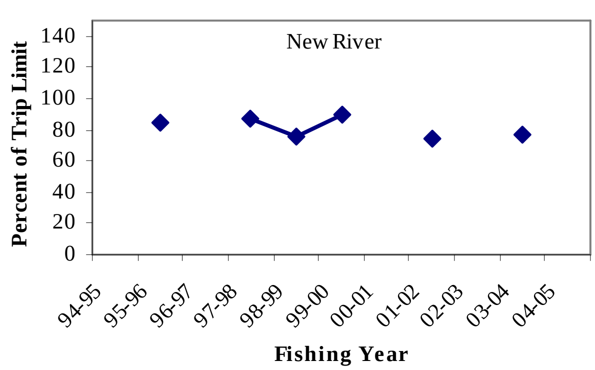


Figure 6.2. Continued.

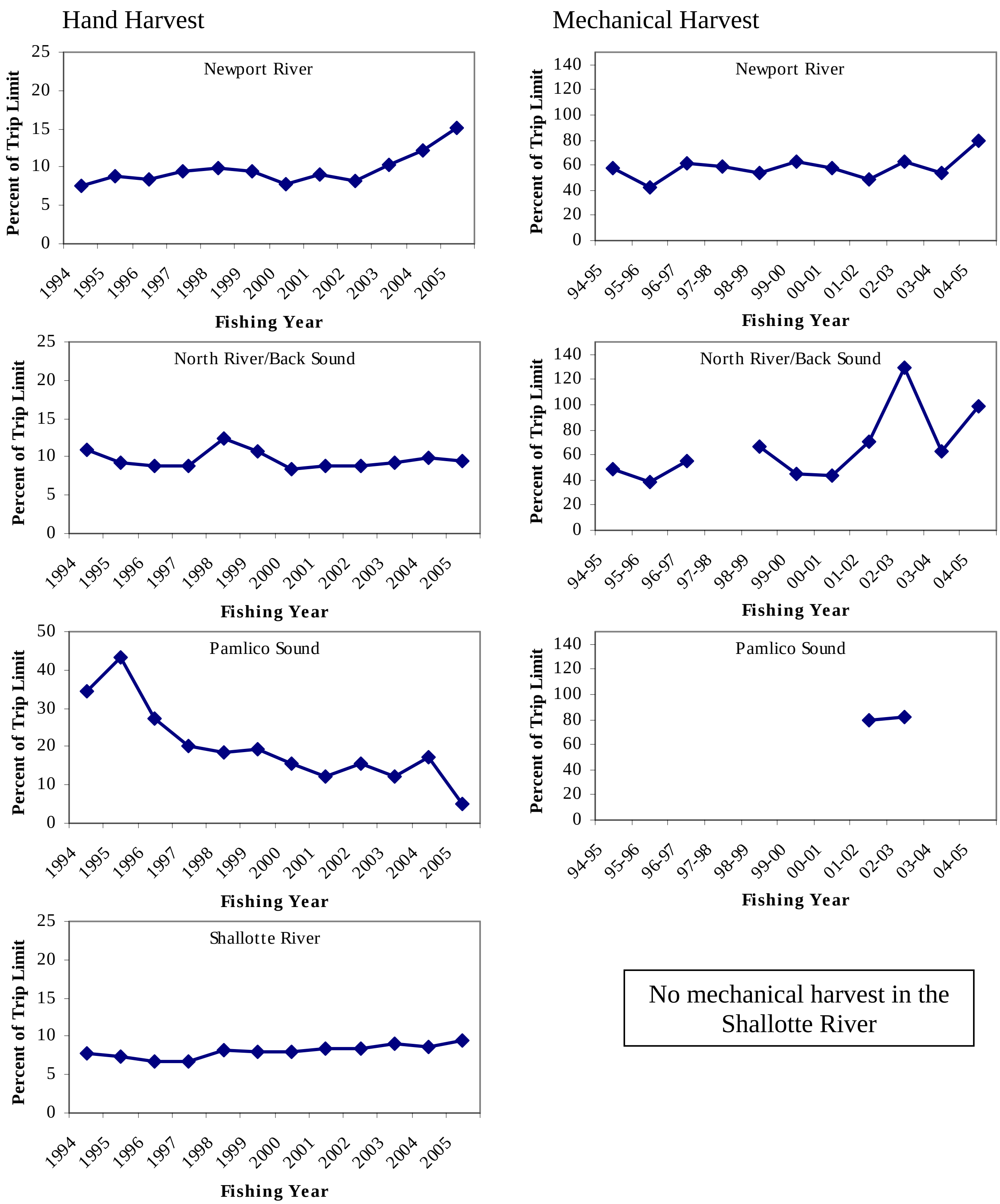


Figure 6.2. Continued.

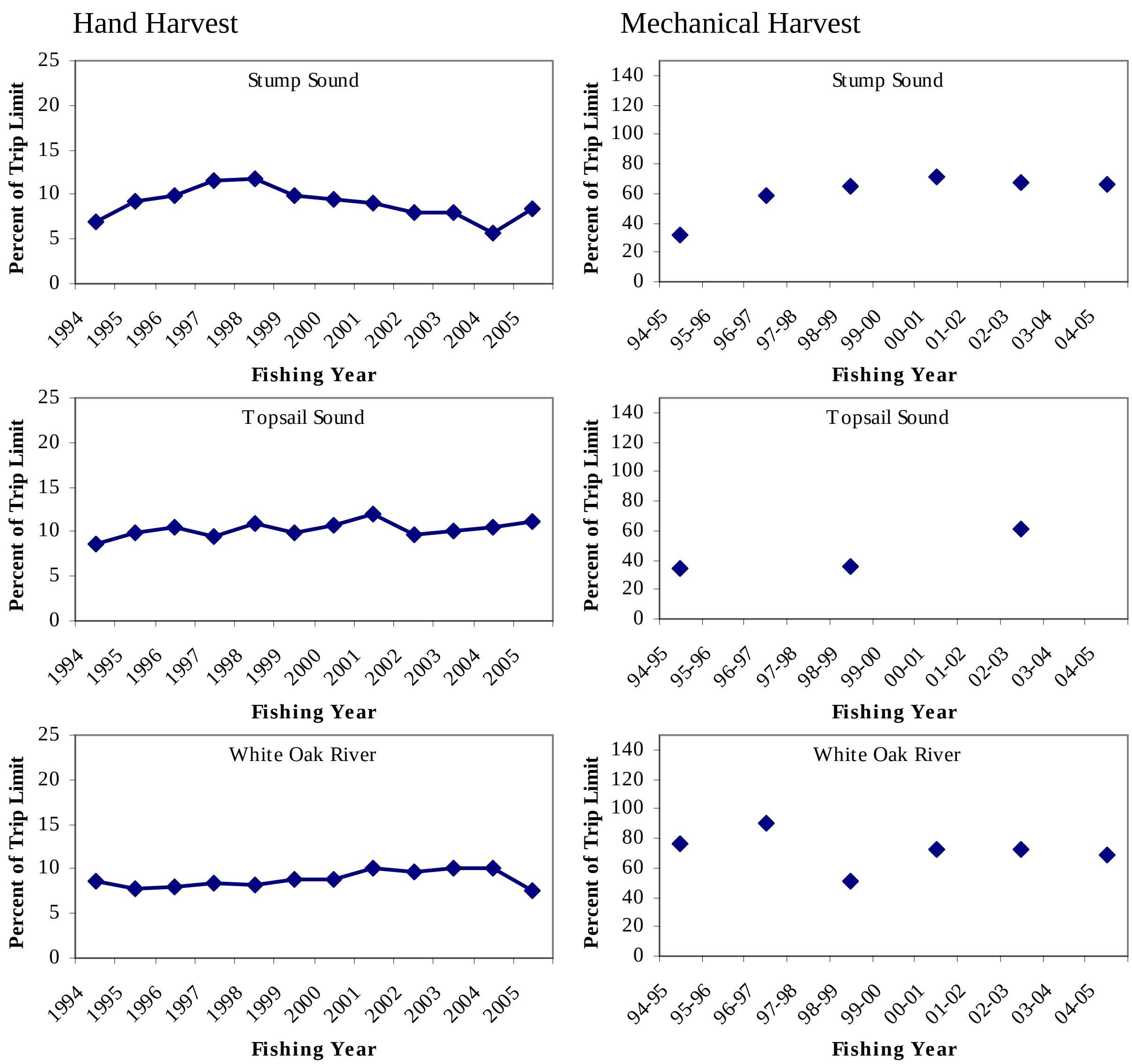


Figure 6.2. Continued.

Hand harvest in Newport River has increased steadily over the past few years ranging from 8% in 2002 to 15% in 2005. However, further examination shows that the number of clams harvested and the number of trips has actually decreased (Figure 6.3). The increase in the percent of the trip limit reached appears to be because fishermen went on fewer trips but caught more of their limit each time they went out; therefore, the increasing trend seen in Figure 6.2 is not likely representative of the actual clam population abundance.

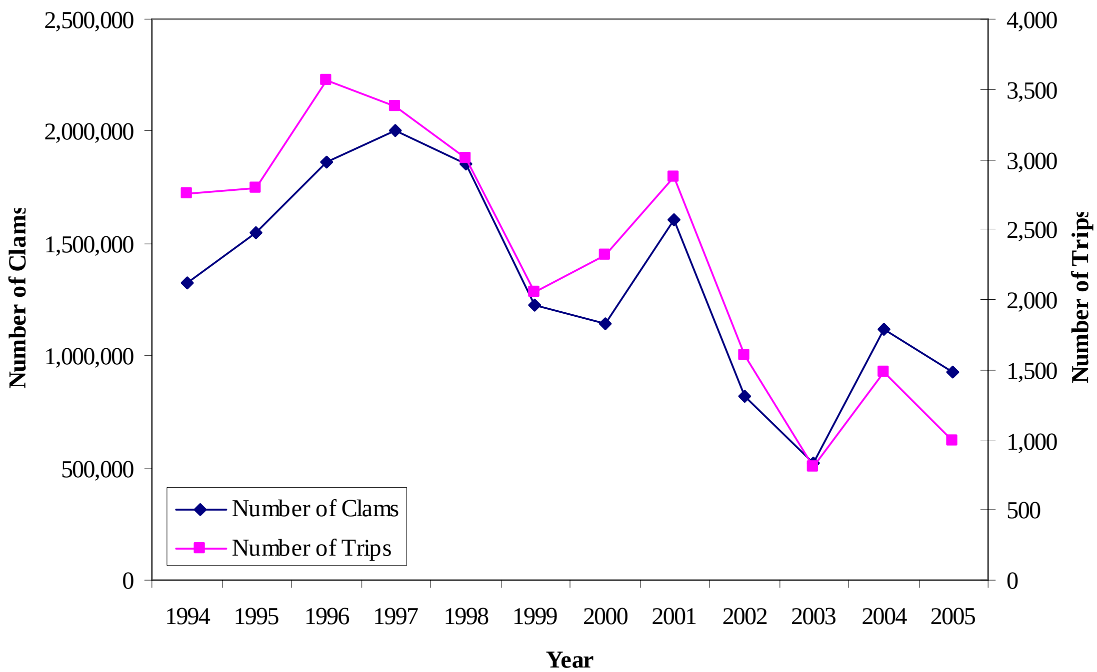


Figure 6.3. Number of trips and number of clams harvested by hand from public bottom in the Newport River, 1994–2005. DMF Trip Ticket Program.

The percent of the trip limit reached by hand harvest in Pamlico Sound was much higher than that of all other waterbodies in the beginning of the period and has declined steadily throughout time ranging from a high of 43% in 1995 to a low of 5% in 2005 (Figure 6.2). The number of clams harvested and the number of trips both peaked in 2000 (Figure 6.4). Generally, hand harvest of hard clams is not a big business for fishermen in Pamlico Sound, and fishermen typically just make a few trips for clams each year to supplement their income. Around the time of the peak in 2000, a few fishermen attempted to focus primarily on hand harvest of clams as their primary target species and put forth a lot of effort to harvest clams. These fishermen abandoned most of their efforts soon after, and overall harvest and effort returned to their prior levels (Figure 6.4)(Greg Allen, DMF, personal communication).

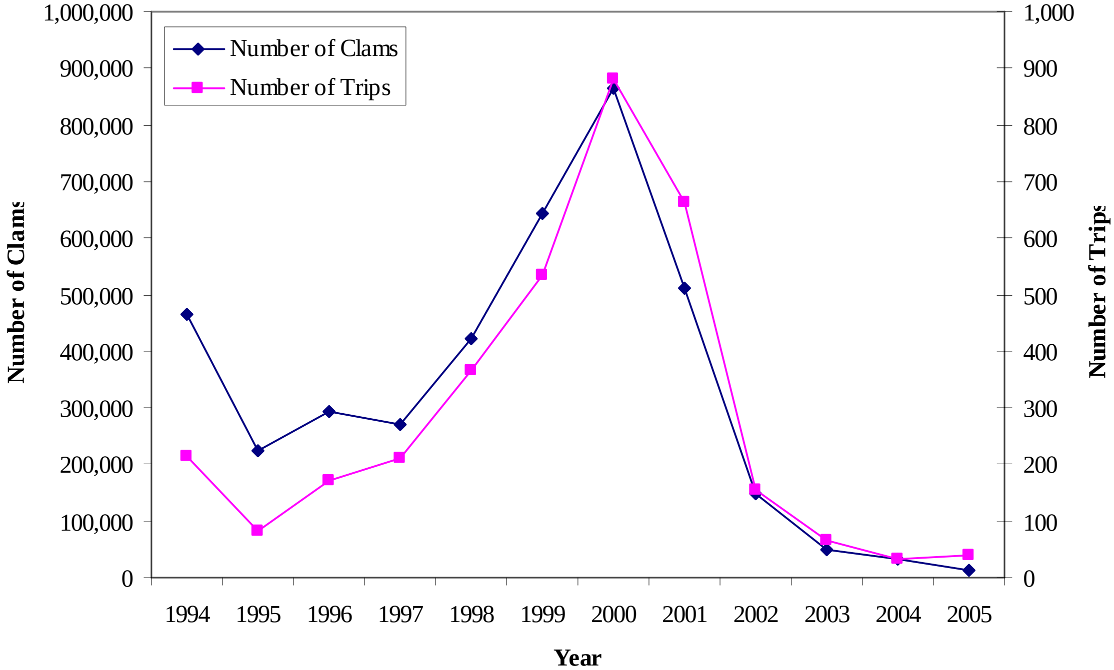


Figure 6.4. Number of trips and number of clams harvested by hand from public bottom in Pamlico Sound, 1994–2005. DMF Trip Ticket Program.

Mechanical harvest of clams was slightly more variable than hand harvest; however, harvest levels in most waterbodies appeared relatively stable. In general, fishermen using mechanical gear typically harvested between 30% and 90% of the limit and frequently caught most of their limit (Figure 6.2). An exception was North River/Back Sound where the percent of the limit landed has been highly variable in recent years and showed an increasing trend from a low of 44% in the 2000–2001 fishing season to a high of 130% in 2002–2003. The trip limit in North River/Back Sound was exceeded in the 2002–2003 fishing year (130%) and met in 2004–2005 (98%). Both the number of clams and the number of trips harvesting clams in this area has oscillated between high and low levels of harvest and effort throughout the time period (Figure 6.5). It is important to note that these calculations were made assuming that fishermen sell their catch on the day of harvest, which is usually the case. However, fishermen may occasionally sell catches from multiple trips on one ticket; therefore, it is possible that these percentages are inflated.

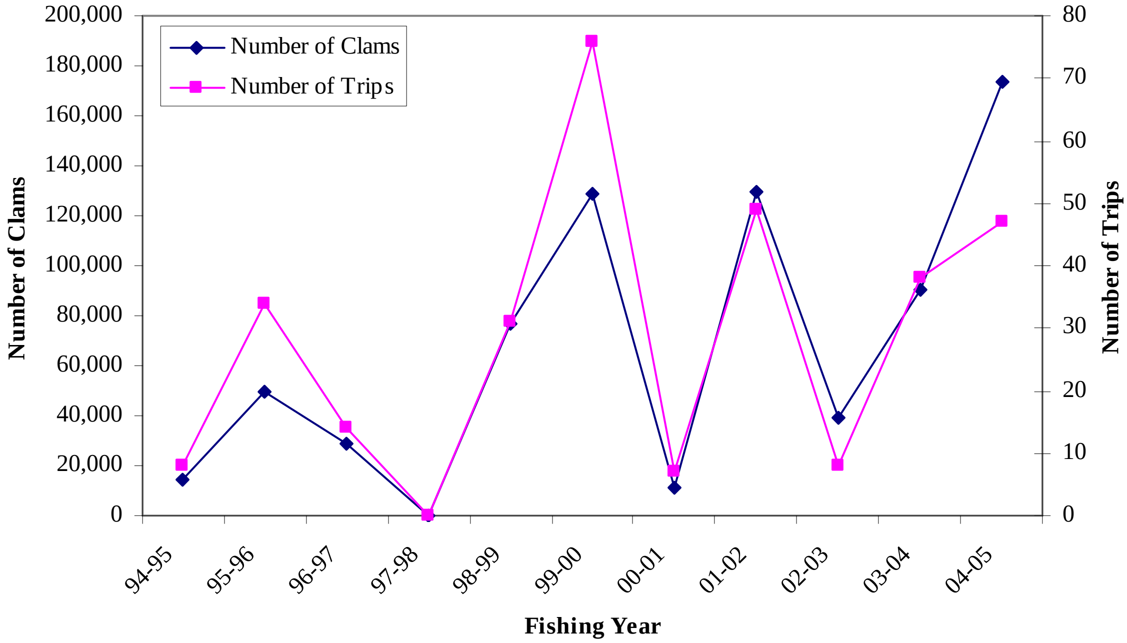


Figure 6.5. Number of trips for mechanical harvest of clams from public bottom in North River/Back Sound, 1994–2005. DMF Trip Ticket Program.

The previous FMP expressed concern over trends in Core Sound where the percent of the trip limit landed declined from around 80% in 1994–1995 to about 30% in 1996–1999 (DMF 2001). Based on this trend, it was determined that clam abundance likely declined in the area of Core Sound open to mechanical harvest. As a result, the limit for mechanical harvest in Core Sound was reduced from 6,250 to 5,000 clams. In addition, Core Sound is one of the largest areas producing clams from both public bottom and private leases. In order to reduce fishing pressure in the northern part of Core Sound, rotation of mechanical harvest areas with Pamlico Sound began in 2001 with a two-year open and close strategy between the two areas. Pamlico Sound was opened again during December of 2005, but no landings were reported because fishermen were not able to access the harvest area due to sedimentation of the channel.

The current analysis of mechanical harvest in Core Sound (Figure 6.2) does not show the high percent of trip limit landed in 1994 and 1995 seen in the 2001 hard clam FMP. Trip ticket data are continuously updated whenever mistakes are encountered, and errors in the first few years of the program were common. It is likely that the original analysis reflected errors primarily due to dealers reporting harvest from private leases as public bottom on their trip tickets. These data have been corrected as much as possible, and the analyses presented in this FMP reflect the most accurate estimates of harvest. The current time series shows only a slight increase in the percent of the trip limit reached from 57% during the 1999–2000 fishing year to 69% during the 2004–2005 fishing year with a peak of 76% during the 2003–2004 fishing year. The actual number of clams harvested and the number of trips also follow this trend. Both increased slightly from 1,110,490 clams and 351 trips during the 1999–2000 fishing year to 1,748,279 clams and 507 trips during the 2004–2005 fishing year with a peak of 2,971,071 clams and 785 trips during the 2003–2004 fishing year (Figure 6.6). Fishing trends in Core Sound may be a reflection of the rotational management strategy mentioned previously. The northern Core Sound area was closed to mechanical harvest during the 2001-2002 and 2002-2003 fishing years, and effort was only allowed in the southern portion of the Core Sound mechanical harvest area, which is traditionally not harvested as intensely.

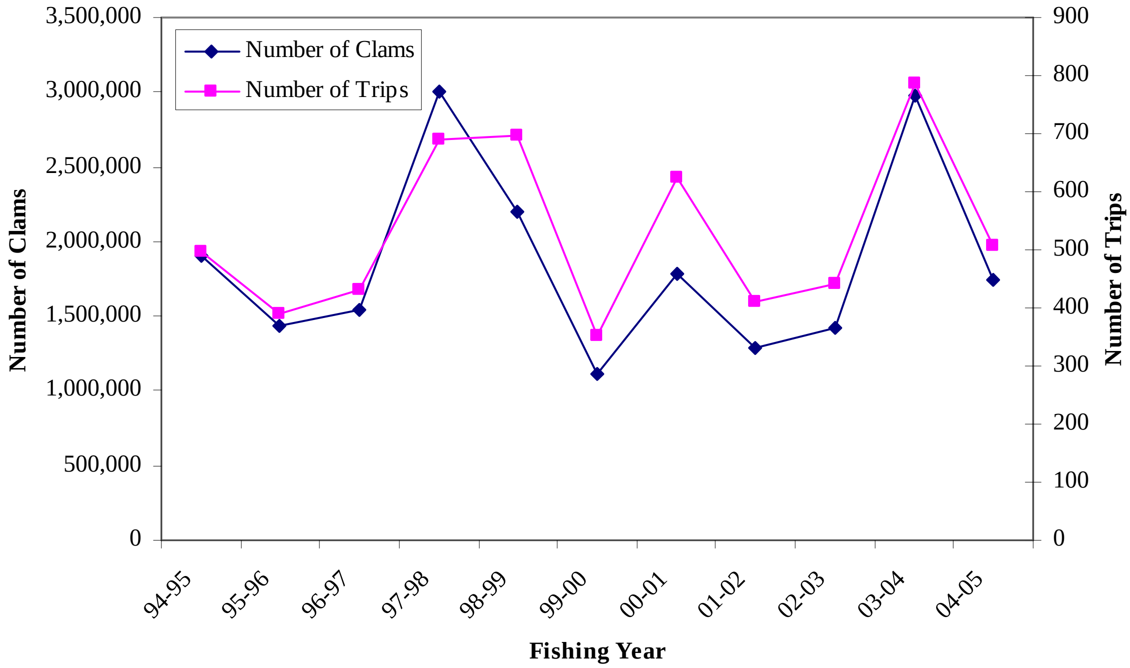


Figure 6.6. Number of trips for mechanical harvest of clams from public bottom in Core Sound, 1994–2005. DMF Trip Ticket Program.

Based on the percent of the trip limit reached, steps should be taken to ensure that mechanical harvest trip limits in North River/Back are not exceeded. In all other waterbodies, the apparent stability of current harvest levels suggest that changes in harvest policies are not warranted at this time. These analyses give only a general guide to actual clam abundance and have the potential to be misleading. Alternative measures of providing more accurate estimates of actual population abundance should be considered for future FMPs when better data is available.

6.3 DETERMINATION OF SUSTAINABLE HARVEST

The only method of estimating relative abundance of hard clams currently available is the examination of landings trends presented in the previous section; however, landings data only give a general indicator of population abundance because they are confounded by changes in effort and regulations, fluctuations in market demand, other competing fisheries, and areas closed due to pollution. In addition, commercial samples are biased because fishermen tend to fish areas with dense numbers of clams and avoid areas with sparse clams (Fegley 2001). Furthermore, the lack of recreational harvest data makes estimates of total fishing mortality for each fishing sector impossible to estimate. Therefore additional data must be collected to better assess North Carolina's hard clam stocks.

Since data collection is currently in its early stages, every effort should be made to evaluate the costs and benefits associated with available data collection methods and choose one that will allow adequate evaluation of the stock. The biological program chosen will need to be in place for several years to show trends in relative abundance. Also, every effort should be made to utilize peer reviewed, standardized monitoring metrics and methodologies for stock assessments so that data can be readily compared to other regional efforts.

Table 6.1 summarizes the advantages, disadvantages, and data requirements for several assessment methodologies that could be used to estimate sustainable harvest for hard clams in the future. Although age-based analysis is commonly used in finfish stock assessments, this method should probably be considered inappropriate for our purposes because ages have not been validated in all sediment types across a geographic range. Length should not be used as a substitute for age in hard clams, since it has been shown that there is a very weak relationship between age and length of hard clams making it difficult to construct a reliable age-length key. Several factors have been shown to influence growth (i.e., adult densities, sediment type), but these relationships are not well understood (Fegley 2001).

Biomass-based analysis should be considered as a possible assessment method for hard clams because the necessary catch and effort data could be collected fairly easily. A noteworthy disadvantage to this approach (that is not unique to hard clams) is that estimating sustainable harvest 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.

Table 6.1. Summary of assessment methodology to estimate sustainable harvest.

	Advantages	Disadvantages	Data demands
Age-based analysis	provides detailed information about population structure	age data not validated	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
		expansion of current biological sampling program needed	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 (preferably fishery-independent)
		expansion of current biological sampling program needed	
Standing stock survey	intuitively understandable results	shellfish mapping must be completed	clam density estimates for fished and unfished areas collected as often as possible
	results may be immediately useful for estimating sustainable harvest	monitoring of clam densities in all areas must be initiated	
		Difficult to collect data from every water body on an frequent basis	

A standing stock survey, or density estimate, is consistent with approaches used by other management agencies (Godwin 1968; Crane et al. 1975; Rhodes et al. 1977; Leblanc et al. 2005; Mann et al. 2005) and would give results that are both immediately useful and easy to understand. Density estimates can be used to estimate overall abundance of hard clams of harvestable size for a given area. Loesch (1974) suggests a sequential sampling design that minimizes sampling effort, when compared to a fixed sampling plan, that categorizes clam populations densities (i.e., low, medium, and high) rather than estimating absolute population abundance. If actual population estimates are desired, Russel (1972) provides a method that uses stratified random sampling to give good estimates of spatial patterns of hard clam abundance. In another approach, Loesch and Haven (1973) provide a quick method for estimating hard clam population abundance using the Leslie method (Leslie and Davis 1939). Hard clam population abundance can also be estimated using modifications of the Leslie-DeLury method (Leslie and Davis 1939; DeLury 1947) suggested by Braatem (1969) and described by Ricker (1975).

A standing stock survey would allow for further investigation of the relationship between environmental parameters and the abundance of hard clams. Prior research suggests that hard clam densities vary in response to factors such as sediment type, flow regime, depth, and predator abundance; however, these relationships are often complex and in some cases unclear (Fegley 2001). These variables should be measured when clam populations are sampled to further investigate these relationships. A standing stock survey could also be designed to investigate the effects of fishing methods (i.e., mechanical and hand harvest) on population abundance using closed areas as control sites.

There are a few disadvantages to conducting a standing stock survey. Because of the patchy nature of clam distributions, extensive sampling may need to be conducted to obtain precise estimates of hard clam abundance. Because of personnel and budget constraints, it is nearly impossible to obtain yearly population estimates for each major clam-producing water body in North Carolina. It may be more efficient to concentrate on a assessing a few water bodies each year and rotate sampling efforts thus providing density estimates for each major water body every few years while minimizing gaps in the time series. Population abundances can vary dramatically from year to year, particularly with response to fishing effort; however, it would be extremely difficult to actively manage clam harvest in response to annual fluctuations in population abundance for all major clam-producing water bodies in the state.

The DMF shellfish mapping program has mapped most of the shellfish habitat in the state providing a baseline for selecting areas for further study. A pilot program is currently underway in Core Sound to expand on the sampling done by the DMF shellfish mapping program. The data from this program should be analyzed and sampling methodology evaluated after which the survey could be expanded into other major clam-producing areas.

The collection of density estimates from fishery-independent programs such as these could be integrated into GIS and tracked across time to create abundance indices for each management area. Integration of GIS technology into the management of hard clams in North Carolina should be exploited further since it would allow for coordination of population monitoring, habitat management, and shellfish sanitation harvest closures. Identification of source and sink areas and a better understanding of the effect of hydrodynamics on the transport of clam larvae would also lead to more efficient management schemes.

Regardless of how we collect and analyze hard clam data, 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. It is quite probable that multiple unit stocks exist in North Carolina waters and, therefore, responsible management of hard clams should include their identification (Charles Peterson, UNC Institute of Marine Science, personal communication). If multiple unit stocks are ignored and managed based on a statewide assessment, there is a risk of over- or under-harvesting clams in regions where conditions differ from the statewide trend.

Given that current data are inadequate for calculation of sustainable harvest levels, it may be prudent to examine methods for calculating a proxy for these levels. Federal and other state management agencies often use information from logbooks, fishery-independent surveys, and other sources to establish such proxies. In North Carolina, the data that could be used currently consist of landings data and trip ticket data. Landings data for hard clams go back as far as 1887, although considerable gaps occur in the data set. The trip ticket database covers a much shorter time frame (1994-present); however, if the total number of trips per year is used as an index of annual harvest effort, the apparent sustainability of current harvest levels may be examined. Under this approach recent harvest levels appear sustainable since the total catch does not decrease while assumed effort is fairly constant. 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 the magnitude of the unreported (recreational) take is unknown. Regional harvest caps may be more appropriate because of the possibility of multiple unit stocks. Harvest ranges for regional water bodies are given in Table 6.2.

Table 6.2. Landings (number of clams) from public bottom during open seasons for major clam-producing regions in North Carolina. DMF Trip Ticket Program.

Year	Bogue Sound	Cape Fear River	Core Creek	Core Sound	Inland Waterway	Lockwood Folly	Masonboro Sound	New River	Newport River	North River/Back Sound
1994	2,096,727	2,317,172		5,596,168	1,961,037	1,026,490	843,258	5,387,628	1,480,207	561,221
1995	2,220,278	2,066,161	154,138	5,150,988	1,978,866	1,100,369	1,466,953	3,929,740	1,654,330	1,124,182
1996	1,355,808	1,914,747		4,897,237	922,342	1,043,446	1,135,615	4,772,885	2,084,642	996,809
1997	1,593,883	1,012,087	59,248	6,404,461	1,180,794	1,061,425	1,413,044	9,197,631	2,141,861	676,615
1998	1,555,552	634,205		5,723,662	1,026,399	492,432	1,165,734	9,976,425	1,996,010	1,106,947
1999	1,326,039	347,218	54,150	4,541,741	1,235,854	565,002	1,035,743	6,156,248	1,596,708	803,143
2000	1,578,758	286,510		5,411,485	2,091,591	1,137,333	1,042,194	8,530,483	1,346,785	531,910
2001	2,104,830	948,345	193,997	6,282,096	2,067,784	1,318,359	1,547,380	6,540,080	1,797,281	498,673
2002	1,862,115	1,791,383		3,539,404	1,784,928	586,731	1,025,226	8,067,588	995,445	499,441
2003	1,744,476	2,473,601		3,275,108	1,711,983	563,319	1,004,833	7,476,547	811,200	354,520
2004	1,995,127	1,641,278		3,464,442	2,051,293	512,159	1,192,244	8,292,245	1,502,172	673,777
2005	1,168,086	380,284	88,847	1,670,845	1,593,983	381,365	904,304	7,910,634	1,116,925	616,349

Year	Pamlico Sound	Shallotte River	Stump Sound	Topsail Sound	White Oak River	Total
1994	465,421	2,145,281	389,592	785,994	1,748,581	26,804,776
1995	224,896	1,338,679	603,471	830,234	1,638,118	25,481,400
1996	293,116	1,116,193	476,356	732,570	1,028,412	22,770,179
1997	269,726	1,476,610	582,081	616,746	995,457	28,681,669
1998	420,874	1,134,281	508,922	881,965	841,114	27,464,522
1999	642,439	1,203,015	355,288	780,330	1,093,706	21,736,624
2000	863,254	1,444,570	390,797	1,751,171	1,001,637	27,408,478
2001	795,501	1,901,876	603,313	1,742,389	2,341,291	30,683,194
2002	683,793	1,113,539	244,225	1,113,049	1,324,521	24,631,388
2003	177,433	1,103,737	293,792	1,061,917	1,038,109	23,090,574
2004	34,116	982,322	224,438	719,444	615,895	23,900,952
2005	12,590	894,479	145,773	567,226	172,450	17,624,140

6.4 RESEARCH RECOMMENDATIONS

Many areas of hard clam biology and factors influencing their population dynamics are unknown and should be investigated prior to attempting more advanced stock assessment techniques. Areas needing further research include:

- Standardize monitoring metrics and methodologies with other researchers when possible.
- Validation of ageing methods in North Carolina.
- Investigate the role of adult dispersion patterns to spawning success.
- Determine fecundity of clams at each age.
- Determine the importance of flushing rates and larval predation on larval survival.
- Identify factors influencing settlement success.
- Identify source and sink areas.
- Describe spatial and temporal patterns of larvae and juveniles.
- Investigate the role of lateral movement of juveniles in recruitment.
- Determine the effects of harvest methods on juvenile settlement and survival.
- Development of an adult abundance index.
- Note regional changes in abundance.
- Determe natural mortality estimates.
- Identify factors influencing hard clam growth in North Carolina.
- Collect recreational landings data.

7.0 STATUS OF THE FISHERIES

7.1 COMMERCIAL FISHERY

7.1.1 HISTORICAL FISHERY

7.1.1.1 PUBLIC BOTTOM

The clam industry has existed since the 1880s when dealers from Virginia sent boats to the sounds of North Carolina to buy clams (Chestnut 1951a). These boats came mostly to the Ocracoke area. J.H. Doxy of Long Island, NY established a clam processing plant in 1898 at the entrance of Silver Lake in Ocracoke. Clams were processed as whole clams, clam chowder, and clam juice and labeled as quahogs from Islip, Long Island, NY. Clam landings increased noticeably as a result of this processing operation and peaked at 134,286 bushels in 1902 (Figure 7.1). Three years later, the plant was moved to Atlantic, NC because of diminished clam resources in the Silver Lake area and later moved to Florida. Following the demise of the processing plant, production slowly dropped to below 45,714 bushels in 1918 and remained low until 1934 (Figure 7.1).

Increased clam abundance in upper Core Sound is attributed to a hurricane that opened up several inlets in 1933 (Chestnut 1951a). High landings of hard clams from 1935 to 1942 are attributed to the opening of a processing plant in Morehead City, NC, which processed clams and also shipped whole clams to Virginia (Figure 7.1). Landings dropped during World War II and reached a low in 1949.

Clam harvest has fluctuated historically, often in response to changes in demand, improved harvesting, and increases in polluted shellfish area closures. Hand harvest accounted for all recorded landings prior to the mid-1940s, when early forms of mechanical harvest were developed. Hand harvest is currently allowed year-round with daily harvest limits. The daily harvest limit was unlimited until 1983 when it was reduced to 40 bags (10,000 clams) per fishing operation in public waters by proclamation. The daily harvest limit was further reduced in 1986 by proclamation to 6,250 clams per fishing operation from public waters and has remained in effect since. The daily harvest limit was written into rule in 1989.

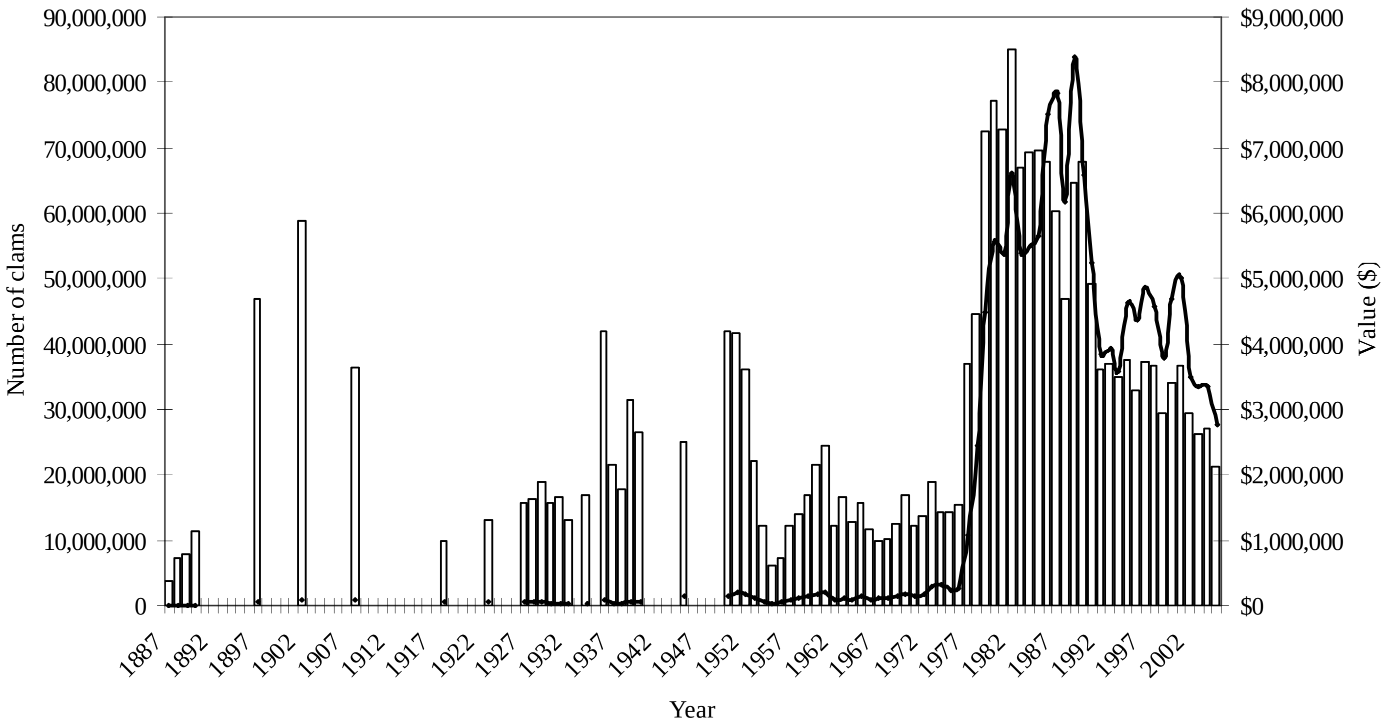


Figure 7.1. Hard clam historical landings (Number of clams) from both public and private bottoms combined and value ($), 1887-2005. DMF Trip Ticket Program and Chestnut and Davis (1975).

The first mechanical method for harvesting clams was known as dredging. Dredging initially evolved from the anchor method, where an anchor was put out behind a boat with a weighted stern to stop forward motion and cause the vessel to swing in an arc (Guthrie and Lewis 1982). Prop wash was then used to expose clams. The fishermen then picked up these exposed clams with a rake. Over time, the bedstead method was developed, in which a wide, low profile sled-like gear called a bedstead was placed behind the anchored boat (Guthrie and Lewis 1982). A bunt with a heavy lead line was attached to the bedstead and used to scoop up clams exposed by the prop wash. This gear allowed fishermen to remain on board and enabled them to work in poor weather. The cumbersome bedstead was replaced by a modified oyster drag in the mid-1940s. The oyster drag was four feet wide, weighed approximately 100 lbs. and had a removable bar on the bottom with three-inch teeth (Guthrie and Lewis 1982). The bag was made of metal rings connected together. A kicking stake was used to anchor the boat while allowing movement in a complete circle. Cable was released out to increase the circle size with each revolution.

A hard clam (*M. campechiensis*) fishery developed in the Atlantic Ocean between Barden's Inlet near Cape Lookout and Beaufort inlet in 1960 (Porter and Chestnut 1960). Hard clams were harvested at water depths between 30-50 feet with "Fall River" dredges weighing approximately 500 pounds towed from shrimp trawlers. About a dozen vessels were involved in the fishery during the January through March period and it continued until 1962. The hard clam stock in the ocean had declined so that it was no longer profitable to fish in the area. In 1990, local fishermen wanted the area re-opened to explore the hard clam stock. The MFC added a provision to the mechanical harvest rule (15A NCAC 03K .0302(a) that enabled a harvest season to open in the area in the Atlantic Ocean at anytime. In the early 1990s there were requests from mechanical clam harvesters to allow them to survey areas in the Atlantic Ocean for hard clams. On March 7, 1994 a proclamation (SF-9-93/94) was issued to open an area in the Atlantic Ocean from Beaufort Inlet east to Cape Point at Cape Lookout after Shellfish Sanitation certified the area for harvest. Dredge weight and harvest restrictions do not apply in this open ocean area to the mechanical harvest of clams and harvest is allowed from 7:00 a.m. to 4:00 p.m. five days a week. The proclamation has not been superseded and still in effect.

Trawls were first used to harvest clams in 1968 and remain in use today in a technique known as "kicking" (Guthrie and Lewis 1982). Increase in market demand along with more efficient gear soon lead to increased landings. However, by 1953, market demand declined and landings dropped (Figure 7.1). Another major development in the fishery occurred in 1968 with the advent of hydraulic dredges. This gear used jets of water from a high-pressure pump to displace bottom sediments covering the clams and a conveyor carried the catch up to the vessel. Hard clam landings remained stable through the 1960s and 1970s. An increase in demand for North Carolina clams was created during the 1976-1977 season, when clam beds became inaccessible in the northeastern states due to abnormally thick ice. Since the late 1980s hard clam landings have declined. This decline may be the result of a decrease in abundance, increase closures of shellfish waters from pollution, changing market demand, and several storms in Core Sound.

Allocation conflicts did not occur in the hard clam fishery until the late 1980's as more management measures were in place to reduce impacts to habitat and harvesters had to compete more for the limited resource. It is accepted that mechanical harvest methods can negatively impact submerged aquatic vegetation (SAV) and oyster rocks (Peterson et al. 1987). Regulations to protect habitats from mechanical harvest methods have been in place since 1977 and mechanical harvest was largely confined to the deeper waters of the sounds and rivers. In the early 1980s, mechanical harvesters proposed a rotation scheme between White Oak River and New River, including a portion of the Intracoastal Waterway with the intent to prevent overharvesting of clam stocks, discourage violations by mechanical harvesters who cross the lines in search of more lucrative clam quantities, and the taking of undersized clams, or "buttons". These measures continue to be in place each year by proclamation. In 1991, the MFC wanted to prevent growth of the mechanical harvest fishery because of habitat concerns and prohibited the opening of any new bottom that had not traditionally been opened since 1977. One management recommendation adopted in the 2001 Hard Clam FMP included opening a mechanical harvest area in southeastern Pamlico Sound and rotate it two years on and off with an area in the northern Core Sound mechanical harvest area (Figure 7.11). The southeastern Pamlico Sound rotational mechanical harvest area was first opened by proclamation for the 2001/2002 harvest season.

7.1.1.2 LEASE PROGRAM AND PRIVATE CULTURE

Although North Carolina law did not formally prescribe the methods for obtaining private shellfish bottoms until 1858, laws existed giving private shellfish growers special privileges in harvesting and selling their shellfish as early as 1855. Early cultivation sites were based on "squatters" rights.

In 1858 a law was established that a license for oyster and hard clam bottoms was to be issued by the Clerk of Superior Court of the respective county at no charge. The licensed bottom 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).

There were 250 such licenses in the state in the 1880s (Winslow 1889). The plots were defined as "gardens," a term which is still in use today to describe shellfish leases. Production from these gardens was normally limited to amounts adequate to supply the licensee's table (Winslow 1889). Although subsequent laws for shellfish 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 that 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 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 in April 1886 to determine the extent and condition of North Carolina's oyster- producing habitat. The survey determined there were 8,328 acres of oyster producing bottom in Dare, Hyde, Pamlico, Carteret and portions of Onslow counties. Additionally, 583,000 acres of bottom were identified as suitable for oyster cultivation (Winslow 1889). An entirely new system for allowing private cultivation of oysters was proposed on public bottoms. Even though oyster cultivation was the driving force for leasing shellfish bottom, 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, which included hard clams (Jernigan 1983).

Under these laws, a board of three Shellfish Commissioners established natural oyster beds held in the public trust. Shellfish franchises had to be approved by the Secretary of State. Application fees were $2.05 and franchises were purchased at a cost of 25 cents per acre. A state surveyor conducted surveys of each grant for the applicant. The grounds were recorded for tax purposes (Winslow 1889).

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

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

Other aspects of the law were somewhat different from today. Shellfish lease acreage was limited to ten acres in the bays and smaller sounds (Chestnut 1951b). Single leaseholders could have 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. For up to four months after the granting of the lease, the public could protest on the grounds that the area contained a natural shellfish bed. In any given year from 1901 to 1949 there were about 264 leased areas totaling 3,232 acres (Chestnut 1951b).

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 Marine Fisheries Commission 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.

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

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

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

The MFC recommendations from the 2001 Hard Clam and Oyster FMP included increases in application fees ($200), renewal of application fees ($100), rental fees ($10 per acre per year), and change the term of the lease contract expiration date to June 30 to coincide to the commercial licensing system (G.S. 113-202). Some shellfish franchises (private culture areas obtained for a one-time fee under the 1889 laws) issued prior to the shellfish leasing program still exist and are currently going through a process to evaluate their validity under North Carolina General Statutes 113-205 and 113-206. Those that are recognized as valid claims to bottomlands were required beginning January 1, 1991, to meet the requirements for surveys, management plans, and commercial shellfish production set for shellfish leases. Currently, 46 shellfish franchises have been recognized. Production data from these franchises began showing up in the 1991 statistics but is not differentiated from the shellfish lease landings. Franchises that are not recognized may be subject to special leasing provisions. It is unknown what portion of the approximately 300 franchise claimants may be issued a shellfish lease.

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

Today the majority of shellfish leases are held by commercial fishermen to supplement their income from public harvest areas by holding shellfish to improve the meat condition and/or sell during better market conditions. Private bottom acreage has fluctuated very little over time while number of leases has shown a gradual increase indicating leases are getting slightly smaller (Table 7.1). Planting clam seed and relaying clams have greatly fluctuated over time. Production from leases varied from 2,357,853 clams in 1994 to a high of 7,663,600 clams in 1993.The overall percent contribution of lease production to the total state landings has increased over time, from 6 percent in 1979 to a high of 21 percent in 1993 (Table 7.1). In 2005, lease production accounted for 16% of the total commercial landings in the state.

There is no evidence of clam culture in North Carolina before 1950 but several leases existed for holding surplus clams until market conditions improved (Chestnut 1951a). Carricker (1959) successfully spawned and raised clam larvae from Chesapeake Bay during the 1950s and minimal success was achieved with clams from North Carolina in the 1960s (Porter 1964). Bayer and Chestnut (1964) began a project to determine the potential of rearing clams in North Carolina in February 1963. Their work consisted of spawning adult clams, rearing larval clams to the juvenile stage and then broadcasting the seed over bottom. Problems included mass mortalities of larvae because of disease and predation of seed not covered with mesh screens (Bayer and Chestnut 1964). Other culture operations over the next 15 to 20 years experienced varying levels of success because of predation resulting from lack of covering seed. North Carolina culturists began to purchase seed clams from various out of state companies in the 1990s. Some of these companies have also established portions of their businesses in North Carolina because of the milder climate.

The importation of shellfish seed has become an integral part of many aquaculture operations and leaseholders in North Carolina. The few shellfish hatcheries in North Carolina are unable to produce sufficient number of seed to meet the demands of shellfish growers. Therefore growers must 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. 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.

Table 7.1. Reported hard clam leases, planting, and harvesting activities (1979-2005). DMF Resource Enhancement and Trip Ticket Program.

	Leases		Planting			
Year	Number	Acreage	Seed (number)	Relay (number)	Harvest (number)	Percent of total state harvest
1979	246	2,185	5,590,000	44,290	4,312,400	6
1980	260	2,333	48,000,000	101,762	7,207,200	9
1981	262	2,257	78,000,000	21,817	5,251,200	7
1982	262	2,257	2,174,400	8,596	7,093,600	8
1983	265	2,286	1,170,000	8,134	4,071,600	6
1984	269	2,291	279,600	82,806	4,634,000	7
1985	272	2,304	514,000		4,218,800	6
1986	282	2,380	3,478,400		4,416,000	7
1987	279	2,354	3,627,600		3,733,600	6
1988	285	2,330	6,008,400		5,844,400	12
1989	276	2,232	8,096,800		5,580,000	9
1990	276	2,214	6,127,600		5,258,800	8
1991	281	2,208	12,088,800		6,577,600	13
1992	280	2,191	13,661,600		6,964,800	19
1993	300	2,441	11,062,800		7,663,600	21
1994	285	2,282	14,638,000		2,357,853	7
1995	279	2,216	18,948,400		3,277,256	9
1996	295	2,193	25,394,000		2,796,334	9
1997	295	2,193	22,327,600		3,934,760	11
1998	284	2,149	11,062,400		4,874,837	13
1999	284	2,121	15,363,600		5,000,210	17
2000	276	2,016	None		4,876,529	14
2001	287	2,308	15,291,360		4,981,601	14
2002	290	2,143	10,507,020		4,093,637	14
2003	290	2,117	15,049,100		3,002,015	11
2004	287	2,050	5,219,500		3,176,821	12
2005	277	1,972	3,628,600		3,378,383	16

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 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 FMP in 2001 recommends formulate and amplify 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. Not specifying the testing requirements 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 a particular 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.

7.1.2 PRESENT FISHERIES

7.1.2.1 COLLECTION OF COMMERCIAL STATISTICS

The Division of Commercial Fisheries (now known as the U.S. Fish and Wildlife Service, Department of the Interior) collected annual commercial landings information for North Carolina from 1880-1974 (Chestnut and Davis 1975). The National Marine Fisheries Service standardized landings statistics collection methods for U.S. South Atlantic fishery species in

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

Since the inception of the Trip Ticket Program (TTP) in 1994, data collection of hard clam information has improved through time. One thing we must consider with hard clam landings is they can come from either public or private bottoms, which are under different regulations therefore trip numbers, landings, and effort cannot be compared between the two bottom types. On July 1, 1999, the DMF changed over to a new licensing system, which was mandated by the 1997 FRA. This new system allows DMF to more accurately assess the impact of commercial fishing activities. In 1994, 16% of the total hard clam landings were identified as an unknown bottom type. Since 2003 the unknown bottom type was less than 1% of the overall annual hard clam landings. Much of the improvement has been from better recording and editing requirements, and from the new licensing system. In the following sections the different gear types in the fishery data are separated into either public or private bottoms. Since there are some trips with unknown bottom types in the database they were excluded in the analyses since they could not be differentiated.

7.1.2.2 LANDINGS ALONG THE ATLANTIC EAST COAST

The hard clam industry has provided people a way to make a living and food for coastal communities along the entire Atlantic east coast from the Canadian maritime region to Florida. The leading hard clam producers historically in the northeast have been New York, New Jersey, Massachusetts, and Rhode Island, and more recently Connecticut (Table 7.2). In the southeast Virginia and North Carolina have led in commercial landings of hard clams (Table 7.2). Fluctuations in commercial annual landings are common along the Atlantic east coast with a general trend of decline through time (Figure 7.2).

New York and Rhode Island have dominated the Atlantic coast hard clam landings from 1950 to 1992. A large part of the decline in Atlantic coast landings occurred after the 1970's as a result of overfishing in New York and closure of shellfish beds due to bacterial pollution. In the southeast, Virginia had higher landings most years except from the mid-1970's through the mid-1980's when North Carolina hard clam landings increased significantly (MacKenzie et al. 2002).

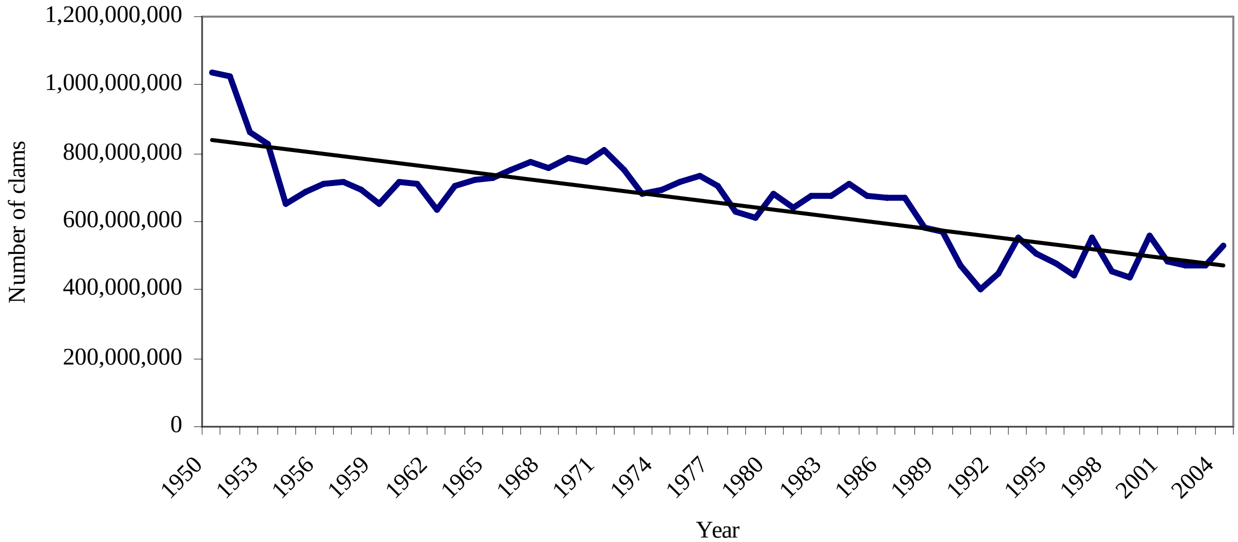


Figure 7.2. Commercial hard clam landings (Number of clams, using a conversion factor of 0.32 oz per individual; ASFMC 1992) along the Atlantic east coast, 1950-2004. Source: NMFS commercial fisheries landings database, except for NC landings from 1994-2004 using DMF Trip Ticket Program.

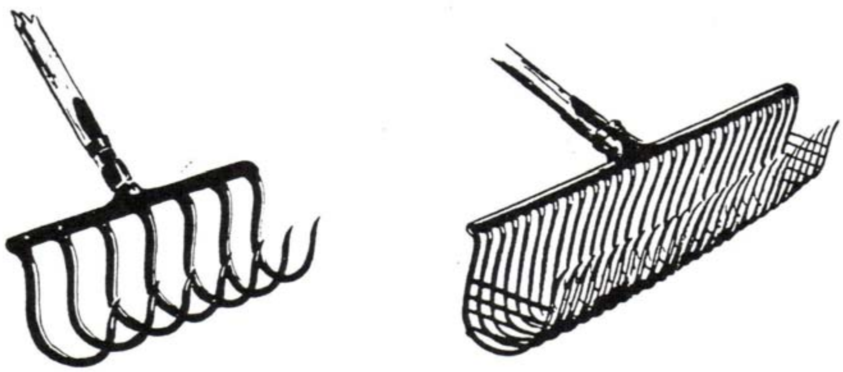
7.1.2.3 GEAR TYPES

7.1.2.3.1 HAND HARVEST

The hand harvest fishery for hard clams is year-round in North Carolina. Hand harvesting methods include signing (spotting siphon holes), treading, hand raking, hand tonging, and bullraking. Clams are taken by hand and rake in shallow water, up to 4 feet deep, ($\leq$1.2 meters) while hand tongs and bull rakes are used in deeper water up to 20 feet deep (1.2 to 12.2 meters) (Cunningham et al. 1992) (Figure 7.3a-c). Bull rakes, a gear introduced to North Carolina in the mid 1970s have been used to exploit clam populations in New River, White Oak River, Bogue Sound, and the Intracoastal Waterway channel of Brunswick, New Hanover, Pender, and Onslow counties (Figure 7.3b). There are a large number of subsistence fishermen in the southern area of the state, who use bullrakes. Clam tongs consist of two long handles joined together like scissors and a rake at each end of the handle with teeth in a basket-like frame to hold the clams as they are dug out of the substrate (Figure 7.3c).

A. Hand rakes; Source: Cunningham et al. 1992

B. Bull rakes; Source: Cunningham et al. 1992



C. Hand tongs; Source: Dumont and Sundstrom 1961

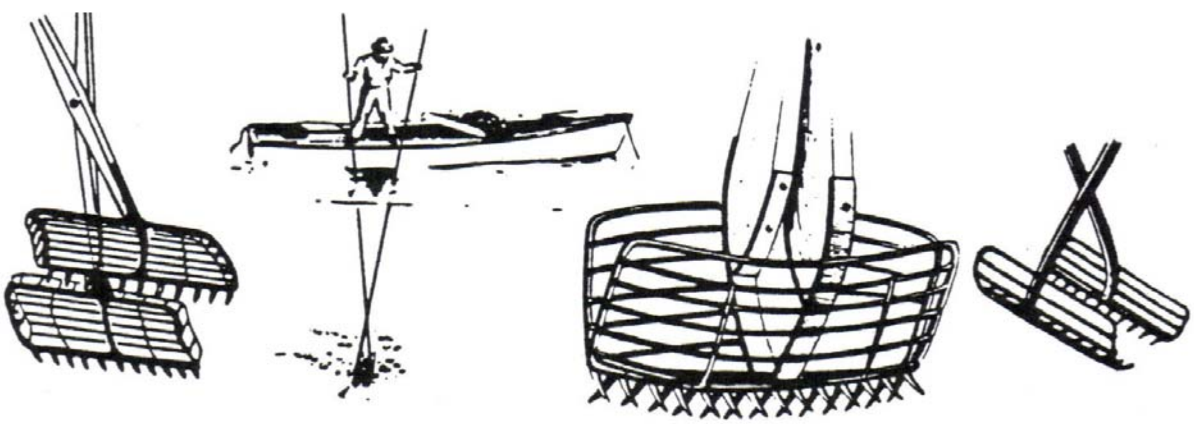
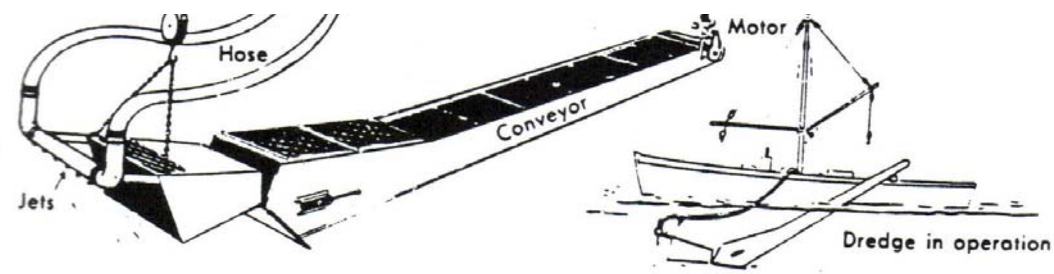


Figure 7.3. Hard clam hand harvest gears (Dumont and Sundstrom 1961; Cunningham et al. 1992).

7.1.2.3.2 MECHANICAL HARVEST

The two types of mechanical harvest gear currently used in North Carolina are the hydraulic escalator dredge and the clam trawl or "clam kicking" vessel. The hydraulic escalator dredge has an escalator or conveyor located on the side of the vessel (Figure 7.4a). A sled is connected to the front end of the escalator. When the front end of the escalator is lowered to the bottom, the sled glides over the bottom. A blade on the sled penetrates the bottom to a depth of about four inches (10 cm) and collects the clams as they are forced from the bottom by water pressure (Cunningham et al. 1992). In clam trawling or "kicking", clams are dislodged from the bottom with prop backwash and a heavily chained trawl with a cage behind the boat gathers the clams (Figure 7.4b). Kick boats are generally 20 to 30 ft long, and can operate in depths from 3 to 10 feet (1.0m to 3.05 m). The propeller is usually positioned 12 to 15 inches above the bottom and extra weight can be added to the stern to improve the angle and height above the bottom. For better efficiency in varying water depths, boats include a winged rudder, which has two iron plates welded on either side of the rudder to deflect water downward (Cunningham et al. 1992). One person operates smaller kick boats, while larger boats may have a crew of two or three (Guthrie and Lewis 1982).

A. Hydraulic escalator dredge; Source: Sundstrom 1957



B. Clam kicking gear; Source: Guthrie and Lewis 1982

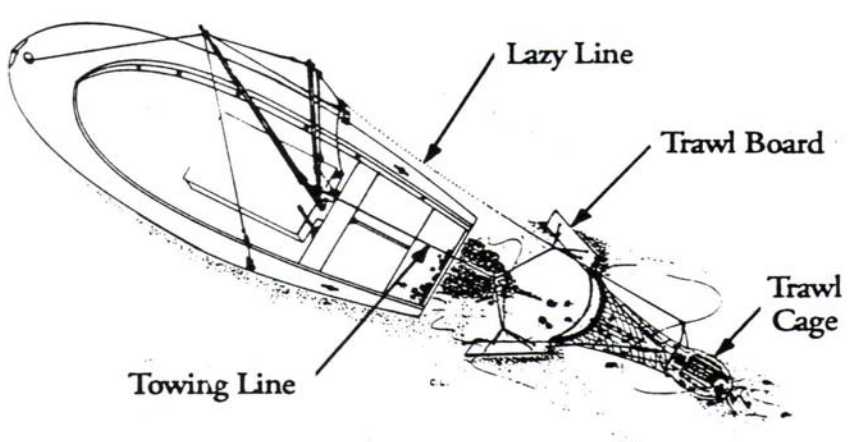


Figure 7.4. Hard clam mechanical harvest gears (Sundstrom 1957; Guthrie and Lewis 1982; Cunningham et al. 1992).

Current mechanical harvest limits vary by designated mechanical harvest areas by waterbody and in some instances are rotated open and close with other areas (Table 7.2). White Oak River, the Intracoastal Waterway (ICW) of Onslow and Pender counties (Marker 65 to the BC Marker at Banks Channel), and New River are fished mainly with escalator dredges and are rotated on a yearly basis with maximum daily limits of 6,250 clams (25 bags at 250 clams per bag) per operation (Figures 7.5 and 7.6). The maximum daily harvest of 3,750 clams is allowed in North River, Newport River, and Bogue Sound (Figures 7.7, 7.8, and 7.9). Since 2001, upon adoption of the 2001 Hard Clam FMP, Core Sound has been divided into two areas and the northern area is rotated open and close every two years with a new area in Pamlico Sound with a daily harvest limit of 5,000 clams per operation (Figures 7.10 and 7.11). The majority of the mechanical harvest area in Core Sound is open each year during the season and is limited to 5,000 clams per operation.

Table 7.2. Current daily mechanical hard clam harvest limits by waterbody.

Waterbody	Daily harvest limits	Additional information
Southeastern Pamlico Sound	5,000 clams	Rotates 2 years on and 2 years off with northern Core Sound area. Began in 2001.
Northern Core Sound	5,000 clams	Rotates 2 years on and 2 years off with southeastern Pamlico Sound area. Began in 2001.
Core Sound	5,000 clams	Limit reduced from 6,250 clams per operation in 2001.
North River	3,750 clams	
Newport River	3,750 clams	
Bogue Sound	3,750 clams	
White Oak River	6,250 clams	Rotates one year on and one year off with New River area.
New River	6,250 clams	Rotates one year on and one year off with White Oak River area.
ICW Onslow/Pender County area	6,250 clams	Marker 65 to the BC marker at Banks Channel

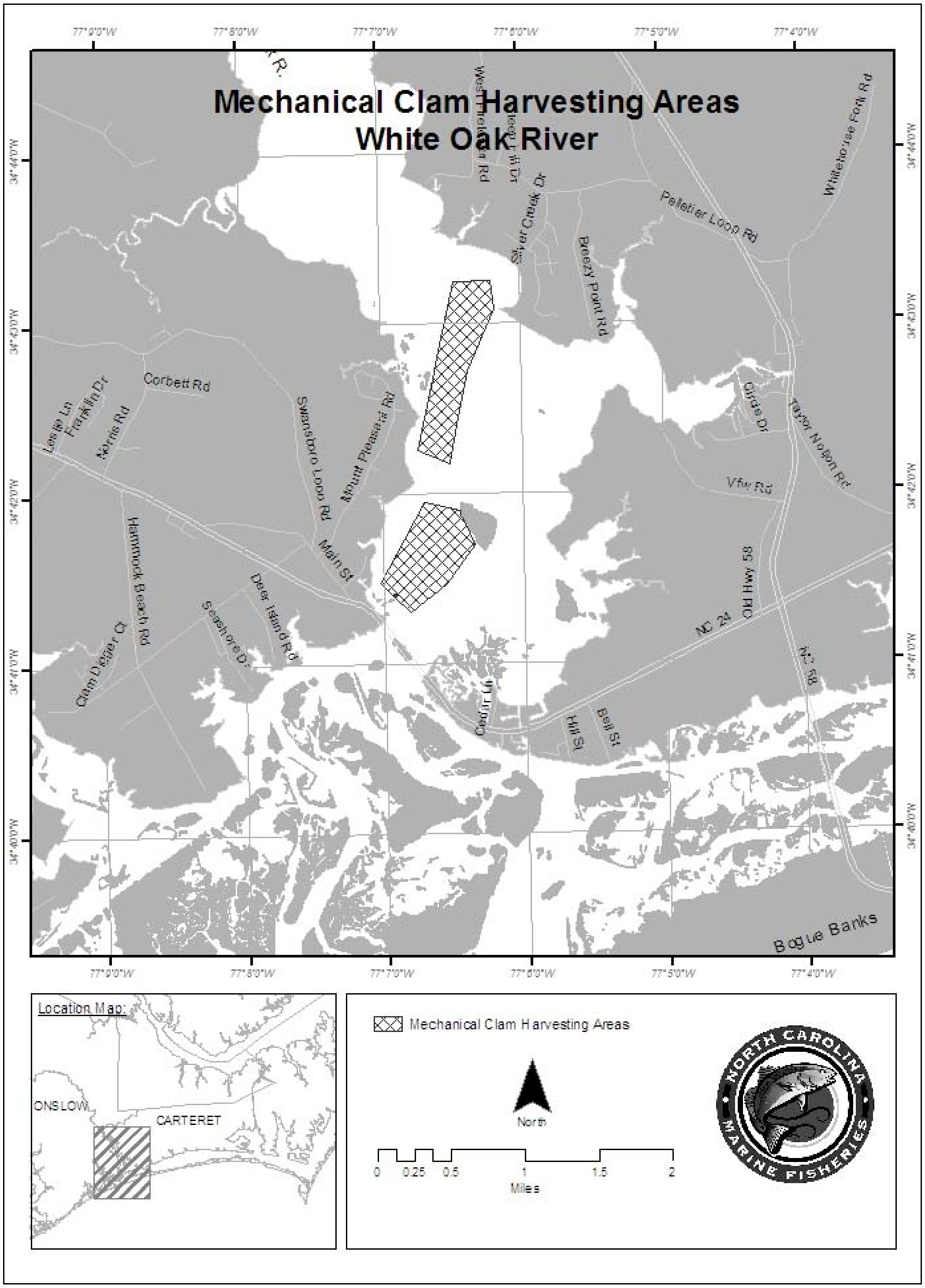


Figure 7.5. The current mechanical harvest area in White Oak River. This area is rotated one year on and then one year off with the mechanical harvest area in New River. DMF GIS database.

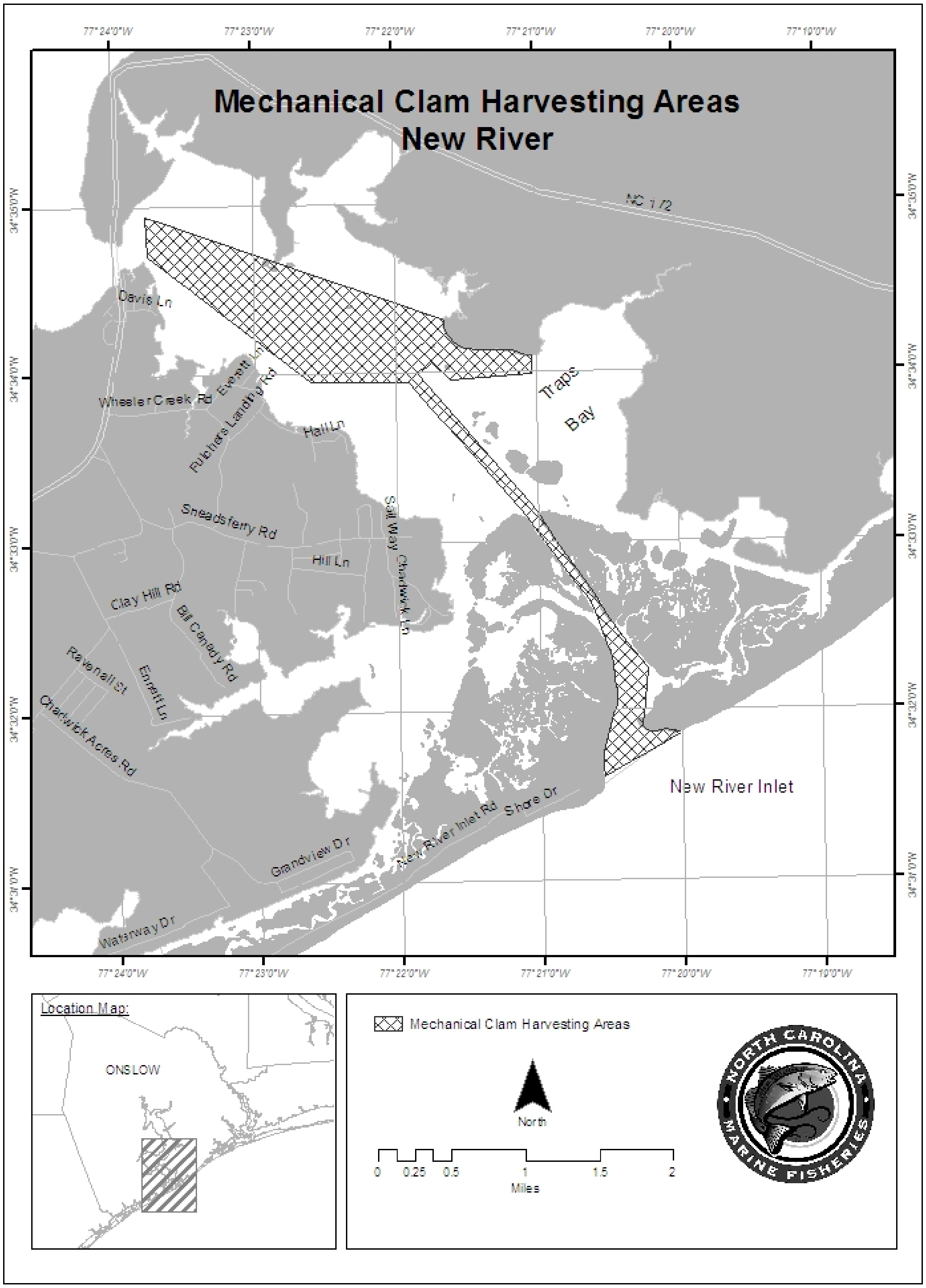


Figure 7.6. The current mechanical harvest area in New River and the Intracoastal Waterway of Onslow and Pender counties (Marker 65 to the BC marker at Banks Channel). This area is rotated one year on and then one year off with the mechanical harvest area in White Oak River. DMF GIS database.

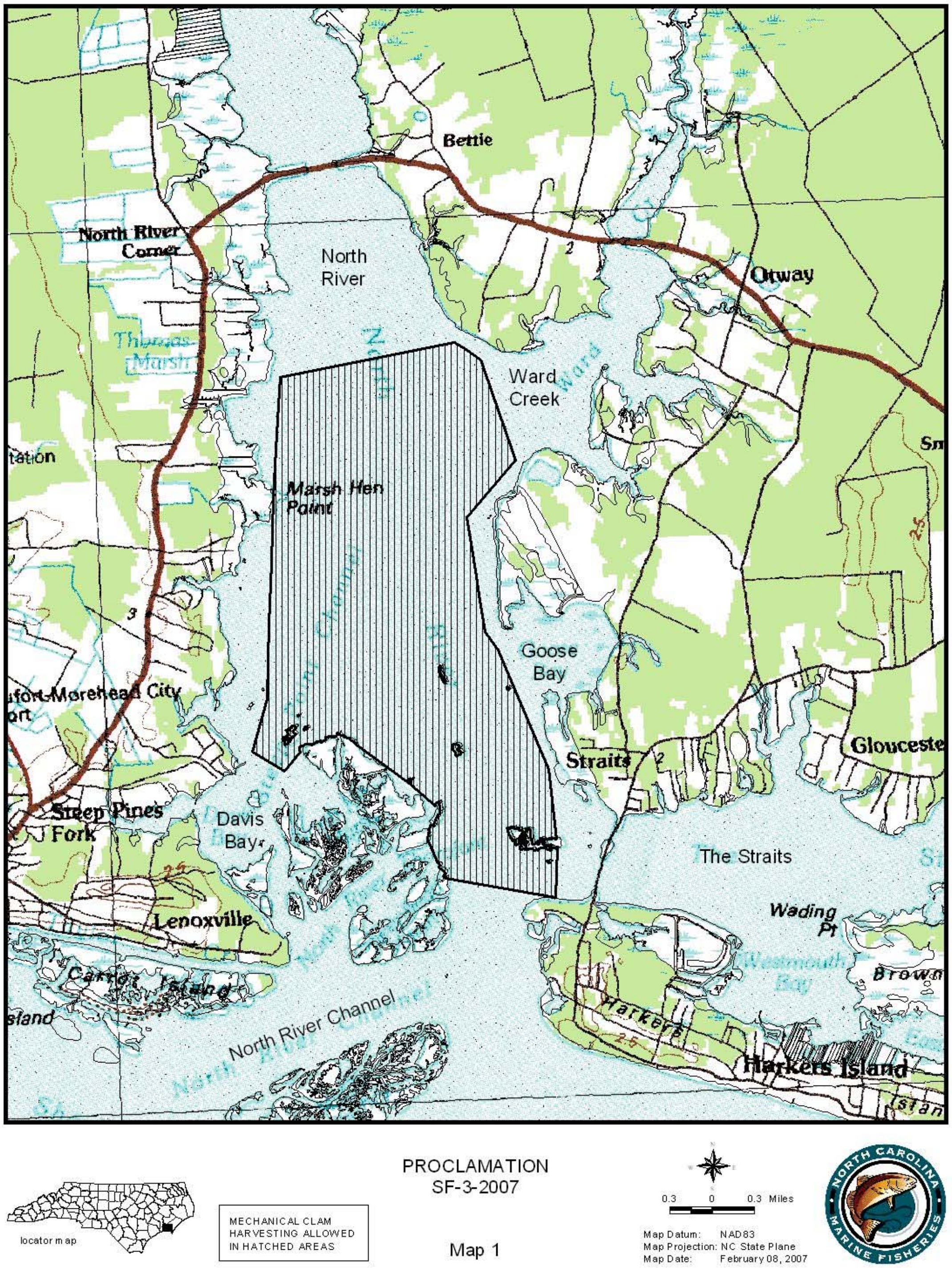


Figure 7.7. The current mechanical harvest area in North River. DMF GIS database.

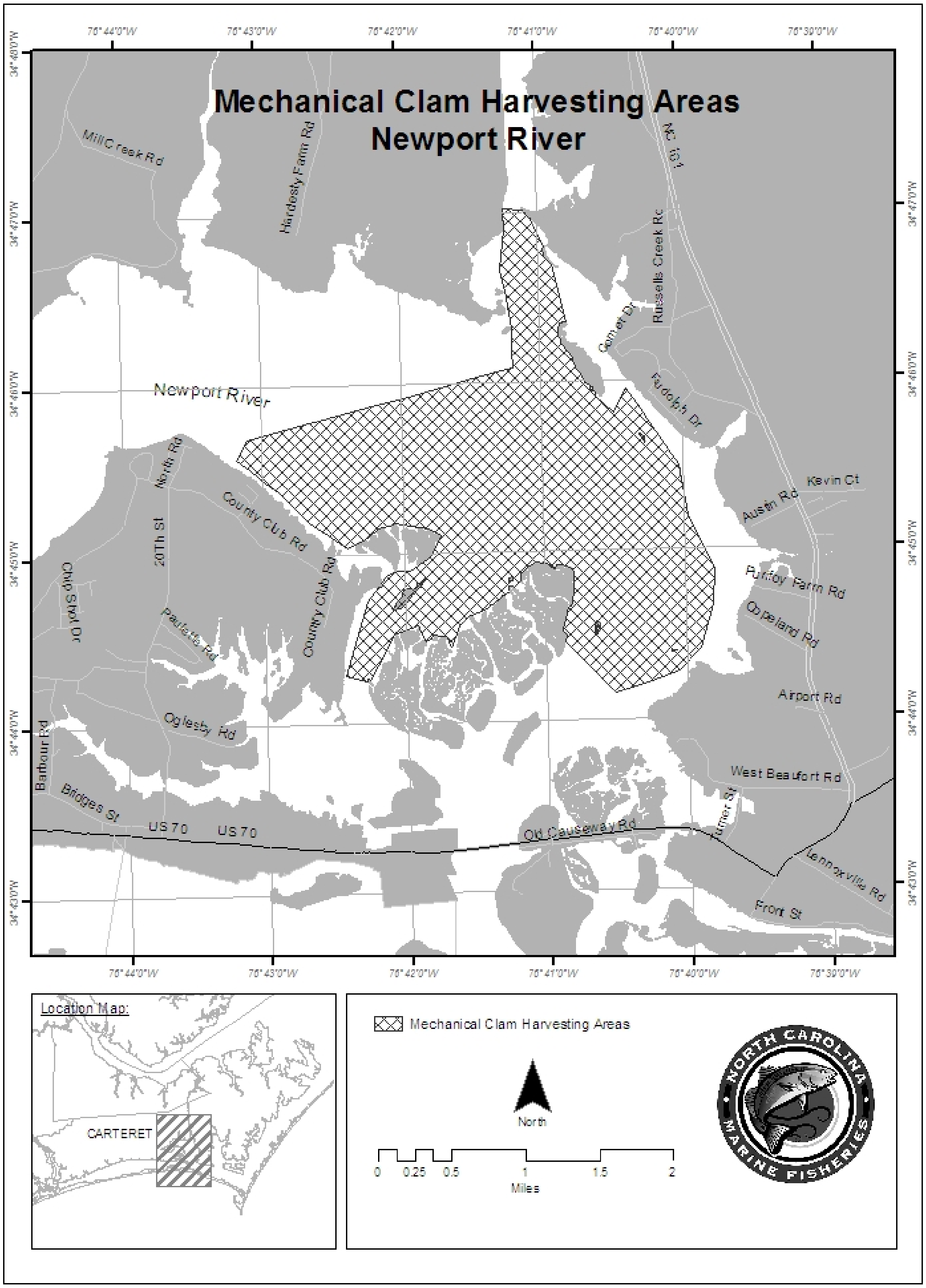


Figure 7.8. The current mechanical harvest area in Newport River. DMF GIS database.

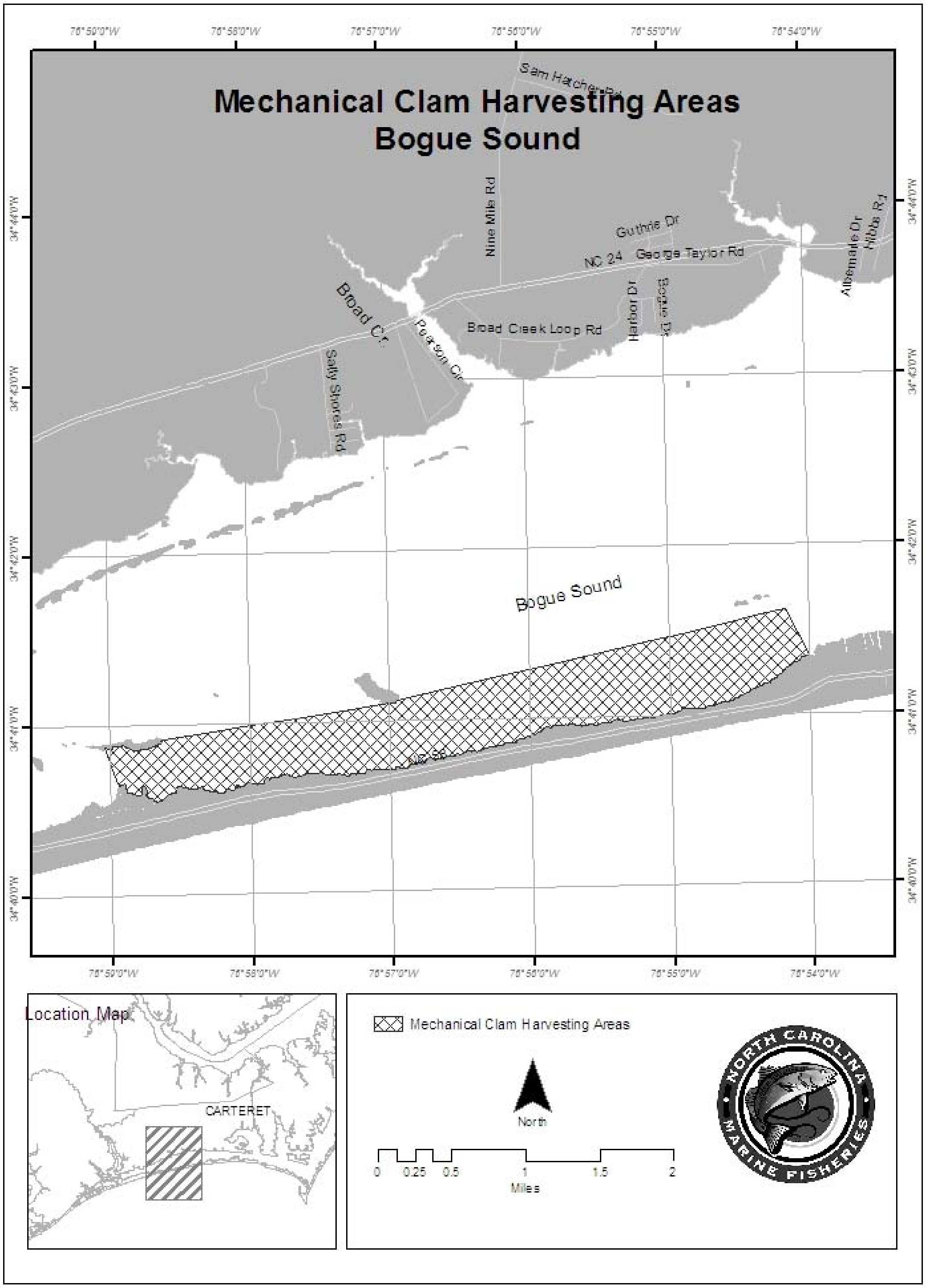


Figure 7.9. The current mechanical harvest area in Bogue Sound. DMF GIS database.

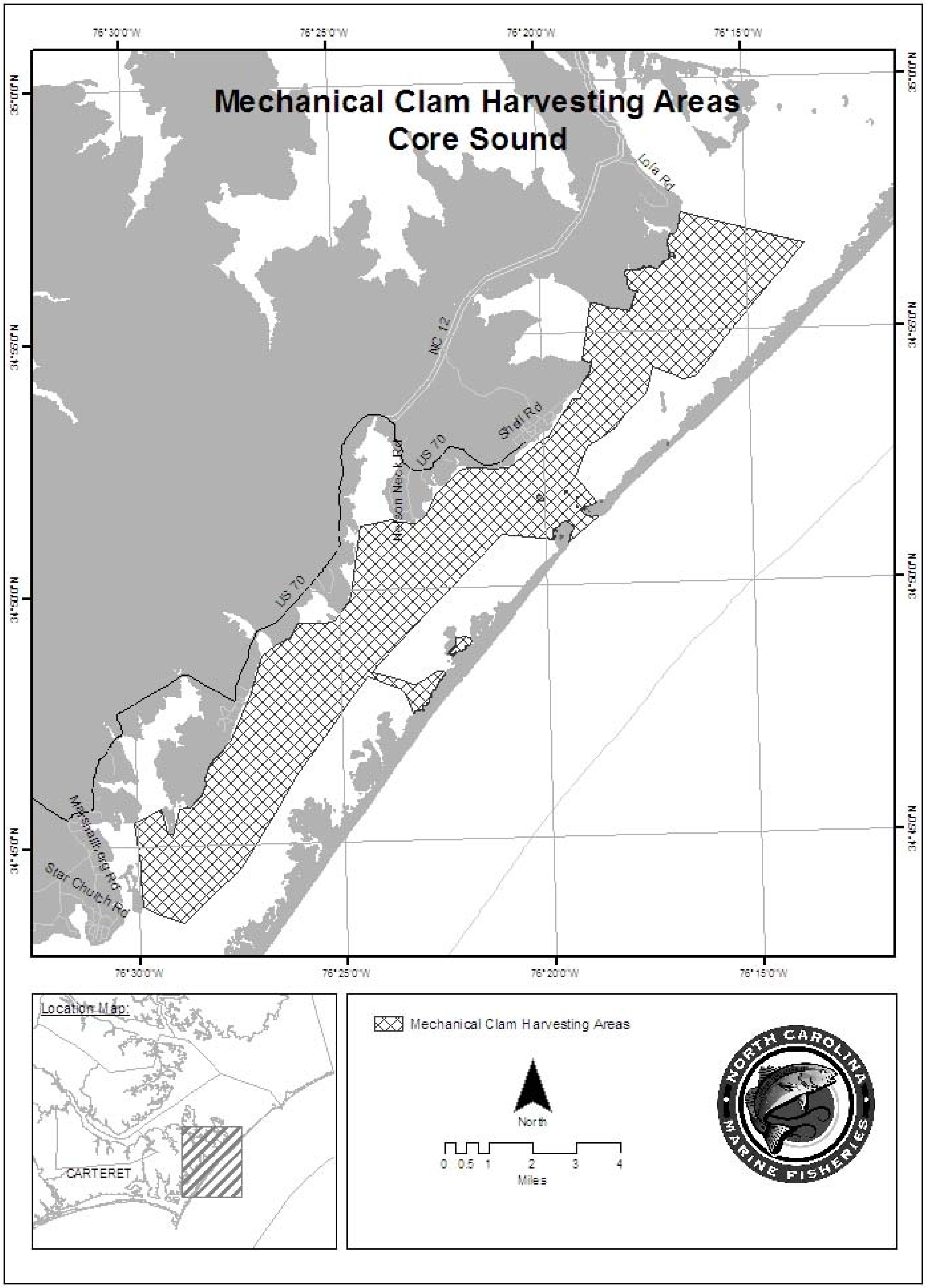


Figure 7.10. The current mechanical harvest area in Core Sound. DMF GIS database.

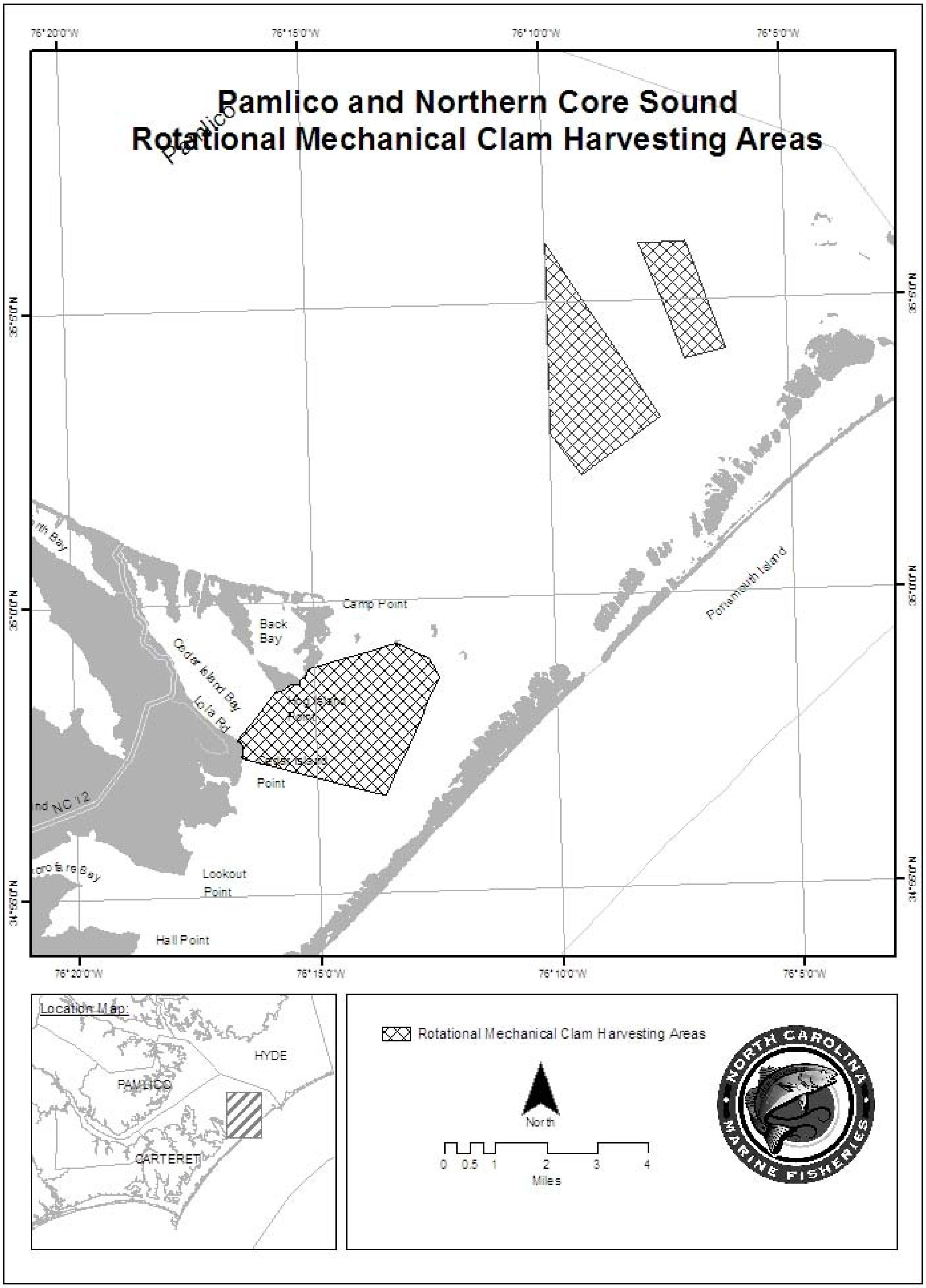


Figure 7.11. The current mechanical harvest areas in Northern Core Sound and Pamlico Sound. These areas are rotated two years on and then two years off with each other. DMF GIS database.

7.1.2.4 PUBLIC BOTTOM

7.1.2.4.1 ANNUAL LANDINGS, TRIPS, AND MARKET GRADES

Separating the hard clam landings data into public and private bottom type is inexact prior to 1994 because landings information was collected only on a voluntary basis. Since 1994 it is known that about 80% (1994-2005 combined estimate) of the total commercial hard clam harvest come from public bottom in North Carolina. It is assumed that trends in hard clam landings from both bottom types combined can be attributed to changes in hard clam landings from public bottom since they make up the largest component to the overall harvest (Figure 7.12). Prior to the 1950s, the lack of a steady market attributed to the fluctuations in landings. From 1950 to 1976 the average annual commercial landings of hard clams was 17,189,943 clams (Figure 7.12). Production declines in New York and New Jersey in the 1970s plus the introduction of new harvest gears (bull rakes and clam kicking) increased landings significantly. From 1977 to 1987, average annual landings were 65,768,514 clams a year (Figure 7.12). The first and only documented red tide event caused by the dinoflagellate, *Karenia brevis*, in North Carolina occurred from October 1987 through February 1988 (Tester et al. 1991; Summerson and Peterson 1990). About 564 square miles (1,460 km^2) of shellfish harvesting areas were closed from as far north as Buxton in Dare County southward to the North Carolina/South Carolina border because of shellfish contamination (DMF 1991; Tester and Fowler 1990). During 1988, landings dropped to 46,988,800 clams harvested that year. Landings over the two-year period after the red tide event increased back to pre-red tide levels but since 1991 annual hard clams landings have been in decline, which may be attributed to less market demand, higher harvesting costs, weather events, and increasing polluted area closures. Annual average hard clam landings from 1994 to 2005 were 33,739,700 clams.

The number of participants involved in the hard clam fishery each year since 1999 ranged from a high of 1,824 in 2001 to a low of 898 in 2005. The number of licensed clam dealers has remained steady from 1999 to 2005.

There are year-to-year fluctuations in the number of trips harvesting hard clams. The annual number of trips has declined during the time series with the highest number of trips in 2001(Figure 7.13). Adverse weather conditions (i.e., hurricanes, heavy rain events) can impact the annual landings. Hurricane Floyd (1999), Tropical storm Dennis (1999), Hurricane Isabel (2003), and Hurricane Ophelia (2005) likely decreased hard clam harvest. Freshwater runoff after storm events often increase shellfish harvest area closures and therefore reduce effort in hard clam harvest.

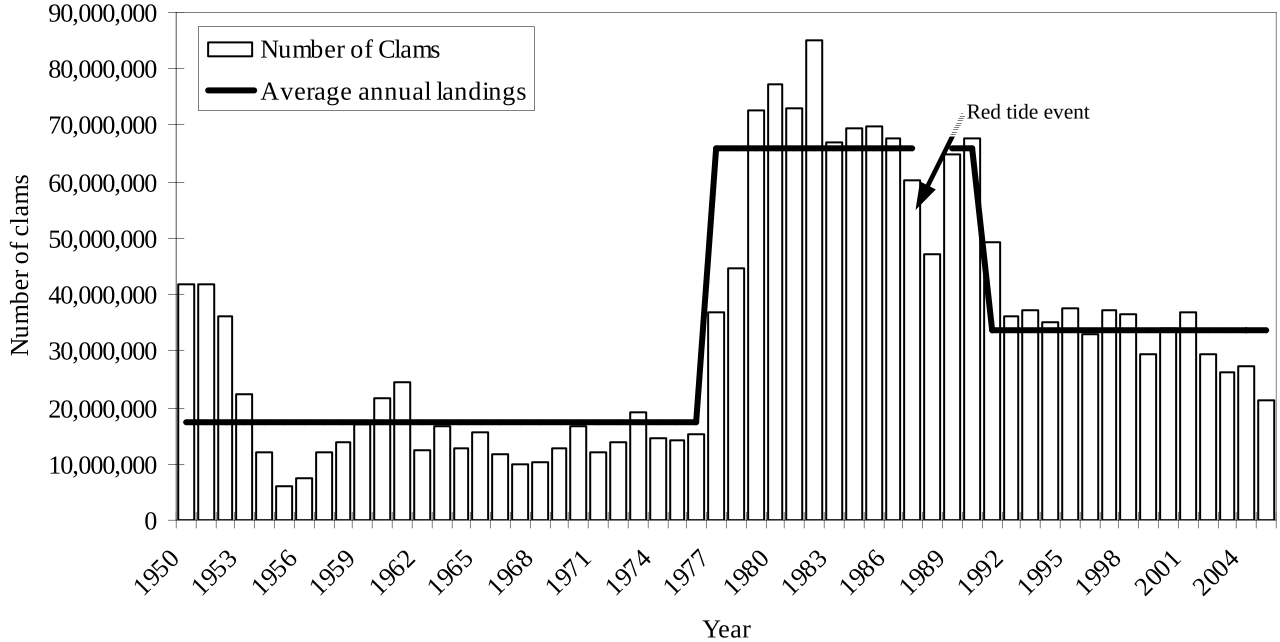


Figure 7.12. Hard clams landings (Number of clams) from public and private bottoms showing the average annual landing trends for specific time periods.

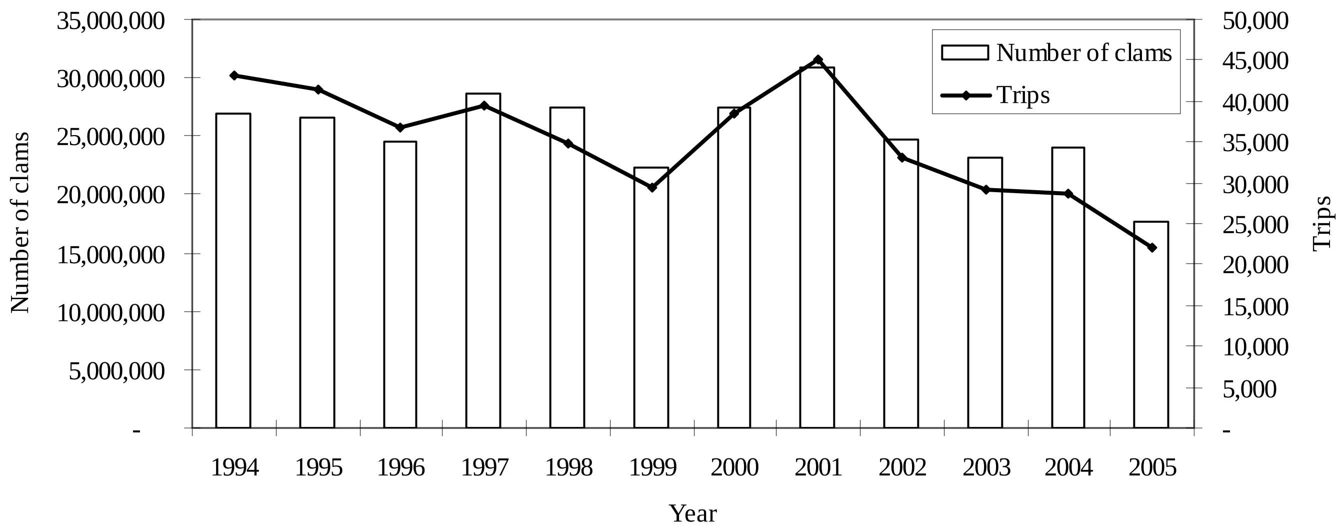


Figure 7.13. North Carolina annual commercial hard clam landings (number of clams) and trips from public bottoms, 1994-2005. DMF Trip Ticket Program.

New River and Core Sound are the top two waterbodies where hard clams are harvested from public bottom and accounted for 46% of the landings from 1994 to 2005 (Figure 7.14). Landings in the southern part of the state, including the areas of Stump Sound, Lockwood Folly, Topsail Sound, Masonboro Sound, Cape Fear River, Shallotte River and the Inland Waterway accounted for an additional 37% of the hard clam landings from public bottoms from 1994-2005.

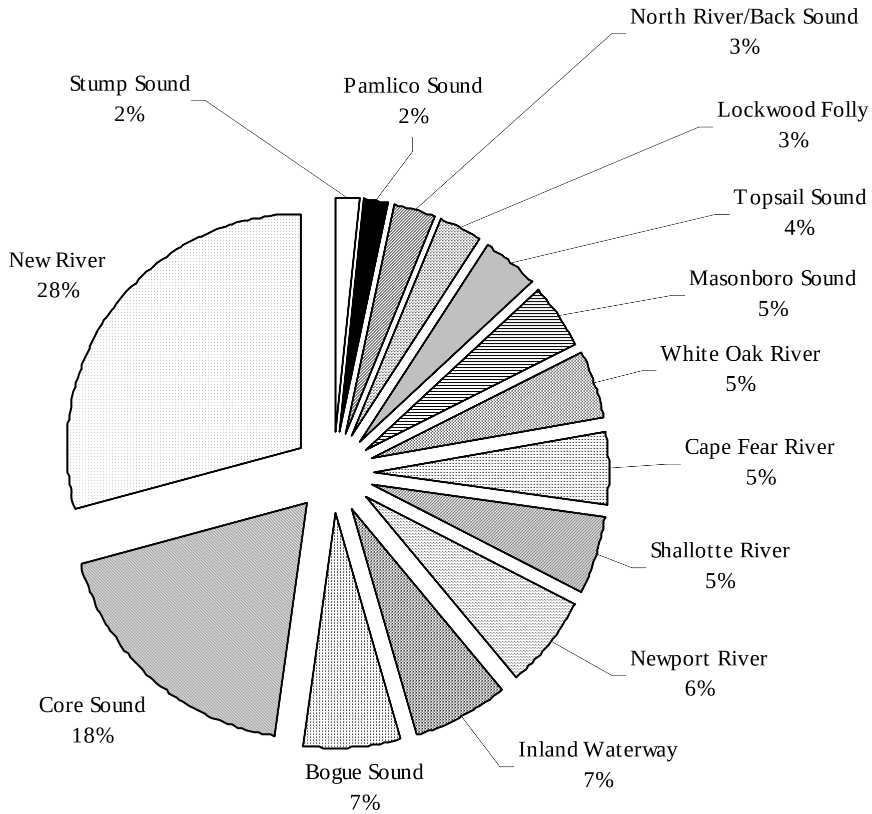


Figure 7.14. Commercial hard clam landings (Percent of total landings) by waterbody from public bottoms, 1994-2005 combined. DMF Trip Ticket Program.

Hard clam harvest is sorted by shell width or thickness into various market grades when purchased by the seafood dealer from the fisherman. A mixed or unclassified market grade is the most common hard clam size category from public bottom and comprised 59% of the total landings from 1994 to 2005 (Figure 7.15a). Commercial fish house sampling shows the size ranges from the minimum allowed of 1-inch (25 mm) thickness to a little over 3-inches (80 mm) thick (Figure 7.16). The trend in the proportion of hard clams in the mixed market category to the total landings from public bottoms has increased each year since 1998. Little neck is the second dominant market category in the hard clam landings from public bottoms (Figure 7.15b). This market grade consists of the smallest sized hard clams measuring between 1-inch (25 mm) to 1 ¼-inch (32 mm) in thickness. From 1994 to 1999 little neck hard clams comprised 10% to 17% of the total hard clam landings from public bottoms, but since 2000 have shown a steady decline (5-7%). Top neck is the next market category in size and ranges from 1 ¼-inch (32 mm) to 1 5/8-inch in thickness (41 mm). The proportion of hard clams as top necks to the total hard clam landings from public bottoms show a similar decline as little neck hard clams since 1997 (Figure 7.15b). Hard clams in the cherry and top cherry market grades are selected by a shell thickness that ranges between 1 5/8-inch (41 mm) to 2 ¼-inches (57 mm). These two market categories have not shown much change in the proportion to the total hard clam harvest from public bottoms from 1994 to 2005 (Figure 7.15b). Chowder hard clams are the largest market category by size and are any hard clams greater than 2 ¼-inch shell width. Chowder clams only make up a small proportion to the total landings but have shown a slight increase in the time series from 1994 to 2005 (Figure 7.15b).

A.

B.

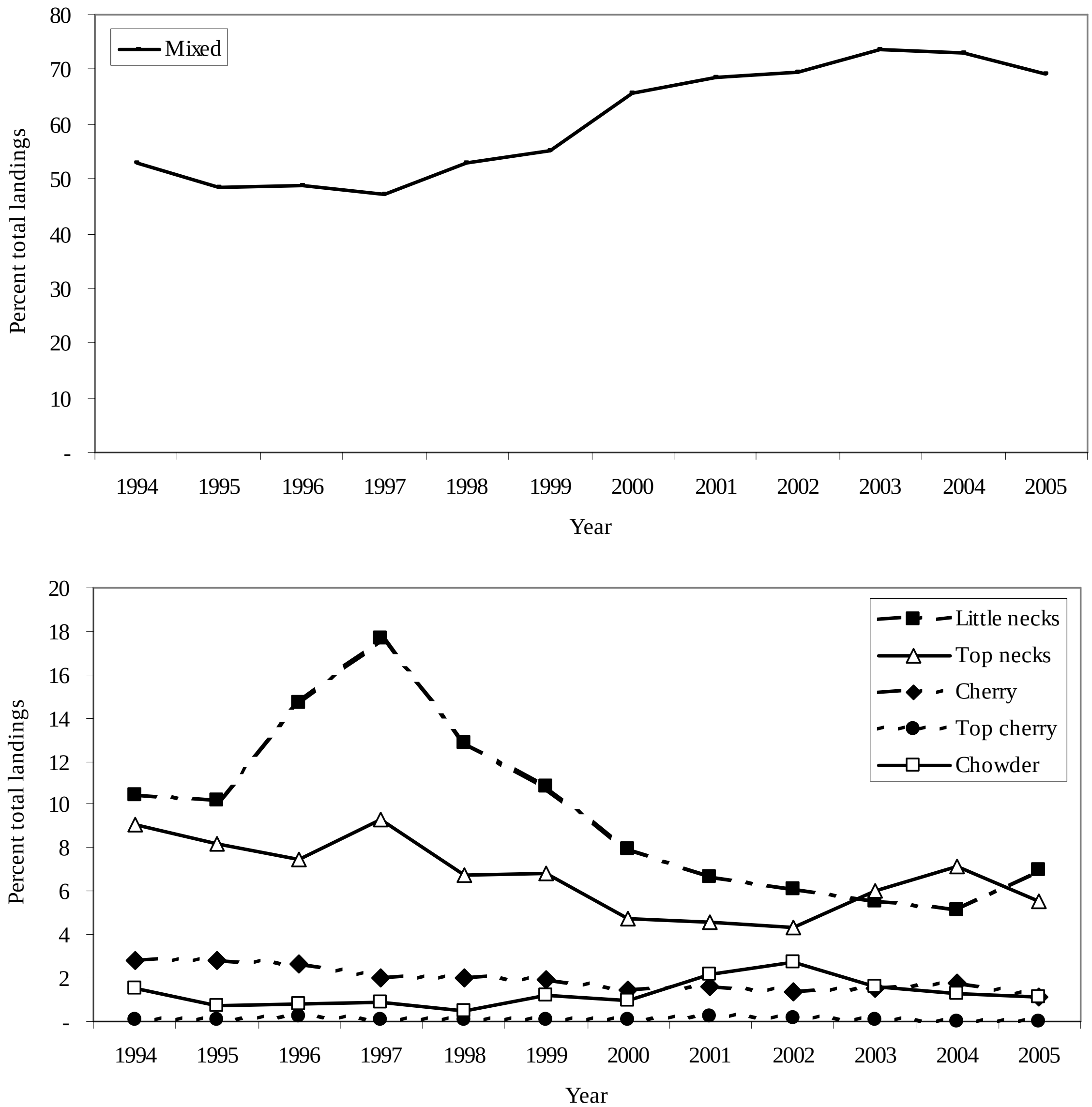


Figure 7.15. Annual landings (Percent to total annual landings) from public bottoms by market grade, 1994-2005 combined. A. Mixed grade only; B. All other market grades. DMF Trip Ticket Program.

Figure 7.16. Size class (shell thickness, 10 mm bins) distribution of hard clams in the unclassified market category from commercial fish house sampling, 1999-2005 combined. DMF biological database.

7.1.2.4.2 HAND HARVEST

Hand harvest from public bottoms is a year round fishery and has average landings of 20,984,955 clams a year (1994-2005). Most hand clamming occurs in the spring and summer when warm water is conducive to wading (Figure 7.17). The number of annual hand harvest trips has declined (Figure 7.18).

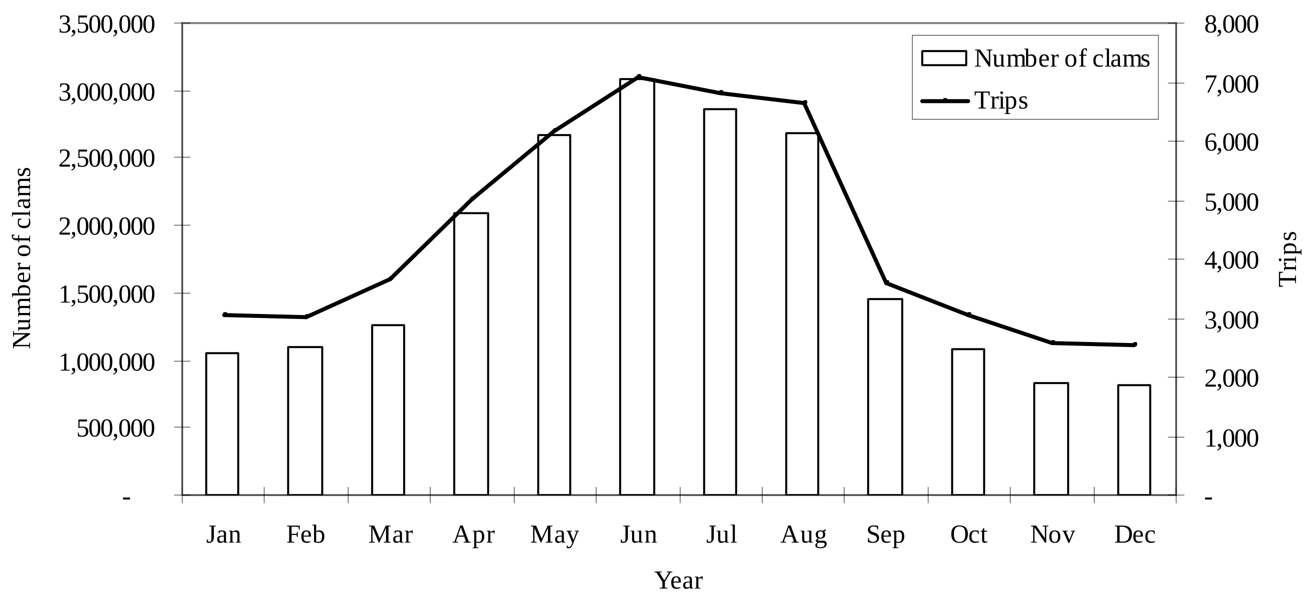


Figure 7.17. Average hard clam landings (Number of clams) and average number of trips by month from public bottom using hand gears, 1994-2005. DMF Trip Ticket Program.

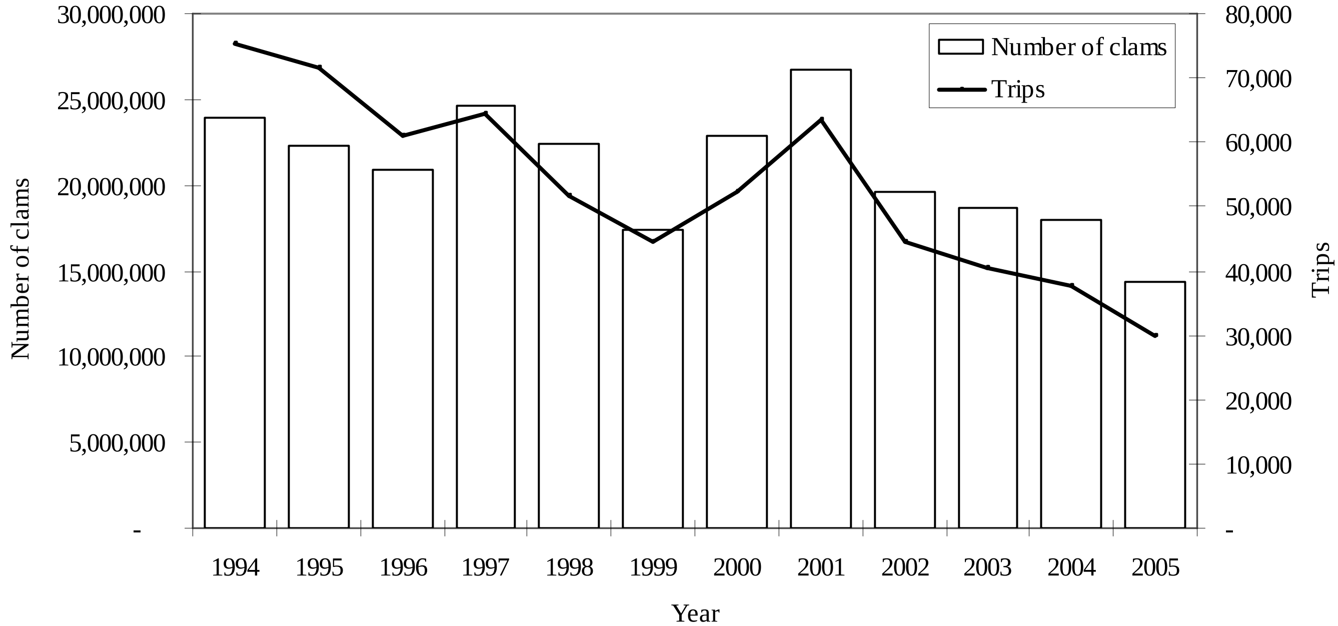


Figure 7.18. Annual hard clam landings (Number of clams) and trips from public bottom using hand gears, 1994-2005. DMF Trip Ticket Program.

7.1.2.4.3 MECHANICAL HARVEST

Mechanical harvest season usually begins the second Monday in December and extends through the week of March 31st. Harvest is allowed only from 7:30 a.m. to 4:00 p.m. on Monday through Friday until some day close to the Christmas holiday and then Monday through Wednesday after December 25th to the remainder of the open harvest season.

Hard clam harvest from public bottom using mechanical methods has average landings of 4,495,195 clams each fishing year (1994/95 to 2004/05). The mechanical clam harvest season usually has the highest landings at the beginning of the fishing season in December and declines as the season progresses (Figure 7.19). Hard clam landings and trips fluctuate from fishing year to fishing year corresponding to alternating open and close of the New River mechanical harvest area (Figure 7.20). When the mechanical harvest area of New River is open 47 to 64 percent of the total mechanical harvest landings are from this area.

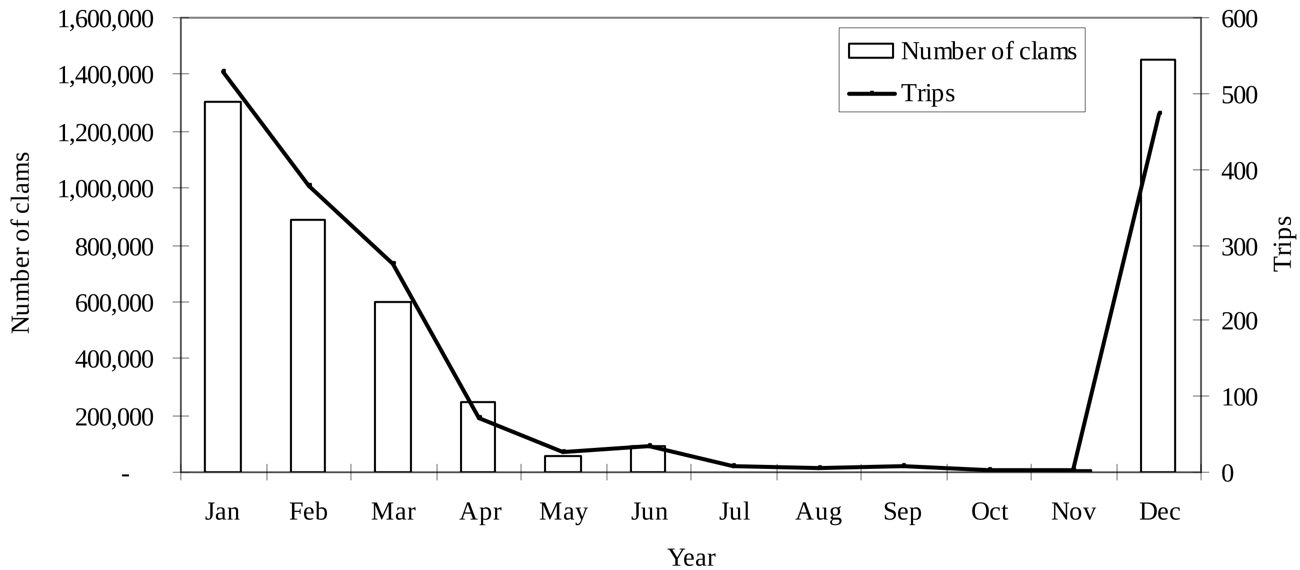


Figure 7.19. Average hard clam landings (Number of clams) and average number of trips by month from public bottom using mechanical gears, 1994-2005. DMF Trip Ticket Program.

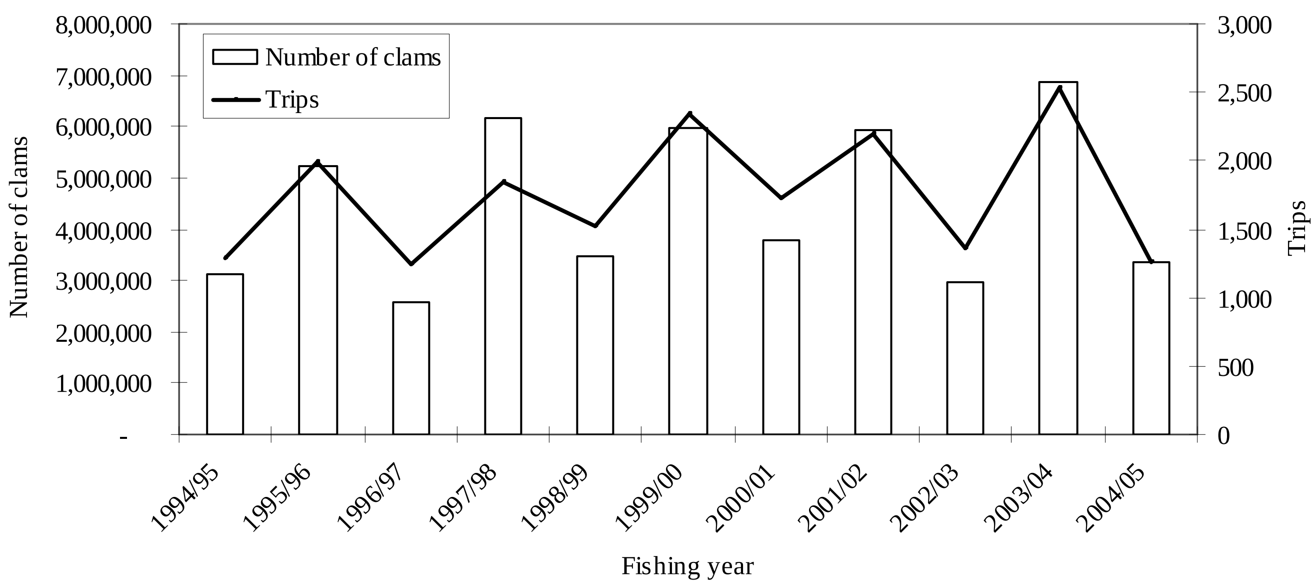


Figure 7.20. Hard clam landings (Number of clams) and trips from public bottom using mechanical gears, 1994-2005 by fishing year (Dec-Nov). DMF Trip Ticket Program.

7.1.2.5 PRIVATE CULTURE AND LEASE PROGRAM

Hard clams are the principal species produced on leased bottom in North Carolina where unique environmental conditions enable development of various hard clam culture methods. There were 277 leases covering over 1,972 acres that planted and harvested hard clams in 2005 (Table 7.1).

The most basic approach is for individuals to use their lease as a traditional culture site for naturally setting clams, although this approach often yields low production and fails to realize the full production potential of many of the leases. Other methods of extensive clam aquaculture can be successful in some areas. These methods require large acreage of estuarine bottom planted at low densities. Research has shown a return of clams when planted at rates of approximately one/m^2 (Peterson et al. 1995). Cultch plantings are also used to attract natural settlement of hard clam spat. Growers can produce clams by planting shell cultch for oysters and later harvesting the crop of clams that settle underneath the cultch that protects them from predation. Cultch planting is not used as extensively for clams as with oysters. Seed clams are planted on leased bottom using methods such as planting with protective netting mesh bags, and broad-casting seed. Harvesting is allowed by hand and mechanical gear that require adherence to regulations established by MFC.

A few leases are cultured intensively. Sections of the lease are planted with cultured immature or “seed” clams. Often various lease sections are rotated through harvest and planting cycles to use all available space and maintain a steady crop. Leaseholders may also produce and rear their own seed clams in small raceways and upwellers in conjunction with their commercial clam production.

Clam aquaculture also occurs on a large scale with hatchery and nursery facilities that produce seed for sale and planting. Many of these operations are small family oriented businesses and are often conducted in conjunction with other commercial fishery activities such as crab shedding. Such leases typically realize much greater production than those on which extensive culture methods are utilized. The aquaculture operator routinely utilizes predator exclusion devices such as mesh covers to protect their small clams. Intensive culture requires smaller acreage of bottom leases and/or water-column areas. Water-column leases are also useful for some intensive culture operations depending on water depth.

Seed supply is critical to successful clam production. Most operations in North Carolina rely on hatchery-produced seed clams for planting. A few small-scale hatcheries operate in North Carolina. There are no large-scale shellfish hatcheries in the state that can supply the industry's needs, thus most seed are imported from other states. Some clam growers produce or purchase very small seed and grow to larger size for planting in on-shore or water-based nurseries.

Most clams are marketed out-of-state. Clams reared in an aquaculture operation are exempt from size limitations for marketing purposes. Limited markets exist for as small as 7/8-inch (22.0 mm) thick clams. The minimum size for wild-harvested clams is 1-inch (25.0 mm) thick. If a grower can develop a market for smaller clams, the risk of mortality and time-to-market are reduced, increasing the economic viability of the operation. Value-added markets are not yet developed for aquaculture clams in North Carolina.

The DMF administers a shellfish lease program whereby State residents may apply to lease estuarine bottom or water columns for commercial production. The DMF does not differentiate between clam, oyster, and mussel leases; consequently, the total number of leases culturing only clams is not known.

An application for a bottom or water column lease must be submitted along with a management plan, a map of the site, and a $200.00 application fee for bottom leases and a $100.oo application fee for water column amendments. Once the application is received, the DMF investigates the site and DMF Biologists, Marine Patrol and Shellfish Sanitation officials review the resulting report prepared by DMF staff. Hearings are held to solicit public input regarding the issuance of a proposed lease. The Secretary of the DENR or his proxy then evaluates the proposed lease. After approval by the Secretary, the applicant must provide a survey plat before execution of the lease contract. The contract includes production and reporting requirements and yearly lease fees. The lease contract is renewable on a 10-year cycle for bottom leases and five years for water column amendments.

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

Public opposition to leasing has become a problem in some areas, especially Core Sound. Obtaining new leases may be difficult depending on the region of the coast. The public often opposes leasing on the grounds that it is a violation of public trust and creates potential conflict between commercial fishermen and leaseholders. This has lead to a legislated Indefinite Moratorium to new leases on the east side of Core Sound and a Temporary Moratorium on the west side (Orbach 2001).

Once leases are granted, theft often becomes a serious problem for many leaseholders. Leases are often located away from shorelines and difficult to observe. There is little to deter theft as the court system has seldom imposed high fines on the rare individual actually caught poaching on a lease.

Another widely used method of extensive culture is relaying polluted clam stocks from closed areas during a 6-week relay season beginning in April. Relaying polluted clams coincides with polluted oyster relay and requires appropriate permitting and access to designated shellfish management areas. Relayed clams are bedded and allowed to depurate (purification of adulteration from clams by any natural or artificially controlled means) on a posted lease for a period of time mandated by the North Carolina Department of Environmental Health (DEH), Shellfish Sanitation Section. Clams are approved for consumption only after representative meat samples indicate that depuration is complete. Clams harvested from closed areas are broadcast onto an open-water lease that is posted for a period of time sufficient for clams to depurate or naturally purge themselves before re-harvest.

The DMF also allows the harvest of clams by mechanical means before maintenance dredging occurs in some navigational channels. In 1994 and 1999 clams were relayed from the closed portions of navigational channels before the U.S. Army Corps of Engineers (COE) performed dredging activity. In March of 1999, approximately 165,000 clams were mechanically harvested from closed portions of the ICW in Brunswick County and transferred to nearby Second Bay, below the Fort Fisher area north of Bald Head Island. The relay effort was funded entirely by DMF using a barge and staff to collect the clams over a 4-day period. The intent was to keep Second Bay marked and closed for 18 months to replenish seed clams lost due to hurricanes shoaling the area. After several months, DMF sampled 30 quadrants (m^2) in Second Bay and found only 34 live and 2 dead clams. It was determined that relaying is not cost effective and has not been attempted since 1999 by DMF.

7.1.2.5.1 ANNUAL LANDINGS, TRIPS, AND MARKET GRADES

Since 1994 it is known that about 12% (1994-2005 combined estimate) of the total commercial hard clam harvest come from private bottom in North Carolina. The annual average hard clam landings from 1994 to 2005 from private bottom were 3,812,520 clams.

Generally, the number of trips harvesting hard clams have remained unchanged from 1994 to 2005 (Figure 7.21). Newport River and Core Sound are the top two waterbodies where hard clams are harvested on private bottoms in North Carolina and accounted for 66% of the landings from 1994 to 2005 (Figure 7.22).

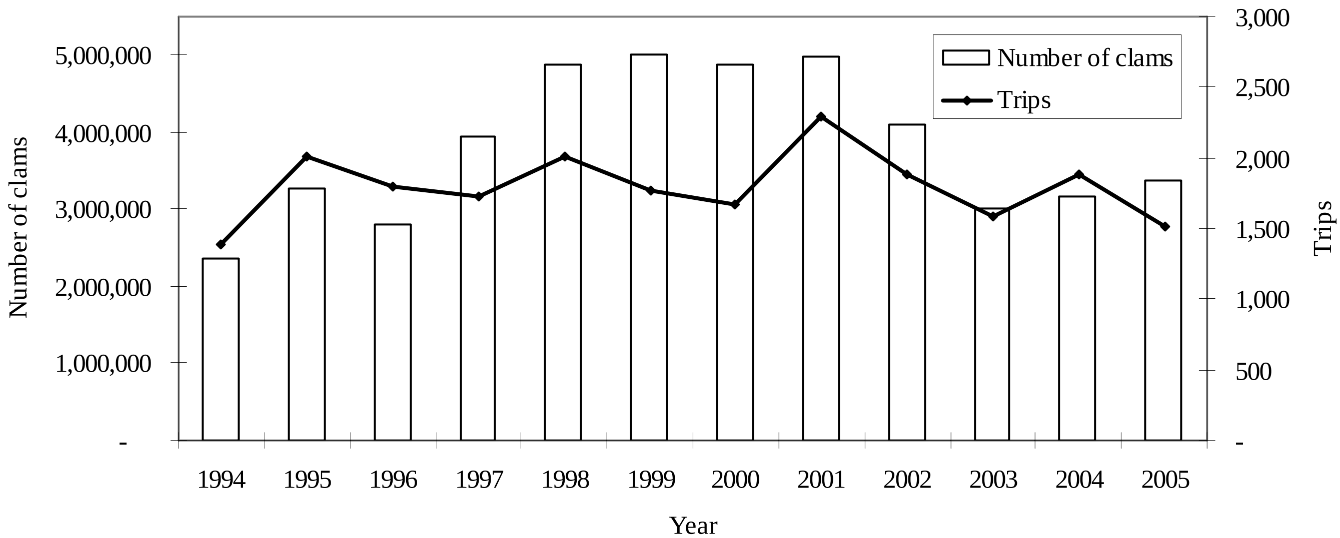


Figure 7.21. North Carolina commercial hard clam landings (Number of clams) and trips from private bottoms, 1994-2005. DMF Trip Ticket Program.

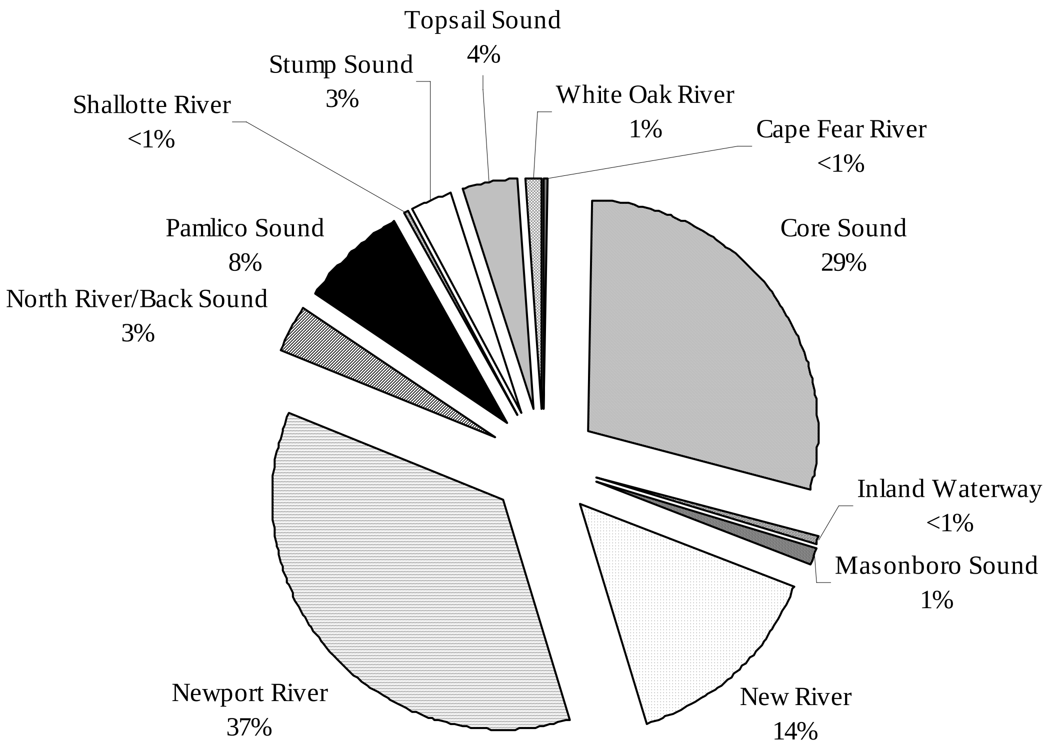


Figure 7.22. Commercial hard clam landings (percent to total) by waterbody from private bottoms, 1994-2005 combined. DMF Trip Ticket Program.

A mixed or unclassified market grade is the most common hard clam size category from private bottom and comprised 9% of the total landings from 1994 to 2005 (Figure 7.23a). The trend in the proportion of hard clams in the mixed market category to the total landings from private bottoms has increased. The increasing trend reached its peak in 1999 and has shown some decline since. The little necks market grade is the second most dominant category in the hard clam landings from private bottom (Figure 7.23b). From 1994 to 1999 little neck hard clams comprised <1% to 6% of the total hard clam landings from private bottom from 1994 to 2005. The proportion of hard clams as top necks, cherry, top cherry, and chowder market grades have remained about the same from year to year (Figure 7.23b). These 4 market grades only make up a small proportion of the total hard clam landings (Figure 7.15b).

A.

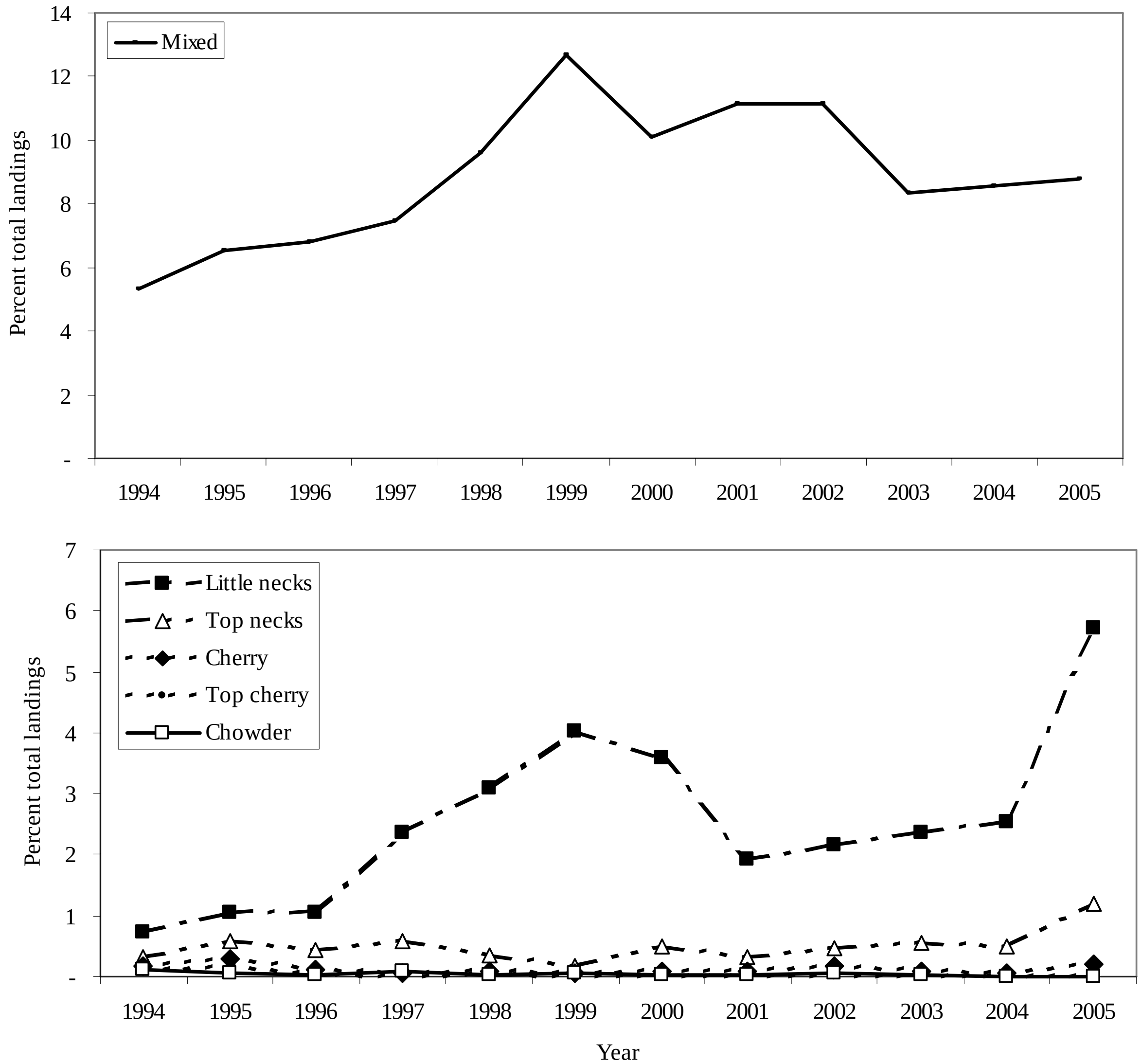


Figure 7.23. Total annual hard clams landings (Percent to annual total landings) from private bottoms by market grade, 1994-2005. A. Mixed grade only; B. All other market grades due to difference in scale. DMF Trip Ticket Program.

7.1.2.5.2 HAND HARVEST

Hand harvest from private bottom is a year round fishery and has average landings of 2,960,032 clams a year (1994-2005). Over 58% of the hard clam landings from private bottom using hand gears occurs from May to August (Figure 7.24). The number of hand harvest trips from private bottom fluctuates from year to year with an average of 2,064 trips a year from 1994 to 2005 (Figure 7.25).

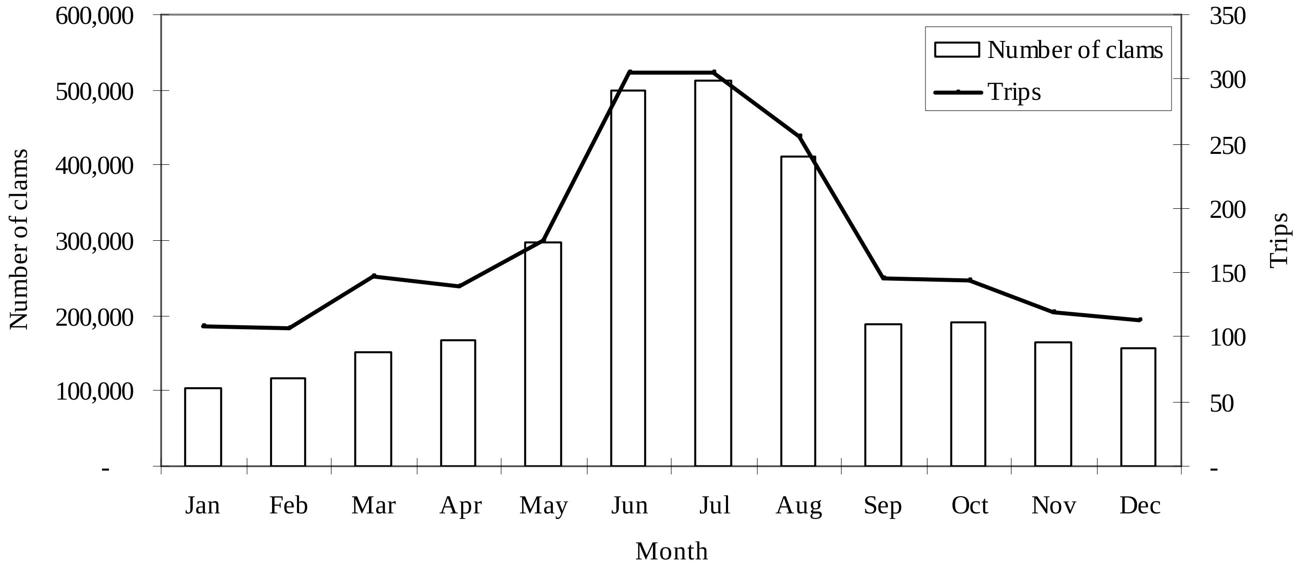


Figure 7.24. Average monthly hard clam landings (Number of clams) and average number of trips from private bottom using hand gears, 1994-2005. DMF Trip Ticket Program.

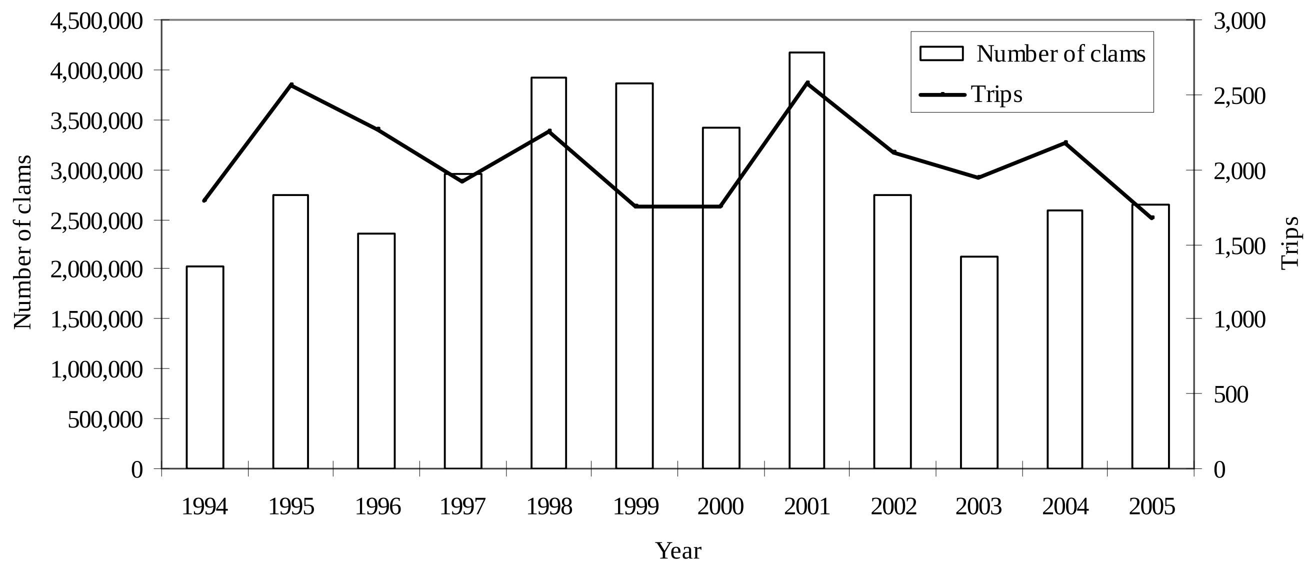


Figure 7.25. Annual hard clam landings (Number of clams) and trips from private bottom using mechanical gears, 1994-2005. DMF Trip Ticket Program.

7.1.2.5.3 MECHANICAL HARVEST

There is no mechanical harvest season for harvesting shellfish from leases or franchises. Leaseholders can harvest shellfish using mechanical methods anytime as long as they have a permit for the gear.

Hard clam harvest from private bottom using mechanical methods has average landings of 852,488 clams a year (1994-2005). Hard clam harvest is highest from April to July on private bottom with mechanical methods (Figure 7.26). Landings and trips with mechanical gears from private bottoms fluctuate from year to year from 1994 to 2005 and showed a very slight increase (Figure 7.27). Recent harvest trends are lower than in the middle of the time series.

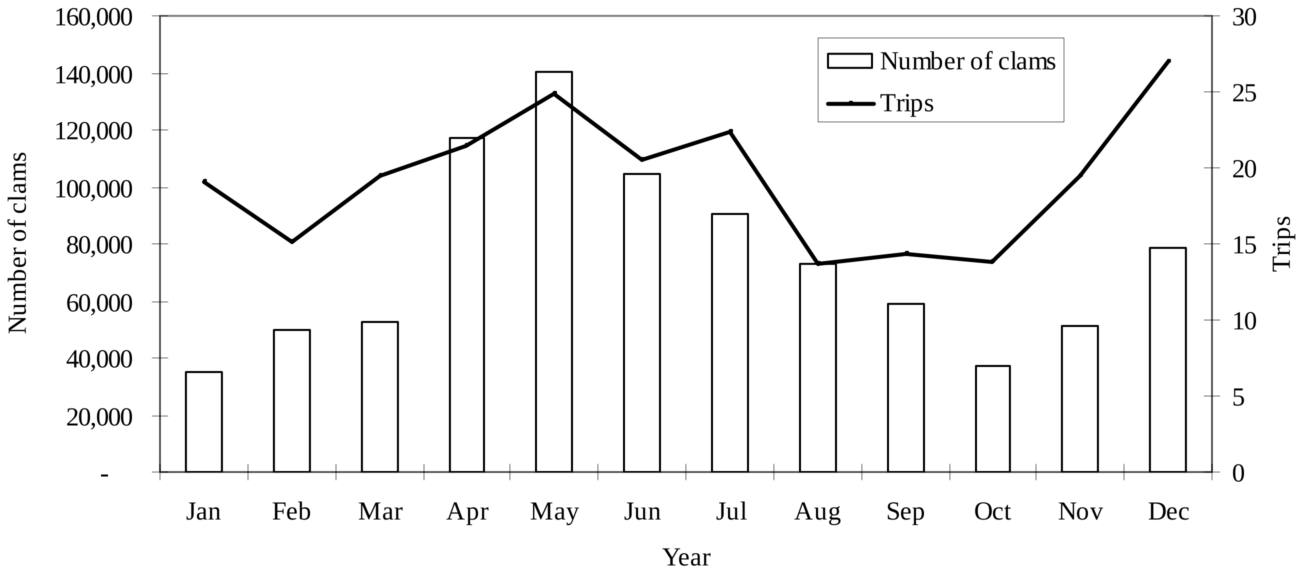


Figure 7.26. Average monthly hard clam landings (number of clams) and average number of trips from private bottom using mechanical gears, 1994-2005 combined. DMF Trip Ticket Program.

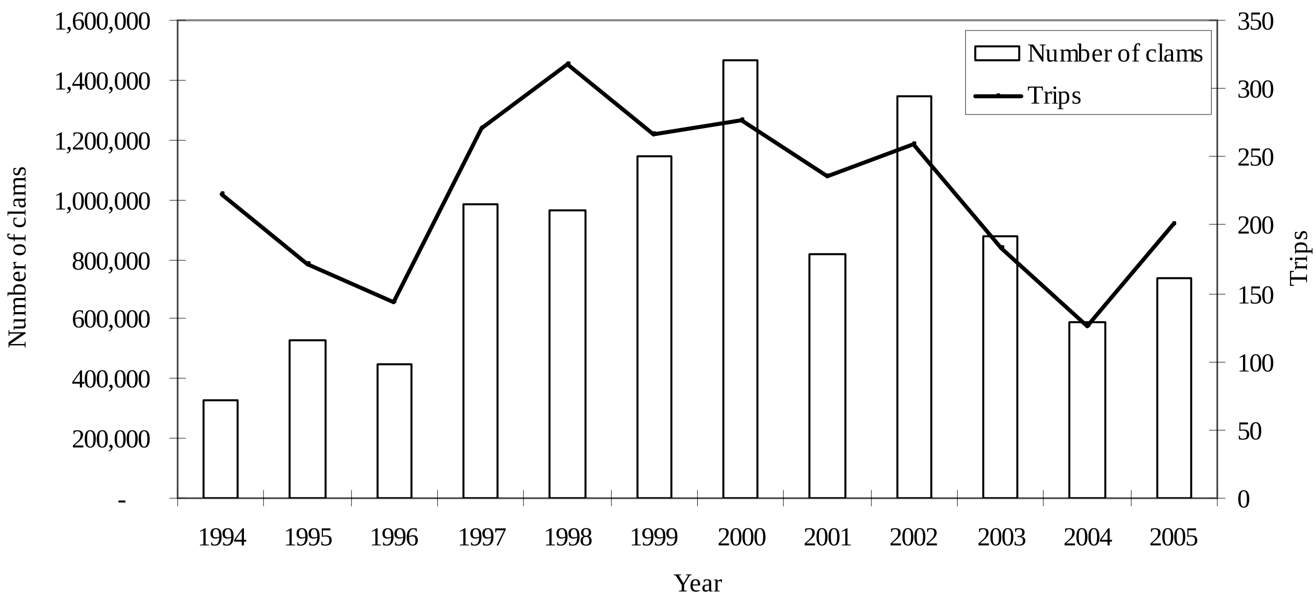


Figure 7.27. Annual hard clam landings (Number of clams) and trips from private bottom using hand gears, 1994-2005. DMF Trip Ticket Program.

7.1.2.6 HARD CLAM ENHANCEMENT AND RESTORATION ACTIVITIES

7.1.2.6.1 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). The plan was sent to the Joint Legislative Commission for Seafood and Aquaculture and awaits funding as of July 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. Flexibility in design allows for production of other shellfish species, such as bay scallops (*Argopecten irradians*) and hard clams. The 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 modern facility supports finfish and shellfish aquaculture efforts and cost $25 million. 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.

7.1.2.6.2 OYSTER RECYCLING PROGRAM

In the fall of 2003 the NC Oyster Shell Recycling Program was established. 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. The Division 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 10 – 20 bushels from small oyster roasts. Collections of oyster shells from larger oyster roasts (church, community, civic organizations, and festivals) require the utilization of trailers or dump trucks. Cooperation between volunteers, solid waste companies, DMF, and the county is needed 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. 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 7.3). During 2004, the DMF constructed five public drop off 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 drop off sites, restaurant participation, and oyster roast/festivals and a shucking house that donated their shells instead of selling them to DMF as most of the other shucking/packing houses in the state do. Between the fall of 2003 and the end of 2006, the program had collected a total of 29,951bushels from 15 counties. The program currently has 65 public drop off sites, 37 participating restaurants with 11 pending, and one shucking house. Volunteers estimate that the majority of donated oyster shell came from restaurants (Table 7.4). The number of participants and public collection sites has grown considerably since the program began due to increased public awareness, education, volunteer assistance, and support of the NC General Assembly.

Table 7.3. 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	187.5	812.8
Carteret		124.9	371.9	1,796.9
Columbus				375
Craven		8	21.5	185
Dare				3,891.5*
Edgecombe			150	217
Lenior				780
New Hanover		465.5	2,211.5	1,423.6
Onslow	20	50	70	97.5
Pamlico		59.3	173.6	496.3
Pender			21	119.9
Pitt	350		75	1,012.9
Washington				26
Wilson	6	27.50	60	
Totals	711	1,053.2	11,092.1	17,095.4

Table 7.4. 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%

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 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 (DMF) 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.

7.2 RECREATIONAL FISHERY

Hard clams are harvested recreationally year-round by hand and rakes. The limit allowed for personal consumption is 100 clams per person per day and 200 clams per vessel [North Carolina General Statute 113-169.2 (i)(1)(2)]. Recreational data are being collected by the MRFSS for finfish, but the survey does not currently collect shellfish data. Although the FRA of 1997 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, 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.

As a result of the recommendation by the Oyster and Hard Clam FMP 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 on January 1, 2007, is only required when targeting finfish. It is not required for shellfishing.

In 1985, the U. S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) and the U. S. Department of the Interior, Fish and Wildlife Service (USFWS) completed a survey in 1985 to quantify recreational shellfishing activities in the United States (USFWS 1991). Trends cannot be assessed for recreational shellfishing because of limitations with the data. The definition of shellfish included all mollusks (i.e., scallops, mussels, oysters, and clams) and crustaceans (i.e., lobsters, crabs, and shrimp). The survey indicated that 129,972 shellfish harvesters expended 1,009,000 days shellfishing in North Carolina in 1985. During 1991, the telephone survey portion of the North Carolina MRFSS included a question on the number of recreational shellfishing trips taken. Results from the survey indicated there were more than one million trips to harvest shellfish in North Carolina during that time. No data on shellfish harvest was given. Currently, no data are collected on the recreational harvest of shellfish in general and none are collected on the recreational harvest of hard clams specifically.

8.0 SOCIOECONOMIC STATUS OF THE HARD CLAM FISHERY

8.1 ECONOMIC ASPECTS OF THE FISHERY

8.1.1 EX-VESSEL VALUE AND PRICE

The value of clams to the North Carolina seafood industry has fluctuated dramatically over time. Before the mid-1970s, their economic impact was relatively small; they represented no more than 1-2% of the total value of landed seafood in the state. During the 1980s, they began accounting for larger shares of the picture, reaching a high point of 12% of the value of North Carolina seafood in 1986 and 1987 before retreating back to the 4-5% level in the past decade. Clams are, however, important to the shellfishermen than harvest them, supplementing their income when other fisheries are slow (DMF Socioeconomic Program).

The value of clam landings in the state peaked in 1989 at $8.4 million and fell sharply thereafter, reaching less than half of that peak three years later. Total landings value leveled off in the 1990s and hovered in the $4 million to $5 million range until it began dropping once again in the past few years, reaching only $2.8 million in the most recent year available (2005). In real dollar (inflation-adjusted) terms, 2005 had the least-valued landings since the mid-1970s. (see Figure 8.1). Prices for some grades of clams have dropped in recent years in real-dollar terms, but this decline in total value is largely driven by a decline in catch (see Table 8.1).[1]

[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.

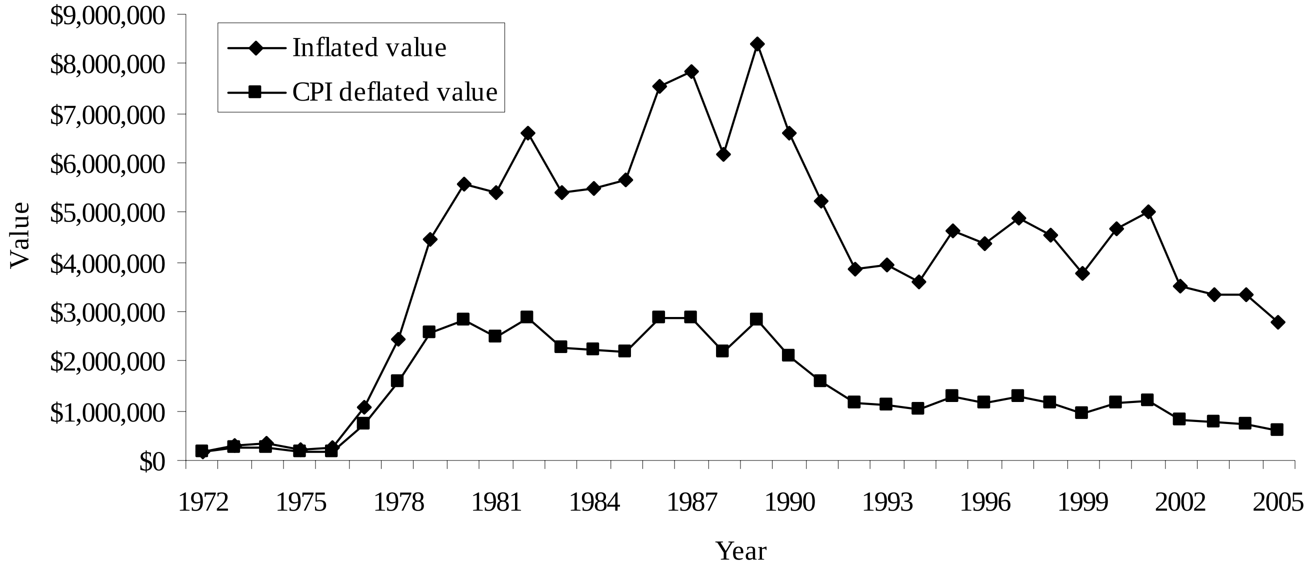


Figure 8.1 Value of clam landings in North Carolina, 1972 – 2005. DMF Trip Ticket Program.

Table 8.1. Detail values of clams landed, total value, deflated value, price per clam, and percent change from year to year for clams landed in North Carolina, 1972 - 2005. DMF Trip Ticket Program.

Year	Clams landed	% Change clams	Total value	CPI deflated value	% Change value	Inflated price per clam	CPI price per clam	% Change per clam
1972	13,707,650	---	$162,655	$162,655	---	$0.01	$0.01	---
1973	18,978,650	38%	$294,098	$276,876	70%	$0.02	$0.01	23%
1974	14,383,750	-24%	$321,983	$273,000	-1%	$0.02	$0.02	30%
1975	14,254,450	-1%	$226,087	$175,659	-36%	$0.02	$0.01	-35%
1976	15,308,950	7%	$258,163	$189,652	8%	$0.02	$0.01	1%
1977	36,953,300	141%	$1,068,880	$737,280	289%	$0.03	$0.02	61%
1978	44,611,750	21%	$2,449,054	$1,570,099	113%	$0.05	$0.04	76%
1979	72,478,500	62%	$4,473,737	$2,575,788	64%	$0.06	$0.04	1%
1980	77,085,950	6%	$5,554,047	$2,817,466	9%	$0.07	$0.04	3%
1981	72,909,800	-5%	$5,386,803	$2,477,100	-12%	$0.07	$0.03	-7%
1982	85,089,650	17%	$6,606,132	$2,861,516	16%	$0.08	$0.03	-1%
1983	67,081,000	-21%	$5,401,824	$2,267,031	-21%	$0.08	$0.03	0%
1984	69,393,200	3%	$5,506,233	$2,215,212	-2%	$0.08	$0.03	-6%
1985	69,664,700	0%	$5,653,779	$2,196,357	-1%	$0.08	$0.03	-1%
1986	67,815,800	-3%	$7,522,393	$2,868,942	31%	$0.11	$0.04	34%
1987	60,370,000	-11%	$7,822,801	$2,878,460	0%	$0.13	$0.05	13%
1988	46,998,800	-22%	$6,178,117	$2,182,969	-24%	$0.13	$0.05	-3%
1989	64,731,400	38%	$8,388,051	$2,827,585	30%	$0.13	$0.04	-6%
1990	67,742,100	5%	$6,584,756	$2,105,913	-26%	$0.10	$0.03	-29%
1991	49,220,500	-27%	$5,235,182	$1,606,686	-24%	$0.11	$0.03	5%
1992	36,111,750	-27%	$3,853,005	$1,147,937	-29%	$0.11	$0.03	-3%
1993	37,062,400	3%	$3,922,932	$1,134,800	-1%	$0.11	$0.03	-4%
1994	35,067,411	-5%	$3,582,049	$1,010,321	-11%	$0.10	$0.03	-6%
1995	37,670,136	7%	$4,628,830	$1,269,587	26%	$0.12	$0.03	17%
1996	32,860,713	-13%	$4,380,620	$1,167,049	-8%	$0.13	$0.04	5%
1997	37,229,129	13%	$4,878,022	$1,270,413	9%	$0.13	$0.03	-4%
1998	36,573,497	-2%	$4,559,846	$1,169,335	-8%	$0.12	$0.03	-6%
1999	29,386,335	-20%	$3,774,453	$947,012	-19%	$0.13	$0.03	1%
2000	34,098,364	16%	$4,680,245	$1,136,087	20%	$0.14	$0.03	3%
2001	36,800,636	8%	$5,007,241	$1,181,833	4%	$0.14	$0.03	-4%
2002	29,323,338	-20%	$3,505,642	$814,541	-31%	$0.12	$0.03	-14%
2003	26,339,256	-10%	$3,339,172	$758,573	-7%	$0.13	$0.03	4%
2004	27,186,895	3%	$3,355,546	$742,519	-2%	$0.12	$0.03	-5%
2005	21,165,143	-22%	$2,777,957	$594,565	-20%	$0.13	$0.03	3%

After unloading, dealers sort clams into a variety of grades for market, with the smaller, more tender clams going for higher prices (although this gap has been shrinking). Fishermen are paid according to the relative value of the different grades of the catch. The average price per clam has stayed remarkably consistent over the decades when adjusted for inflation—the three cents a clam landed in the mid-1970s is equivalent to the eight cents it was worth in the mid-1980s or the 13 cents it is worth today. The exception was during the late 1980s boom, when prices rose by twenty percent even with record harvests levels, indicating a relatively inelastic demand curve by clam consumers. (Figure 8.2).

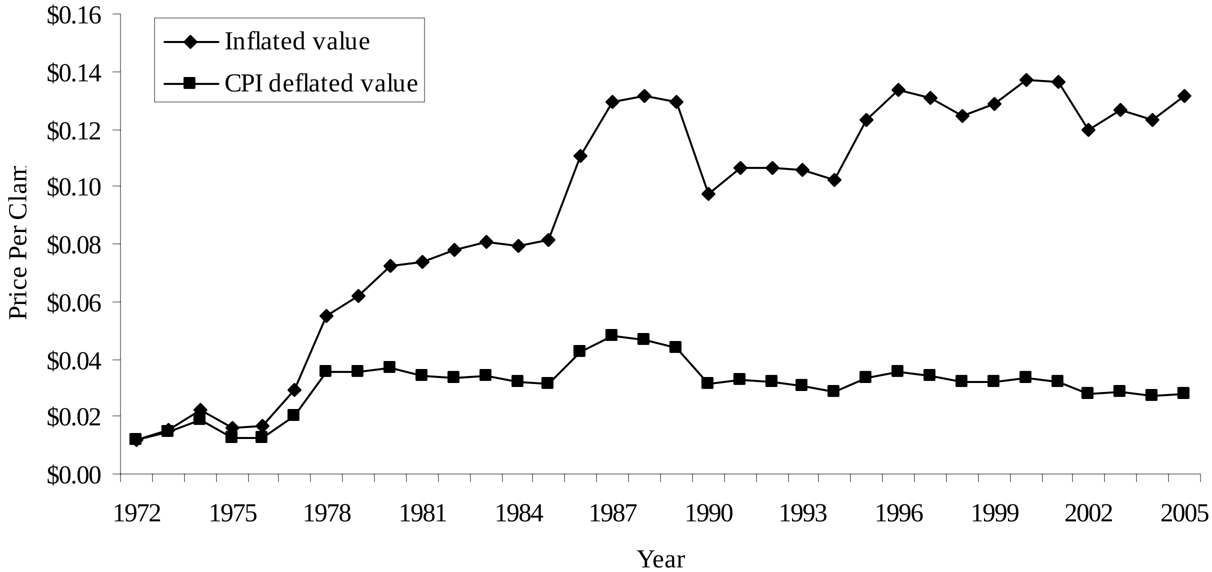


Figure 8.2. Average price per clam of clam landings in North Carolina, 1972-2005. DMF Trip Ticket Program.

In the past decade, however, price differences between grades have been closing, with the restaurant-quality littlenecks and topnecks falling in value while the larger cherries and chowders have nearly doubled in price, even while holding constant for inflation. (Figure 8.3.) The perception among many dealers is that this is largely due to aquaculture flooding the market with smaller-grade clams (see Section 8.1.3).

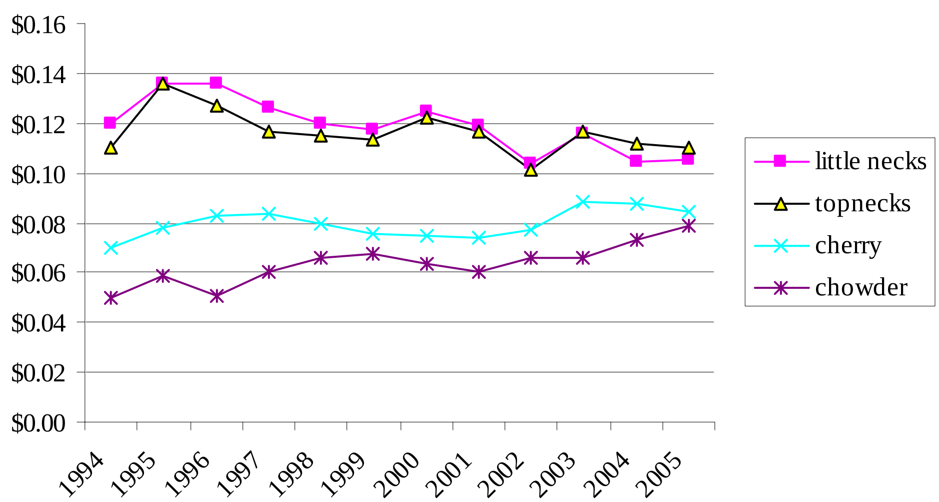


Figure 8.3. Average ex-vessel grade prices (deflated to 1994 values) in North Carolina, 1994-2005. DMF Trip Ticket Program.

8.1.2 PARTICIPANTS AND TRIPS

The Division of Marine Fisheries keeps rigorous 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 clammers participating in the fishery since 1999, broken down by the number of individual trips that they took in each year. Notice that the percentages of fishermen in each category are relatively constant, with roughly half taking ten or fewer trips in any particular year. The fleet has lost roughly a third of its participants since the high point in 2001; however, fluctuations have been common in recent years in all fisheries, and the stability of clam prices relative to inflation is a strength of this product.

Table 8.2 Number of participants and the number of trips taken that landed clams in North Carolina, 1999-2005. DMF Trip Ticket Program.

	Year						
	1999	2000	2001	2002	2003	2004	2005
1 Trip	247	195	218	186	153	145	110
% within year	17%	12%	12%	13%	13%	14%	12%
2 - 10 Trips	545	594	650	497	426	337	327
% within year	37%	36%	36%	35%	35%	32%	36%
11 - 20 Trips	220	233	238	206	163	123	126
% within Year	15%	14%	13%	15%	14%	12%	14%
21 - 50 Trips	258	286	297	237	217	211	167
% within year	17%	17%	16%	17%	18%	20%	19%
51 - 100 Trips	106	181	236	156	135	141	83
% within year	7%	11%	13%	11%	11%	13%	9%
More than 100 Trips	111	150	185	128	111	109	85
% within year	7%	9%	10%	9%	9%	10%	9%
Total	1487	1639	1824	1410	1205	1066	898

Table 8.3 breaks down participants in this fishery by annual income from clamming. Few people make their living solely from harvesting clams, with between 40% and 50% of all commercial clammers' annual catch fetching $500 or less in any given year. Fewer than 100 people have made over $10,000 a year from clams in the most recent years, although this represents an increased proportion of all clammers due to a more rapid decline in the number of lower-income clammers. There is a wide disparity between the average income from clamming ($3093 in 2005) and what the median clammer brings in ($702 in 2005), indicating most of the income is generated by a few fishermen.

Table 8.3. Number of participants in the clam 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	739	686	808	680	553	452	394
% within year	50%	42%	44%	48%	46%	42%	44%
$501 - $1,000	178	219	225	168	164	115	122
% within year	12%	13%	12%	12%	14%	11%	14%
$1,001 - $2,000	198	219	204	147	130	124	88
% within year	13%	13%	11%	10%	11%	12%	10%
$2,001 - $5,000	209	248	283	213	153	172	133
% within year	14%	15%	16%	15%	13%	16%	15%
$5,001 - $10,000	88	169	171	114	111	106	77
% within year	6%	10%	9%	8%	9%	10%	9%
> $10,000	75	98	133	88	94	97	84
% within year	5%	6%	7%	6%	8%	9%	9%
Total	1487	1639	1824	1410	1205	1066	898

As with any commercial fishery in the state, clam fishermen may only sell their catch to licensed dealers. The number of dealers who deal in clams has remained stable for the past decade, hovering between 85 and 95 dealers in any single year (Figure 8.4). Most of the dealers are spread out from Carteret County to the South Carolina border.

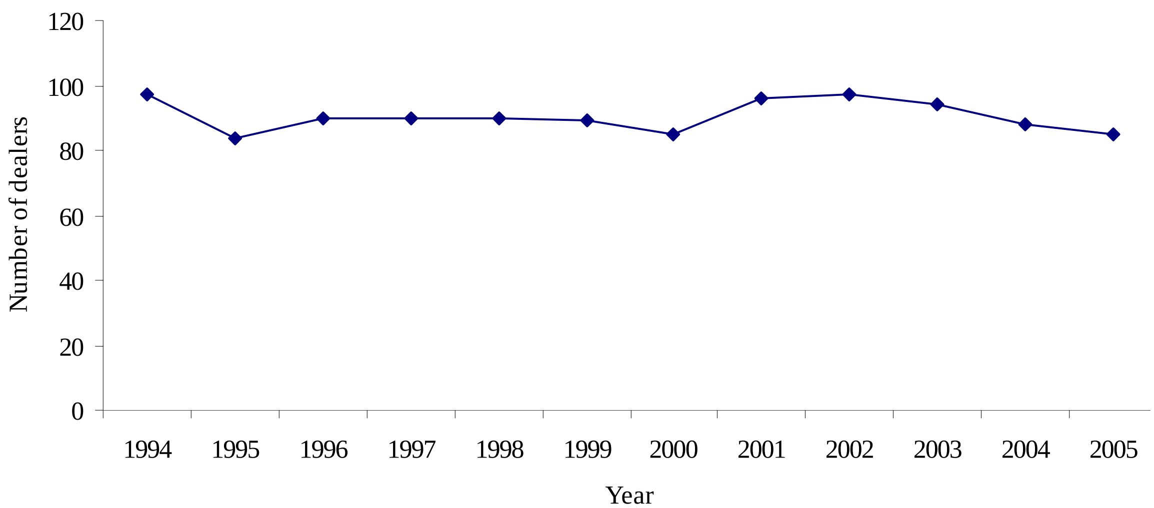


Figure 8.4. Number of dealers who purchased clams from 1994-2005. DMF Trip Ticket Program.

8.1.3 PROCESSING, MARKETING, AND DISTRIBUTION

As mentioned previously, the markets for clams have undergone significant changes in the past decade, with the smaller grades falling in value and prices for the larger grades rising. In a series of interviews in Onslow County in January 2006, the consensus among clam dealers was that the increase in clam aquaculture had “destroyed the markets for littlenecks” in recent years and that this trend was accelerating, but that the supply for the larger grades was currently unable to meet demand and had led accordingly to price increases for cherries and chowders. Clam dealers ship what fishermen bring them and not what dealers might wish for, and currently have to ask restaurants, wholesalers, and markets to take a number of smaller clams along with the more-desired large grade clams. This is the opposite of what was historically the case, when dealers had difficulty getting rid of the large clams without including smaller grades along with them. Dealers have limited information about what happens to the clams post-sale, but have heard that the cherries are now going to supermarkets and being processed as “prepared” or “ready to cook” meals like Clams Casino before being sold to the consumer. Small grades are sold to restaurants, markets, or dumped back into the water if there is no buyer for them.

Many of the dealers ship out of state, with the most commonly mentioned destinations being the Baltimore/D.C. area, followed by Philadelphia, New York, and Florida. None of the interviewed dealers had bought out-of-state or cultured clams.

8.1.4 ECONOMIC IMPACT OF THE COMMERCIAL FISHERY

Table 8.4 shows the economic impact of the clam harvest to North Carolina’s economy over the past half decade. These impacts were calculated using IMPLAN, an economic modeling software. Trip ticket data includes crew sizes (on average between 1.1 and 1.2 for clamming trips), so the number of fishermen actually involved is slightly larger than the “participants” number than DMF uses to indicate the 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 clamming 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	$4,680,245	1841	$ 7,827,636	40.4
2001	$5,007,241	2039	$ 8,374,535	43.2
2002	$3,505,642	1592	$ 5,863,520	30.3
2003	$3,339,172	1364	$ 5,584,743	28.8
2004	$3,355,546	1242	$ 5,961,658	25.8
2005	$2,777,957	1047	$ 4,935,231	21.3

In 2005, the clam harvest accounted for slightly more than 4% of the total value of seafood landed in North Carolina.

8.1.5 RECREATIONAL FISHERY ECONOMICS

The DMF collects data about recreational fishing in conjunction with the federal government's MRFSS. However, MRFSS collects information about finfish only. Beginning in 2007, the state required a CRFL for recreational saltwater finfishing in state waters, but specifically exempts recreational shellfish gathering from this requirement. Currently, the DMF has almost no data about recreational clamming, including the number of participants and the effect of their economic activity.

8.2 SOCIAL ASPECTS 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 cost since 2001. Data from these interviews are added to a growing database and used for fishery management plans, among other uses. In of the current database, 273 of the fishermen reported that they commercially harvest clams. That group is used to provide a snapshot of the North Carolina commercial clammer in this section.

8.2.1.1 DEMOGRAPHIC CHARACTERISTICS OF COMMRCIAL FISHERMEN

Table 8.5 shows the demographic characteristics of the 273 clam harvesters surveyed by the Socioeconomic Program over the past five years. Nearly all were white males, with an average age of 47 and almost 23 years of commercial fishing experience. Two thirds of them had a high school diploma and 21% had at least some college education. About 67% had $30,000 or less in household income when surveyed, with less than 10% bringing in $50,000 or more. Almost 20% had less than $15,000 in annual household income (Table 8.5).[2]

Fishing accounted for 60% of the household income from these fishermen, and a third reported that fishing was their sole source of income. Almost 20% supplemented their income with social security or pensions. Only 59% fished all year long, and were least likely to fish from May through October, which is the peak season for the rest of the commercial fishing population. A tenth held a shellfish lease. The average number of vessels was 1.19, and almost everyone had at least one—only 37 clammers did not have a registered commercial fishing vessel.

[2] The refusal rate on the household income question was 10.6%.

Table 8.5. Demographic characteristics of clam harvesters. DMF Socioeconomic Program.

Variable	n = 273	Average or %
Years Fishing		22.8
Age		47.3
Gender		
	Male	96.0%
	Female	4.0%
Race		
	White	97.8%
	Black	1.4%
	other	0.8%
Education Level		
	Less than HS	33.7%
	HS Grad	45.4%
	Some College	15.4%
	College Graduate	5.5%
Marital Status		
	Married	69.6%
	Divorced	10.3%
	Widowed	3.7%
	Never Married	2.6%
	Separated	13.9%
Total Household Income		
	Less than $15,000	20.1%
	$15,001 - $30,000	46.7%
	$30,001 - $50,000	23.0%
	$50,001 - $75,000	8.2%
	More than $75,000	1.9%

8.2.1.2 HISTORICAL IMPORTANCE OF THE COMMERCIAL FISHERY

A historical overview of the clam fishery can be found in Section 7.0, Status of the Fisheries. The socioeconomic interviewers asked clammers how important commercial fishing has historically been in their communities. Almost all of them felt it had been vital, giving it a 9.2 on a 10-point scale. Perceptions of current community support were somewhat lower, at 7.4 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 8.5.

8.2.1.3 COMMUNITY RELIANCE ON THE COMMERCIAL FISHERY

North Carolina coastal communities have historically been strongly dependent on the tourism and fishing industries, but the latter has been decreasing in recent years, and fewer fishermen make their entire living from commercial fishing. Still, the average clam harvester reported 60.2% of his income came from commercial fishing. Few of them only harvest clams, and clams represented only 59% of their commercial fishing income. The other species they are most likely to target was oysters, with a third of them participating in that fishery as well. Flounder and shrimp were also well represented, as can be seen in Table 8.6.

Table 8.6. Prevalent species targeted by clam harvesters. DMF Socioeconomic Program.

Species	% Who land	% Income
Clams	100.0%	59.0%
Oysters	33.0%	28.8%
Flounder	29.9%	32.8%
Shrimp	26.4%	39.8%
Spot	13.7%	13.1%
Striped mullet	11.8%	28.7%
Blue crabs	7.7%	28.3%
Scallops	6.5%	12.5%
Atlantic croaker	1.3%	10.0%
Weakfish	1.3%	3.5%

8.2.1.4 PERCEIVED CONFLICTS

Fishermen were asked about conflicts in the previous year with recreational users and with other commercial fishermen. Conflicts with other users of a public resource are to be expected, and part of the job of the DMF to balance the needs of different user groups. Clams have low mobility compared to finfish and it is conceivable that arguments over clam beds would be more common than disagreements over fish that move around the sounds and ocean. This was not the case—69% of clammers reported no conflicts at all with other commercial fishermen, and another 9% reported having had only one (Figure 8.5).

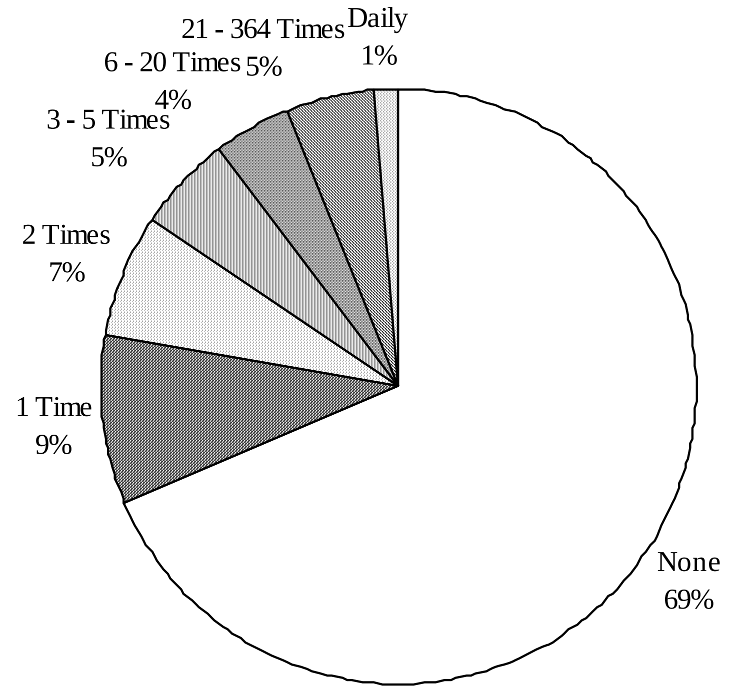


Figure 8.5. Frequency of conflict experiences with other commercial fishermen in the past year. DMF Socioeconomic Program.

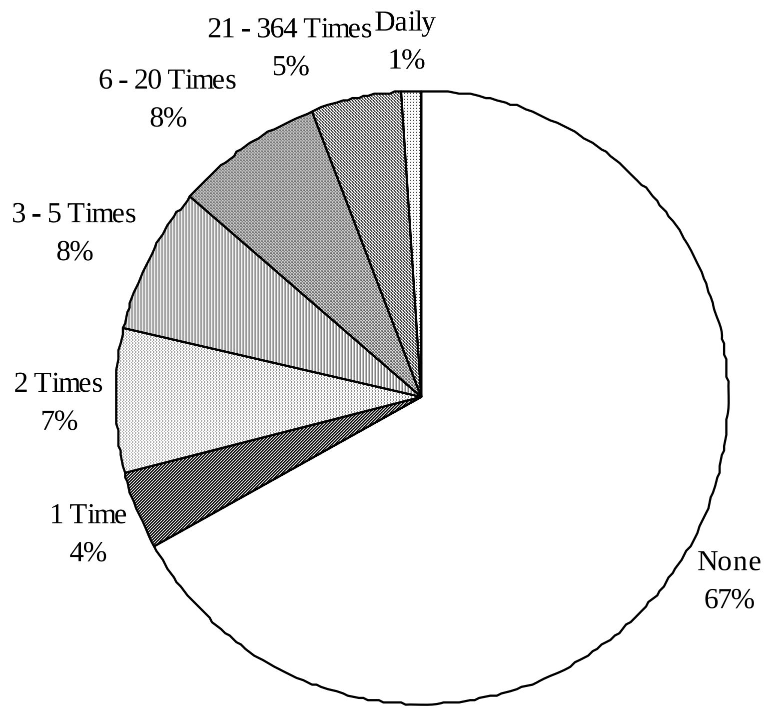


Figure 8.6. Frequency of conflict experiences with recreational fishermen in the past year. DMF Socioeconomic Program.

A slightly larger percentage reported having had conflicts with recreational fishermen, but again, the numbers are relatively low, with two-thirds reporting no conflict in the previous year (Figure 8.6.). Perceptions of conflicts with federal regulations were nearly non-existent, unsurprising since authority and management of hard clams 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 8.7.

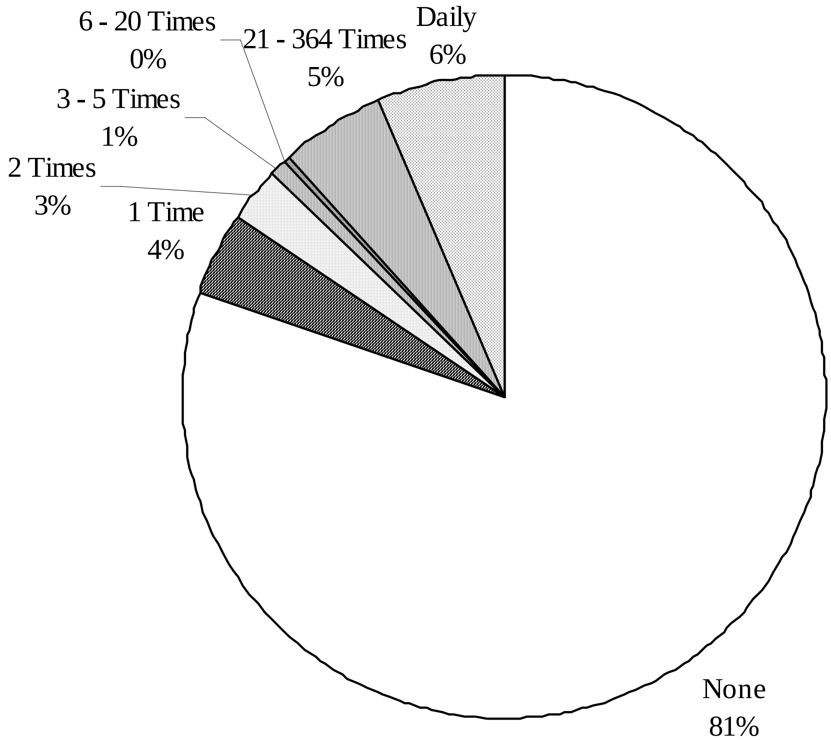


Figure 8.7. Frequency of conflict experiences with federal regulations in the past year. DMF Socioeconomic Program.

Reported conflicts with state regulations are quite different (Figure 8.8). The Division of Environmental Health is responsible for classifying coastal waters as to their suitability for shellfish harvesting, monitoring and issuing advisories for coastal recreational swimming areas, and certification of shellfish and crustacean processing plants. Shellfish harvesting is closed when high levels of contaminants are found to prevent human illness associated with the consumption of shellfish.

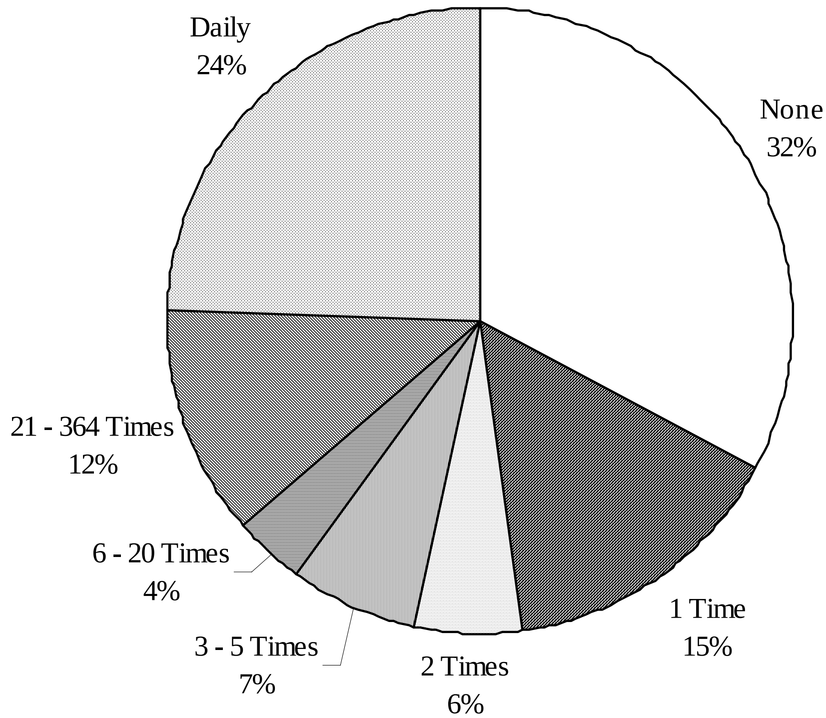


Figure 8.8. Frequency of conflict experiences with state regulations in the past year. DMF Socioeconomic Program.

8.2.1.5 PERCEPTION OF IMPORTANT ISSUES

The commercial clammers were also asked to rate the seriousness of a number of issues facing themselves and their businesses. As with most of the fishermen in the survey, they found the most important issue to be keeping up with rules and proclamations. The second most important issue to them was area closures (an issue that for shellfishermen has a strong relation to the first), followed by overharvesting. Other fishermen tend to rank the related issues of imported seafood and low prices higher than shellfishermen do, although these are still important issues to the clam harvesters in the state (Table 8.7).

Table 8.7. Fishing related issues considered most important to clam harvesters. DMF Socioeconomic Program.

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

8.2.2 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.

8.3 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 clammers for demographic and spending data.

8.4 DEFINITIONS AND ACRONYMS

<u>CPI (Consumer Price Index)</u> – 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.

<u>Deflated (Inflation-adjusted) price and value</u> – 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.

<u>Elasticity</u> – The relationship between the price of a good or service and the supply of it. For example, if a large increase in the number of clams in the market led to a large decline in the price per clam, then the consumers' demand curve for clams would be considered fairly elastic. If the large increase in supply did not lead to any decline in price at all, then consumer's demand curve for clams would be considered inelastic.

<u>Inflated (Ex-vessel) price and value</u> - The total landed dollar amount of a given species (or species landing condition and market category). Example: 100 clams at a PRICE of $.14 per clam will have a VALUE of $14. These values represent the amounts paid to a fisherman by a seafood dealer.

9.0 ENVIRONMENTAL FACTORS

The CHPP provides information on many aspects of clam habitat. 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 clams, some habitats are of particular importance because they are actually inhabited by clams. Those habitats include soft bottom, shell bottom, and submerged aquatic vegetation (SAV). The importance of each habitat to clams will be discussed in the following sections.

Threats to clam habitat include mobile bottom disturbing fishing gear, hand harvest methods, water-dependent development, and dredge material disposal. 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 MFC. Those threats include fishing activities and associated turbidity/ sedimentation, and microbial contamination (causing shellfish harvest area closures). For information on the other threats, consult Street et al. 2005.

9.1 HABITAT DESCRIPTION AND DISTRIBUTION

Hard clams occur extensively in estuarine systems. Juvenile and adult habitats for hard clams include intertidal sand flats, shell bottom, and SAV. Hard clams may also be found in shallow subtidal flats and deeper channels (Pattilo et al. 1997). On mudflats, suspension feeding hard clams cannot compete with deposit feeders that tend to resuspend sediment particles and clog the feeding apparatus of the hard clam. On the other hand, deposit feeders are not found on sand flats because the larger sediment particle size has fewer bacteria to ingest (Peterson and Peterson 1979).

The filtering activity of dense aggregations of suspension feeders clears significant amounts of plankton and sediment from the water column, thus improving water clarity (Joergensen 1990; Miller et al. 1996). Work done in the Chesapeake Bay seems to indicate that based on bivalve abundance, filtering capacities, and water mixing parameters, bivalves could consume more than 50% of the primary production in shallow freshwater and low salinity areas. However, in deeper more saline systems, primary production was reduced by 10%. Estuary width may also influence the ability of bivalves to filter primary production because of the low transport of water to the banks of an estuary where bivalves can be abundant. These results suggest that by using bivalves to improve water quality may be limited by depth and width of the estuary, unless the bivalves are suspended in the water column by artificial means (Gerritsen et al. 1994). The intertidal flats inhabited by hard clams also provide a low tide breakwater for adjoining seagrass beds (Giuseppe Di Carlo, NOAA, personal communication, 2007).

While hard clams commonly inhabit soft bottom habitat, they are more abundant in structured habitats. Peterson et al. (1983) found higher abundances of hard clams in seagrass beds than in sand bottom. He also found that growth rates were higher in seagrass beds compared to sand bottom. The higher growth rates are possibly due to the refuge from predation provided and the baffling effect of grassbeds on current flow. This baffling effect slows current on the bottom of the seagrass bed creating a concentration of food particles on the bottom where the hard clam feeds. Thus, restoration efforts targeting these SAV beds will also benefit hard clams.

Shell bottom also provides significant protection for adult and juvenile hard clams. Peterson et al. (1995) reported that young clams survived better in shell bottom than open soft bottom areas. Specifically, clams are most abundant in the scattered shells forming the perimeter of oyster beds (Noble 1996). The DMF specifically manages some intertidal oyster cultch planting sites in the southern coastal area to take advantage of this hard clam–oyster shell relationship. After oysters are harvested off the planted site, the areas are opened specifically for clam harvest by hand gears. Fishermen dig under the cultch to take high concentrations of hard clams that recruited under the oyster shell. Once the clam harvest is over, the areas are re-planted with cultch, and the two-year cycle begins again. Shell bottom as clam habitat is a major focus of this section.

In order to identify the threats to clam habitat, the current distribution of clam habitat must be documented. The DMF shellfish habitat and abundance mapping program has been ongoing since 1988. Maps are 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, SAV, and intertidal/subtidal 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 was completed from Carolina Beach north to 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 2% (6,736 acres) of the bottom was classified as intertidal soft bottom, 75% (309,814 acres) was classified as subtidal soft bottom, and 4% (14,600 acres) was classified as shell bottom (Table 9.1). The majority of intertidal soft bottom was located in Core and Bogue sounds and the southern estuaries. The southern estuaries also had the greatest relative area of shell bottom (17% - mostly intertidal) among the areas mapped to date. 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. However, the estimate does not account for shell bottom in deep water outside of shellfish mapping areas. While the distribution of bottom types shows an area within which hard clams may occur, more factors are needed to adequately predict actual clam habitat.

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 classified as shellfish leases. For more information on shellfish leases, consult "Private Culture and Lease Program" section 7.1.2.5.

Table 9.1. Shell bottom and soft bottom habitat mapped within Coastal Habitat Protection Management Units by the DMF Shellfish Habitat and Abundance Mapping Program (January 2007).

		Total area mapped		Subtidal soft bottom		Intertidal soft bottom		Shell bottom	
Management unit	Mapping area	Acres	% complete	Acres	% mapped	Acres	% mapped	Acres	% mapped
Albemarle	61,408	49,354	80	47,030	95	163	0	319	1
Cape Fear	17,251	6,218	36	4,989	80	130	2	785	13
Coastal ocean	264	246	93	153	62	3	1	2	1
Core/Bogue	152,235	152,235	100	113,684	75	1,290	1	7,533	5
Neuse	20,594	20,594	100	20,469	100	0	0	43	0
New/White Oak	34,511	34,511	100	30,151	87	436	1	679	2
Pamlico	223,587	90,039	40	57,649	64	360	0	658	1
Southern estuaries	30,820	25,896	84	6,564	25	4,336	17	4,387	17
Tar/Pamlico	43,482	30,036	69	29,125	97	0	0	194	1
Total	584,152	409,129	70	309,814	76	6,736	2	14,600	4

[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. Estimates for overall shell bottom coverage are probably underestimated.

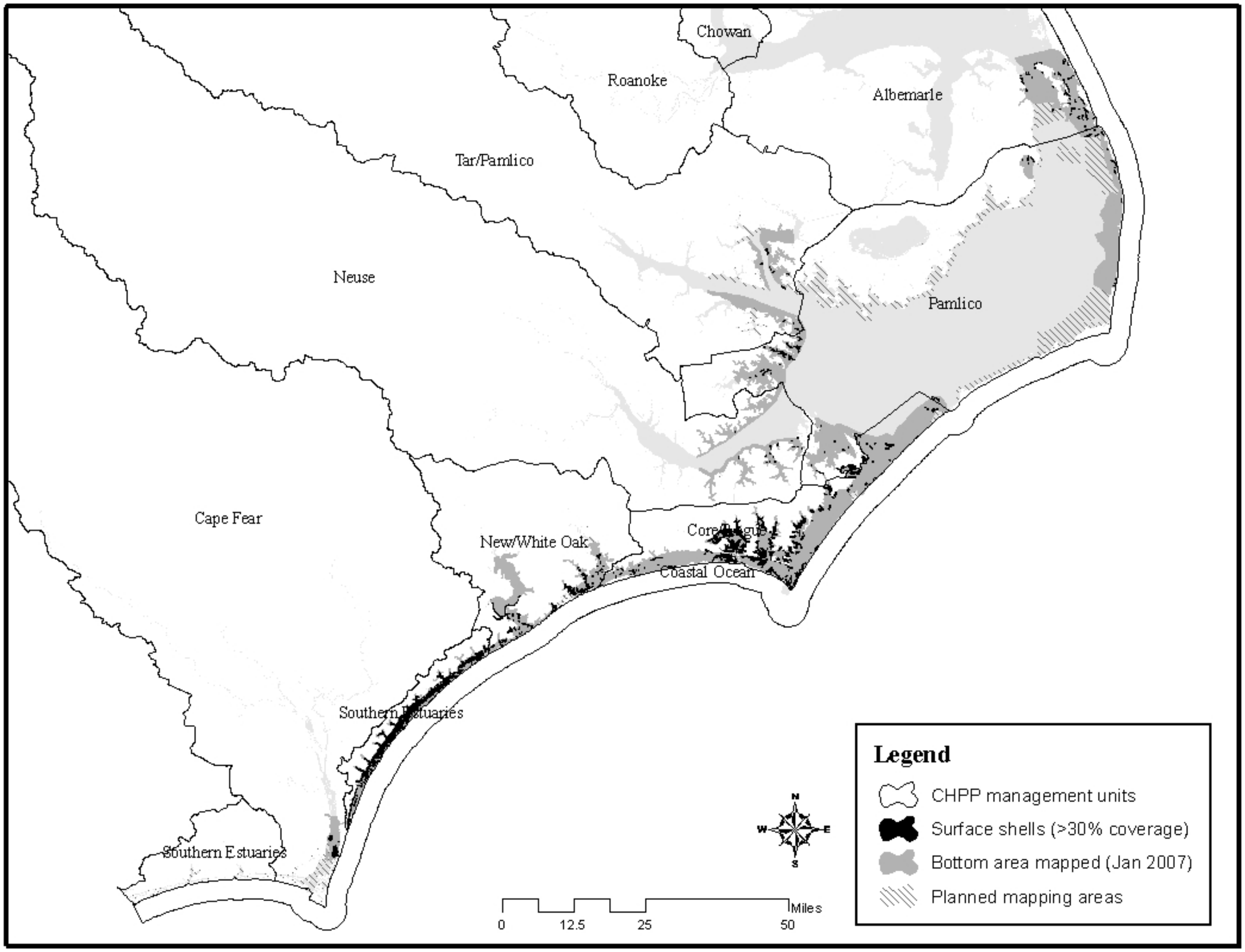


Figure 9.1. Distribution of mapped shell bottom based on DMF bottom mapping, January 2007.

The amount of SAV in North Carolina was estimated to be between 134,000 and 200,000 acres around 1990 (Ferguson and Wood 1994). However, the current spatial distribution and acreage of SAV may be somewhat different since some areas that historically supported SAV were not mapped, and changes may have occurred in mapped areas since the original mapping. Along the Atlantic coast, North Carolina supports more SAV than any other state, except Florida. The majority of SAV occurs in eastern Pamlico Sound and Core Sound in high salinity waters (Ferguson and Wood 1994) (Figure 9.2.). Bogue Sound was mapped in 1981 (Carraway and Priddy 1983), and seagrass beds south of Bogue Sound have not been mapped at all. Because light is the primary limiting factor affecting its distribution, SAV is restricted to relatively shallow waters, usually less than 1 m in depth at low tide.

Changes in the amount or condition of high salinity seagrass beds will have a direct impact on hard clam populations. Although there are reports of large-scale losses of SAV in North Carolina's low salinity tributaries on the mainland side of Pamlico Sound (North Carolina Sea Grant 1997; J. Hawkins, DMF, personal communication, 2003), the high salinity grass beds inhabited by hard clams appear relatively stable (Ferguson and Wood 1994). However, temporary loss of SAV from prop scouring and boat groundings is a growing problem in coastal North Carolina. Protection, enhancement, and restoration of this habitat should therefore be high priorities for management of hard clam populations.

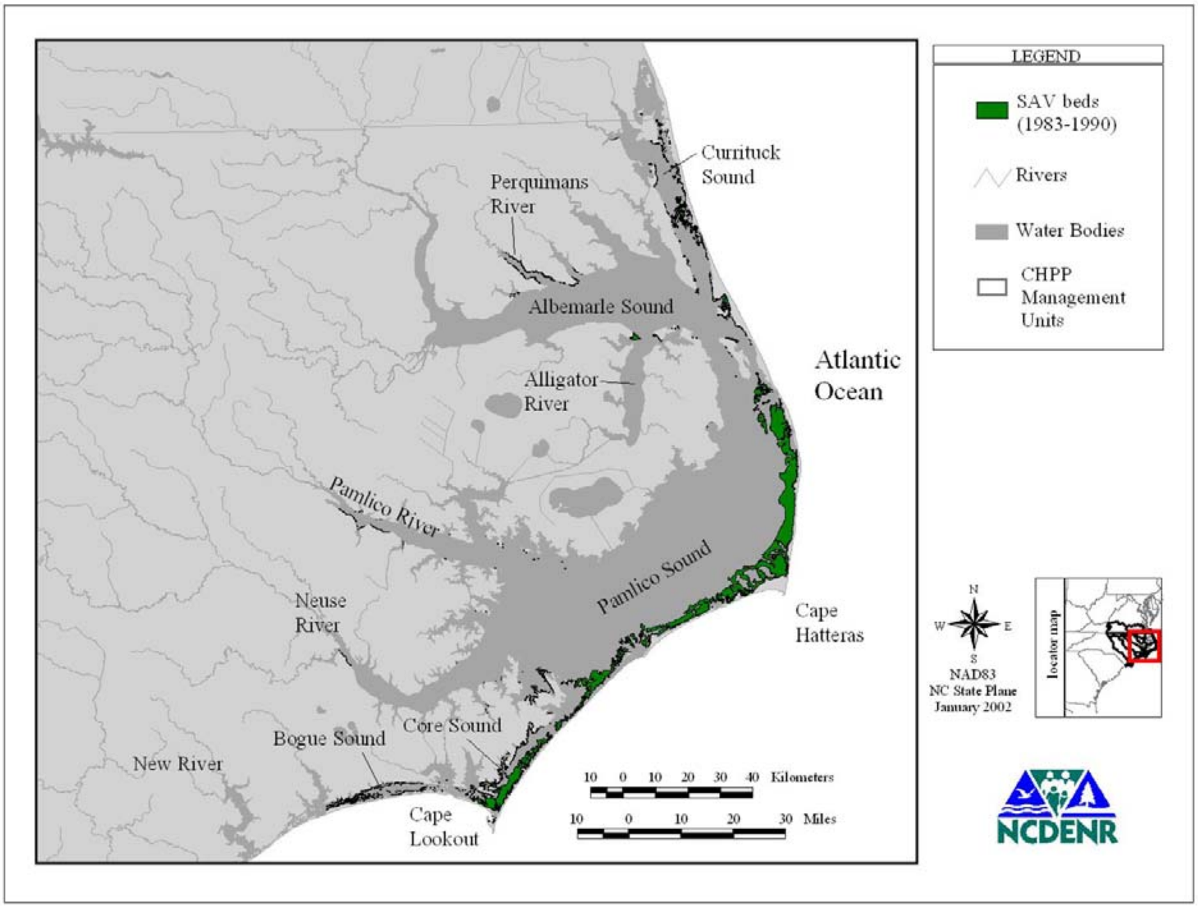


Figure 9.2. Mapped distribution of submerged aquatic vegetation in North Carolina based on aerial photography spanning the year 1983-1992 (Carroway and Priddy 1983; Ferguson and Wood 1994).

9.2 PHYSICAL THREATS

Mobile Bottom Disturbing Fishing Gear

Soft bottom habitat, because of its low structure and dynamic nature, has historically been considered the most appropriate location to use bottom disturbing gear. There are some fishery rules that restrict bottom disturbing gears in soft bottom habitat, based on DMF research. These include prohibition of trawls, dredges, and long haul seines in PNAs [15A NCAC 03N .0104] and prohibition of trawls or mechanical shellfish gear in crab spawning sanctuaries [15A NCAC 03L .0205] in the five northern-most inlets of North Carolina during the blue crab spawning season (March-August).

Fishing related impacts to fish habitat have been reviewed and compiled in federal fishery management plans for managed species and have been summarized in fishery management plans by the South Atlantic Fisheries Management (SAFMC) and Mid-Atlantic Fisheries Management Council (MAFMC), as well as by the Moratorium Steering Committee (MSC 1996), Auster and Langton (1999), DMF (1999), and Collie et al. (2000). The gears with the greatest potential for damage to soft bottom or other habitats include dredges and trawls. However, research suggests that neither activity has a significant effect on clam recruitment (Godcharles 1971; Peterson et al. 1987). Dredges and trawls have a greater impact on structured habitat where clams are more abundant.

Of the factors affecting the condition of structured clam habitat, mechanical shellfish harvest of clams and oyster harvest are the most obvious. Both Chestnut (1955a) 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 acres 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 (DMF 2007d).

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).

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. One of the recommendations of the CHPP is to protect habitat from fishing gears effects by establishing protective buffers around habitats and further restriction on mechanical shellfish harvesting. Modifying clam kicking and hydraulic dredging areas to avoid all SAV and oyster beds and allow a buffer of 50-100 feet between mechanical shellfish gear and SAV and shell bottom is an implementation action of CHPP. Refer to the issue paper 10.18 for further discussion on the effects of mechanical clam harvest on fish habitat.

Other fishing gears also impact clam habitat. Shrimp and crab trawling can result in removing oysters and cultch material from rocks and firm bottom and deposited on unsuitable bottoms where they will be covered by sediments (Berrigan et al. 1991; Chestnut 1955a). However, commercial fishermen generally avoid oysters beds because they damage towed nets. Intentional disturbance of clam 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 clam 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. Conrad, DMF-Resource Enhancement, personal communication, March 2007). However, restoration and enforcement of these areas will be an additional burden on already limited enforcement capabilities.

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 2001a). 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 issue paper regarding this topic is found in section 10.9 and contains more background, discussion, and development of the recommendations.

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). *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.*

9.3 WATER QUALITY DEGRADATION

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 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 2000). 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.

Organisms in soft bottom habitat are adapted to shifting and changing sediments. Shoreline erosion and stormwater runoff transport sediment into coastal waters, which helps maintain shallow water habitat. However, when sedimentation is excessive, there can be negative impacts. 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 clam beds and oyster reefs indirectly by re-suspending sediment. High levels of suspended sediment in an estuarine or marine habitat can greatly reduce successful settlement of larval clams and oysters, and can smother other benthic invertebrates (Coen et al. 1999; AFS 2003). 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 such bacteria would live in clear waters (Schueler 1999). While fecal coliform bacteria do not affect the viability of clams or oysters, pathogenic bacteria can make shellfish 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 downstream clam and 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. Pate, DMF-Director, personal communication, 2004; C.H. Peterson, UNC-IMS, personal communication, 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 function 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 2000). 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.*

Chemical Contamination

Marine bivalves have been shown to accumulate chemical contaminates such as hydrocarbons and heavy metals in high concentrations. Exposure to organic contaminates has resulted in impairment of physiological mechanisms, histopathological disorders, and loss of reproductive potential (Capuzzo 1996). Reductions in growth and increased mortality have been observed in soft-shelled clams (*M. arenaria*) following oil spill pollution events (Appeldoorn 1981).

Increased respiration, reduction in shell thickness, inhibition of shell growth, and general emaciation of tissues has been attributed to adult bivalve exposure to heavy metal contamination. Early developmental stages of bivalve molluscs are most sensitive to metal toxicity. Metals such as mercury, cadmium, and copper are capable of adversely affecting genetic development in bivalve embryos (Roesijadi 1996).

Hackney et al. (1998) studied North Carolina's estuaries and found widespread contamination of surface sediments by several chemical contaminants including heavy metals, DDT, and hydrocarbons. Although attributing direct impacts to the hard clam fishery from such chemical contaminates may be difficult at best, the presence of these contaminants in many of the State's estuaries is a cause of concern for clam stocks in those areas.

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 2000). 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. (1997; 2000; 2001), studying water quality in several tidal creeks in New Hanover County, 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 tend to be associated with suspended particulate matter, and survive longer when in association with sediment particles (Mallin 1998; 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 nonpoint 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 2001a and 2001b), 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. Gilbert, DEH, personal communication, 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; and DMF 2001a and 2001b) 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 are 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 9.2). 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 1998).

Table 9.2. Primary causes of fecal coliform impairment in localized North Carolina studies.

Waterbody, CHPP MU*	Primary causes of	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. 2001b
N.E. Cape Fear River, Cape Fear MU	Swine waste lagoon spills and ruptures	Mallin et al. 1997

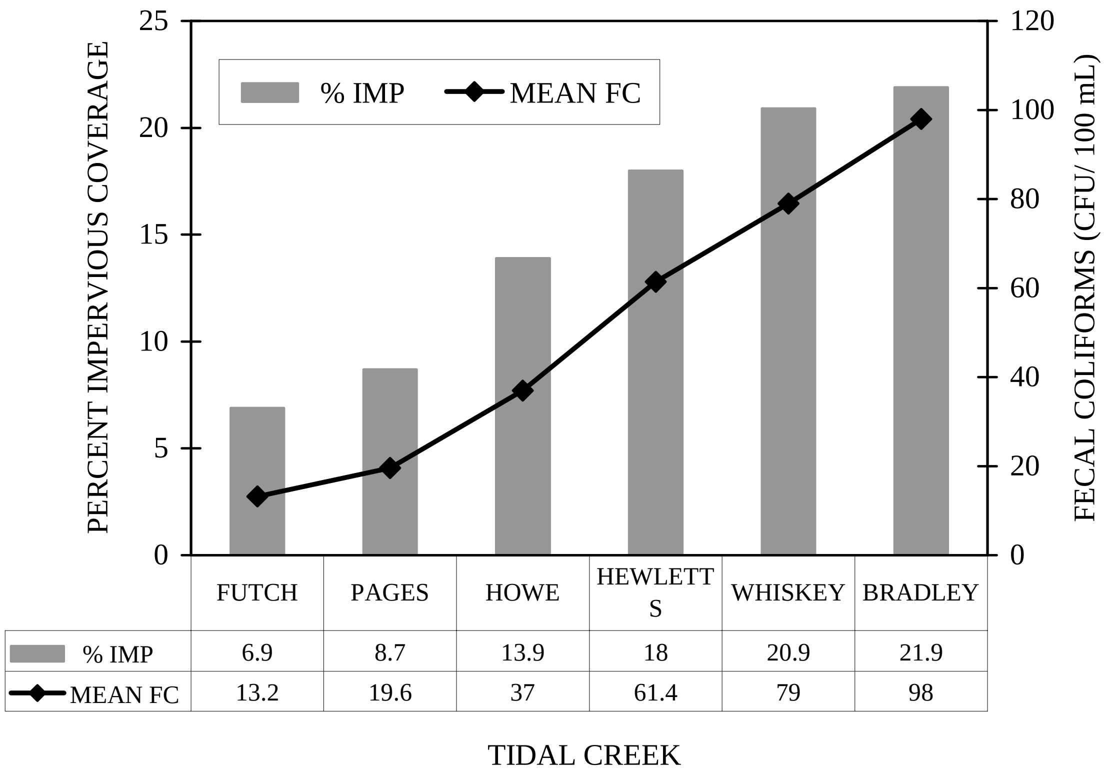
* CHPP MU means CHPP management unit.

Some recommendations from the above referenced bacteria tracking studies for reducing fecal coliform contamination include:

- Improve enforcement of existing Forestry Practice Guidelines and Best Managements Practices (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.

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 North Carolina State University (NCSU) and NOAA to determine accurate and cost effective methods of bacterial source tracking (M. Fulton, personal communication, 2003). DENR should continue supporting 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 9.3).



	FUTCH	PAGES	HOWE	HEWLETTS	WHISKEY	BRADLEY
% IMP	6.9	8.7	13.9	18	20.9	21.9
MEAN FC	13.2	19.6	37	61.4	79	98

Figure 9.3. Percent watershed impervious surface coverage versus geometric mean fecal coliform bacteria counts for six New Hanover County tidal creeks (Mallin et al. 2001).

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, a list of impaired waters, because of fecal coliform contamination. The DWQ 305(b) report which is an assessment of water quality in the state, 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.

Trends in shellfish harvest closures reflect trends in fecal coliform contamination. Over 364,325 acres 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 2001a and 2001b). 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 9.4). 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 9.4. 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 the "Water Quality" issue paper of this document.

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 9.3). 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 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, there is nothing in rule or policy stopping a marina permit in conditionally approved closed areas (S. Jenkins, DEH-SS, personal communication, May 2007). 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. Reeder, DWQ, personal communication, June 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 9.3. Area of shell bottom mapped by January 2007 in different shellfish harvest water classifications. Resource Enhancement Shellfish Mapping Program and DEH, 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	
Area	Acres	% mapped	Acres	% mapped	Acres	% mapped	Acres	% mapped	Acres	% 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 Management Unit (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 will become more difficult as population pressures and associated infrastructures increase. For more information regarding shellfish closures consult section 10.21 in the plan.

Red Tide

The first recorded red tide (*Karenia brevis*), a toxic dinoflagellate, was recorded in North Carolina in October of 1987 causing 358,993 acres (145,280 hectares) of shellfish growing waters to be closed between 2 November 1987 and 21 January 1988. These closures affected 98% of the clam harvesting areas. This red tide normally occur in low concentrations (<1000 cell/l) in the Gulf of Mexico but blooms (>5,000 cells/l) can occur offshore of which 25% can move to nearshore waters (Tester and Fowler 1990).

There have been three documented cases of *K. brevis* on the Atlantic coast of Florida. Each of these occurrences happened after a bloom on the west coast and it is believed the Florida Current-Gulf Stream system transported these cells to the Atlantic coast . In August of 1987, a *K. brevis* bloom occurred off the coast of Naples Florida. By 19 October, an intrusion of the gulfstream water containing *K. brevis* cells moved shoreward onto the continental shelf and continued to move shoreward east of Cape Lookout (Tester and Fowler 1990).

K. brevis cells are a motile and are attracted to light, therefore they concentrate on the surface of the water during the day where their distribution can be affected by cloud cover, wind, and tide (Tester and Fowler 1990). The FDA recommended shellfish closures when cell counts were higher than 5,000 cells/liter (Tester and Fowler 1990).

K. brevis produces a neurotoxin that will accumulate in filter feeding shellfish such as clams. Mild to severe nausea, vomiting, diarrhea, chills, dizziness, numbness and tingling of the face and extremities will occur within three to four hours after consumption of contaminated shellfish (Tester et al. 1991). There were approximately 48 persons with confirmed neurotoxic shellfish poisoning (NSP) in North Carolina. Most of the cases (35) occurred before the first shellfish closure on 2 November (Tester et al. 1988).

The economic lost to the coast was estimated at $25 million and had its greatest impact on the clam fishermen. Clam landings were less than half of the previous year and caused a $2 million reduction in dockside value (Tester and Fowler, 1990). The Shellfish Sanitation Section now has a contingency plan, required by the FDA, in case another red tide should occur. This plan includes a monitoring program and a management plan. DMF also has a contingency plan to provide assistance to Shellfish Sanitation by conducting aerial surveillance of offshore waters, collecting samples, and closing and patrolling areas closed to harvest because of red tide (P. Fowler, Shellfish Sanitation, personal comment 2007). Collaboration with both Shellfish Sanitation and NOAA to monitor potential outbreaks is also a recommendation in the Bay Scallop FMP.

Green Gill

Green gill in clams comes from the single-celled alga called *Haslea ostrearia.* This is a blue-green diatom found in the coastal waters of North Carolina. The diatom produces a blue pigment called marennine. This pigment is released into the water turning it a bluish color. Clams pick it up while filtering the blue colored water, which combines with the clam's natural yellow color, turning the gills green. The greened gilled clams, usually found in the cooler months are harmless. The French consider the green gilled shellfish a delicacy and actually culture the alga to produce a somewhat nuttier tasting shellfish. However, in the US, shellfish markets have a hard time selling them because the American consumer thinks they are inedible.

9.4 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.

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 clam habitat such as shell bottom (Table 9.4). Other protections for shell bottom are actually based on protecting oyster – 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. These areas have served as target and bombing ranges since the World War II period. Military restricted areas cover 24,051 acres of the shellfish mapping study area, and all of these areas have been mapped (Table 9.4). 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 2001b).

Table 9.4 Amount of bottom habitat mapped (acres) by the DMF Shellfish Habitat and Mapping Program within areas receiving specific MFC 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	% completed
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 biologists 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.

Environmental Management Commission

By 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 DWQ has established water quality classifications and standards program for "best usage." Recent water quality classifications and standards have 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 non-point 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 incorporating into the CHPP. In addition to CHPP, achievement of basinwide water quality management objectives by the DWQ should also improve coastal water quality.

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. Reeder, DWQ, personal communication 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. Issue paper 10.21 – Water Quality degradation by biological contamination of shellfish growing waters has more information of these programs.   *The MFC should support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation.*

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 DENR 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 clam habitat for both protection and restoration. The identification of SHA should also be coordinated with DENR's Strategic Conservation Plan – the land-based component of strategic area protections.

Restoration Activities

Restoring clam habitat involves both oysters and SAV restoration. The Shellfish 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 1955a; 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[4]. 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 (Craig Hardy, DMF-Resource Enhancement, personal communication, March 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 (TNC).* The issue paper 10.4.1 – Oyster Sanctuary Development/Construction in the Oyster FMP (DMF 2007d) 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 (NCCF) to draft an oyster restoration plan for North Carolina. Many of the protective recommendations (listed in section 8.6) 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 DMF 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 (Ballance 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 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.

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[4] 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).

Restoration of submerged aquatic vegetation is generally conducted for compensatory mitigation, mitigation banking, or research purposes. Benefits of SAV restoration include fish habitat enhancement, sediment and shoreline stabilization, and water quality enhancement. Compensatory mitigation is the replacement of a natural resource, such as a bed of SAV destroyed or severely degraded by a permitted action. Such replacement is often required by the enforcement of Section 404 of the Clean Water Act by the COE or by state regulations enforced by other regulatory agencies (DCM, DWQ). The intent is replacement of ecological functions such as water quality, habitat, and hydrology. Mitigation is usually also meant to replace an acreage equal to or greater than that which was lost or impacted (DCM 2002).

Seagrass restoration techniques have been developed and evaluated by the NMFS. Depending on environmental variables, a similar faunal community can return, at the earliest, within two years (Fonseca et al. 1998). The success of replanting efforts is often gauged by an evaluation of "functional equivalency." As defined by Fonseca et al. (1998), an area has achieved functional equivalency when "a restored or mitigated system attains [ecological] functions the same as those of an unimpacted system in a similar setting." According to the authors, an impacted seagrass bed has the potential to become functionally equivalent, but not identical, to an undisturbed seagrass bed if a) it is at least equal in space to that of the original area prior to disturbance and b) the seagrass species composition is unchanged and persists after the disturbance. Based on review by Fonseca et al. (1998), the time needed to attain functional equivalency for seagrasses ranges dramatically, from less than two to more than 31 years. Seagrass shoot densities and canopy height can be used to determine when a restoration project has reached functional equivalency (Fonseca et al. 1998).
There were 12 SAV restoration projects in Carteret and two in Onslow counties between 1978 and 1991 (DCM 2002). Of these 14 sites, 11 were considered "successful." Three projects were done as N.C. Department of Transportation (DOT) mitigation, while the others were research projects conducted by NMFS. A total of 1.95 acres (0.79 ha) of bottom was restored to SAV by these projects. This area is relatively small compared to restored shell bottom areas. Seagrass restoration projects tend to be more limited due to the relatively high water quality conditions needed for survival of the plants.

9.5 RECOMMENDED MANAGEMENT STRATEGIES

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 9.4). 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.

9.5.1 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 hard clam stocks. To work toward this goal, the MFC, CRC, and EMC should adopt rules to protect critical habitats for hard clams 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 DENR. 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 CHPP Implementation Plan or the CHPP research report. In addition, there are also specific recommendations from the Oyster and Hard Clam FMP AC and the DMF based on effects of mechanical clam harvest on fish habitat (issue paper 10.18).

Strategic Habitat Areas

1. Identify and delineate Strategic Habitat Areas that will enhance protection of clam habitats; research physical factors influencing clam abundance predictably.
2. Coordinate SHAs with land-based conservation and restoration activities such as One North Carolina Naturally and DENR's green infrastructure planning.

Shell bottom and SAV

3. Ensure oyster and SAV habitat definitions are consistent across regulating agencies.
4. Completely map all structured habitat (i.e., shell bottom, SAV) in North Carolina, including the deep, subtidal rocks on Pamlico Sound.
5. Remap structured habitats to assess changes in distribution and abundance over time.
6. Restore historical distribution and acreage of oysters and SAV where possible; *coordinate with land-based protection and restoration efforts*
7. Balance protection of oyster beds and SAV (as habitat) with harvest provisions; *expand oyster sanctuary planting and designation.*
8. *Monitor biological/ecological condition and effectiveness of oyster sanctuaries and restored SAV beds*.
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 and SAV habitat.
11. Develop permit application survey protocols for shellfish and SAV habitats for CAMA applicants.
12. Evaluate and adjust as necessary dredging and trawling boundaries to protect and enhance oyster and SAV habitat.
13. Seek additional resources to enhance enforcement of and compliance with expanded bottom disturbing fishing gear restrictions that protect oyster and SAV habitat.
14. Evaluate making conservation leasing available to non-government organizations for the purpose of oyster restoration and sanctuary development.

MFC preferred management option (see issue paper 10.18)

1. Modify mechanical harvest lines to exclude areas currently open to mechanical clam harvest where oyster habitat and SAV habitat exist based on all available information

9.5.2 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 hard clam 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. Additional recommendations from the Oyster and Hard Clam FMP AC and the DMF are also listed below.

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 SAV growth and clam production.
2. Seek 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.
3. Target productive shellfish resources in conditionally approved closed areas for land-based protection and restoration efforts. This could include designation as Strategic Habitat Are or Use-Restoration Water.

MFC preferred management options (see issue paper 10.20)

1. Recommend to DWQ to accept a lower threshold of 10,000 square feet to coastal stormwater rules.
2. Recommend a naturally vegetative riparian buffer width of 50 feet.
3. Support DWQ's efforts to improve stormwater rules through permit comments, CHPP implementation and coordination with sister agencies.
4. Recommend DWQ 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.
5. 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.
6. Recommend the exclusion of all wetlands (coastal and non-coastal), from the built-upon area calculations.

9.6. 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 clam 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)
- Utilize standardized monitoring metrics and methodologies with other researchers for clam restoration when possible

10.0 PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

10.1 NO DATA ON RECREATIONAL HARVEST OF SHELLFISH[5]

ISSUE

No recreational shellfish harvest data are currently being collected.

[5] Presented to the Plan Development Team on Jan. 4, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Jan. 17, 2007.
Presented to Management review Team on June 6, 2007.

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 MRFSS indicated that 3% of households in coastal North Carolina participated in recreational shellfishing compared to an average of approximately 7% for finfish (D. Mumford, DMF, personal communication). Recreational data are being collected by MRFSS for finfish, but the survey does not currently collect shellfish data. Although the FRA of 1997 created a 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, 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

<u>North Carolina General Statutes</u>
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 TTP would provide a better estimate of fishing mortality and relative abundance of hard clams. 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 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 recommendations are not yet fully adopted by the MFC, the MFC recommended the DMF produce a mechanism to obtain data on the recreational scallop harvest (DMF 2007c).

DMF developed a survey to obtain additional information on shellfishing from CRFL license holders at the point of license sale. One of the survey questions is, "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 TTP 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 TTP 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 recollective 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

MFC Selected Management Option

- *Status quo*, no change

AC - *Status quo*, no change

DMF - Recommend requiring recreational shellfish harvesters to be licensed to provide a sampling universe for surveys

RESEARCH RECOMMENDATIONS

None

10.2 OPEN OCEAN AREA FOR HARVEST OF CLAMS[6]

ISSUE

To continue or discontinue an open ocean mechanical harvest area for clams by proclamation.

[6] Presented to the Plan Development Team on Jan. 4, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Jan. 17, 2007.
Presented to the Management Review Team on June 6, 2007.

BACKGROUND

In the early 1990s there were requests from mechanical clam harvesters to allow them to survey areas in the Atlantic Ocean for hard clams. On March 7, 1994 a proclamation (SF-9-93/94) was issued to open an area in the Atlantic Ocean from Beaufort Inlet east to Cape Point at Cape Lookout after Shellfish Sanitation certified the area for harvest. Dredge weight and harvest restrictions do not apply in this open ocean area to the mechanical harvest of clams and harvest is allowed from 7:00 a.m. to 4:00 p.m. five days a week. The proclamation has not been superseded and is still in effect.

CURRENT AUTHORITY

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03J .0303(a) Dredges and mechanical methods prohibited.
03K .0302 Mechanical harvest season.

DISCUSSION

Only a few trips with less than 5,000 clams combined have been taken in this open ocean area in 1995 and 1996. One Scientific and Educational Collecting Permit (SECP) was issued in 2005 to explore shellfish resources in the ocean with no success. On occasion, fishermen have used this open ocean area to test new mechanical harvest gear, such as towed hydraulic dredges outside of the main harvest season and in deeper water.

Proclamation authority allows flexibility to implement regulations 48 hours after issuance. If this area were to be closed by rescinding the proclamation it could be reopened relatively easily by proclamation after Shellfish Sanitation certifies the area suitable for harvest.

MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*

\+ Continued access to resource by mechanical clam harvesters
\+ Proclamation authority allows flexibility to continue to remain open or close the area at anytime
\+ Allows fishermen the opportunity to test mechanical harvest gears outside of the allowed harvest season and in deeper waters with minimal impact to the resource
\- Minimal use over time
\- Impractical area to harvest clams
\- Longterm static proclamations should be in rule

B. Rescind the proclamation but keep authority to open if and when necessary

+ Minimal impact to fishermen since the area is not used extensively
+ Access to fishermen to test mechanical harvest gears outside of the allowed harvest season and in deeper waters within the time period it takes to issue a proclamation
+ Proclamation authority allows flexibility to continue to open or close the area at anytime
- Some delay for fisherman to regain access to the area

C. Place current proclamation in rule

+ Makes a longterm static proclamation easier to find in the rulebook
- Reduces the flexibility to close the area anytime

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option

- Rescind the proclamation but keep authority to open if and when necessary

AC and DMF - Rescind the proclamation but keep authority to open if and when necessary

RESEARCH RECOMMENDATIONS

None

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Marine Fisheries

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
William T. Hogarth, Ph.D., Director

DEHNR

SF-9-93/94

PROCLAMATION

RE: MECHANICAL CLAM HARVEST - ATLANTIC OCEAN

William T. Hogarth, Fisheries Director, Division of Marine Fisheries, hereby announces that effective at 7:00 A.M., Monday, March 7, 1994, the following will apply to the harvest of clams by mechanical methods:

ATLANTIC OCEAN

The Atlantic Ocean from Beaufort Inlet to Cape Point at Cape Lookout will open to the harvest of clams by mechanical methods from 7:00 A.M. to 4:00 P.M. Monday through Friday of each week.

NOTES:

(1) This proclamation is issued under the authority of G.S. 113-182; 113-221(e); 143B-289.4 and implementing N.C. Marine Fisheries Rules 15A NCAC 3H .0003, 3J .0303 (a) and 3K .0301 through 3K .0304.

(2) It is unlawful to violate the provisions of any proclamation issued by the Fisheries Director under his delegated authority per 15A NCAC 3H .0003 (b).

(3) Effective March 1, 1994 dredge weight restrictions as specified in NC Marine Fisheries Rule 15A NCAC 3J .0303 and daily harvest limits of clams as specified in NC Marine Fisheries Rule 15A NCAC 3K .0301 do not apply to the Atlantic Ocean.

(4) Pursuant to the authority of 15A NCAC 3K .0303 (a), a valid permit for mechanical harvest of clams will be required to harvest clams from the opened area by mechanical methods and all conditions of the permit apply.

BY: William T. Hogarth
WILLIAM T. HOGARTH, PH.D., FISHERIES DIRECTOR
DIVISION OF MARINE FISHERIES

March 3, 1994
9:00 A.M.
SF-9-93/94
/sh

P.O. Box 769, Morehead City, North Carolina 28557-0769 Telephone 919-726-7021 FAX 919-726-0254

10.3 RECREATIONAL AND WEEKEND SHELLFISH HARVEST PROVISIONS[7]

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.

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[7] Presented to the Plan Development Team on Jan. 4, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Jan. 17, 2007.
Presented to the Management Review Team on June 6, 2007.

CURRENT AUTHORITY

<u>North Carolina General Statutes</u>
113-169.2. Shellfish licenses for North Carolina residents without a SCFL.

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

MFC Selected Management Options
- Define recreational 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

AC and DMF
- Define recreational 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

RESEARCH RECOMMENDATIONS

None

10.4 MECHANICAL HARVEST OF OTHER SHELLFISH[8]

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 (i.e., 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.

[8] Presented to the Plan Development Team on Jan. 4, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Jan. 17, 2007.
Presented to the Management Review Team on June 6, 2007.

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 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, scallop, 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

MFC Selected Management Options

- 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

AC and DMF - 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

RESEARCH RECOMMENDATIONS

None

10.5 EFFECTS OF AN OPEN HARVEST LICENSE ON SHELLFISH FISHERIES[9]

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 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 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.

[9] Presented to the Plan Development Team on Jan. 25, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Feb. 26, 2007.
Presented to the Management Review Team on June 6, 2007.

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

General Statutes of North Carolina
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. DMF License Program.

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 are low in number 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. DMF License Program.

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 mechanically harvesting oysters 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. DMF License Program.

	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 FRA. 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 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
1. Would require fishermen who only have a shellfish license to go through the eligibility pool application process to obtain a SCFL
2. 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

MFC Selected Management Option
- *Status quo*, no change

AC and DMF - *Status quo*, no change

RESEARCH RECOMMENDATIONS

None

10.6 REQUIRE ALL SHELLFISH (OUT-OF-STATE) AT DEALER LEVEL TO BE TAGGED[10]

ISSUES

Marine Fisheries rule 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 DMF cannot enforce misbranded or untagged shellfish if shellfish are from waters outside North Carolina, dealers can fraudulently claim that untagged or mistagged shellfish are not from North Carolina waters. The dealer could 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 put DMF and Shellfish Sanitation on the same page. Shellfish Sanitation already has the authority to inspect all shellfish at the dealer level.

BACKGROUND

Currently The North Carolina Shellfish Sanitation Section 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. FDA Interstate Certified Shellfish Shippers List.

In the event of a shellfish related illness, tags used in concert with records, provide for trace ability 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.

[10] Presented to the Plan Development Team on Feb. 15, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on Mar. 26, 2007.
Presented to the Management Review Team on June 6, 2007.

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 (ISSC) required North Carolina to comply with tagging requirements of the NSSP. In 1993 the DMF established a rule requiring shellfish tagging by the shellfish harvester when shellfish are 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 DMF tagging rule only applies to shellfish harvested from North Carolina waters when harvester is in possession of a commercial amount or if the shellfish are to be sold by fishermen.

Enforcement under the DMF current tagging requirements at the dealer level only applies to shellfish that have been taken from North Carolina waters. Shellfish from out-of-state do not have to meet harvester tag requirements by the current DMF 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 the DMF tagging rule only applies to shellfish taken from North Carolina waters. Situations have occurred in the past when officers have suspected shellfish harvested illegally. The shellfish in question will not have a tag affixed to the bag. The dealer will indicate the shellfish are from out-of-state, produce a receipt from an out-of-state dealer, thus hampering the enforcement efforts of the officers.

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 all shellfish at the dealer this would allow DMF to do what DEH (Shellfish Sanitation) is currently doing.

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 shellfish

+ 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

MFC Selected Management Option
- Require all shellfish to be tagged at the dealer level

AC and DMF - Require all shellfish to be tagged at the dealer level

RESEARCH RECOMMENDATIONS

None

10.7 ROTATION OF SOUTHEAST PAMLICO SOUND WITH CORE SOUND[11]

ISSUE

A management recommendation of the 2001 Hard Clam FMP to rotate an area of southeast Pamlico Sound with an area in northern Core Sound every two years to allow recovery of hard clam populations in Core Sound was implemented during the 2001-2002 mechanical clam harvest season.

BACKGROUND

When “modern” clam kicking began, there were no bounds to the harvest areas, times of harvest, or bag limits. In the late 1970s, seagrass beds and oyster rocks were protected and mechanical harvest was largely confined to the deeper waters of the sounds and rivers. Today mechanical harvest gears include clam kicking trawls and hydraulic dredges. In the early 1980s, the hydraulic dredge operators proposed a rotation scheme between White Oak River, including a portion of the Intracoastal Waterway and New River. New River and White Oak are opened in alternate years and the bag limit was reduced from 40 bags (250 clams/bag) to 25 bags because of the efficiency of the fishing gear. Although White Oak River is depleted within a month or so of opening, New River seems to support that harvest level throughout the season.

The Division has conducted several surveys with DMF vessels and commercial vessels in response to past requests for additional clam kicking bottom. These surveys indicated that significant clam populations existed in southeastern Pamlico Sound, but the higher concentrations were associated with seagrass beds. Surveys of Kingfish Shoal north of Wainwright Island resulted in its opening to mechanical harvest from 1988 through 1993, but closed in 1994 when fishing effort ceased. Surveys in the Intracoastal Waterway from Swansboro to Morehead City in 1989 yielded almost no clams. The “Cut Bank” of the Bogue Sound ICW has been opened in the past, but seagrass, hand clam harvesters, and development have prevented its opening in recent years.

During development of the 2001 Hard Clam FMP, the issue of rotation of Core Sound with an area in Pamlico Sound was addressed to prevent overharvesting of clam stocks, discourage violations by mechanical harvesters who cross the lines in search of more clams, and the taking of undersized clams or “buttons”. Core Sound mechanical clam harvest landings had decreased since the 1980s. By 1996, landings and effort had dropped to an average of 15 bags per trip.

In order to address the issue, Division staff surveyed an area west of Portsmouth Island in the vicinity of Schooner Shoal in May of 2000 using a commercial clam kicking boat. Water depths in the area ranged from 7 to 13 feet. Sixteen tows produced a sample of 2,820 clams of which 769 clams were measured. Catch per unit effort averaged 11 clams per minute.

[11] Presented to the Plan Development Team Apr. 17, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on May 7, 2007.
Presented to the Management Review Team on June 6, 2007.

More clams were taken in the shallow water (<10 ft) than in deep water ($\geq$10) probably due to gear limitations because of water depth. Hard clams from shallow water were significantly larger (p>0.05) than those taken in deep water (Figure 10.1). Aerial photographs of seagrass beds taken by NMFS in 1988 show the presence of grass along the eastern edge of the proposed area and some small patch beds on Schooner Shoal. Shellfish mapping data taken in 1998 also show seagrass beds along the eastern edge of the proposed area. It was concluded that there was an adequate resource of hard clams to support a small closely regulated fishery in the surveyed area. Two mechanical harvest areas were established based on aerial photography and groundtruthing to avoid SAVs. These areas encompassed approximately 4,500 acres in water depths from seven to 13 feet.

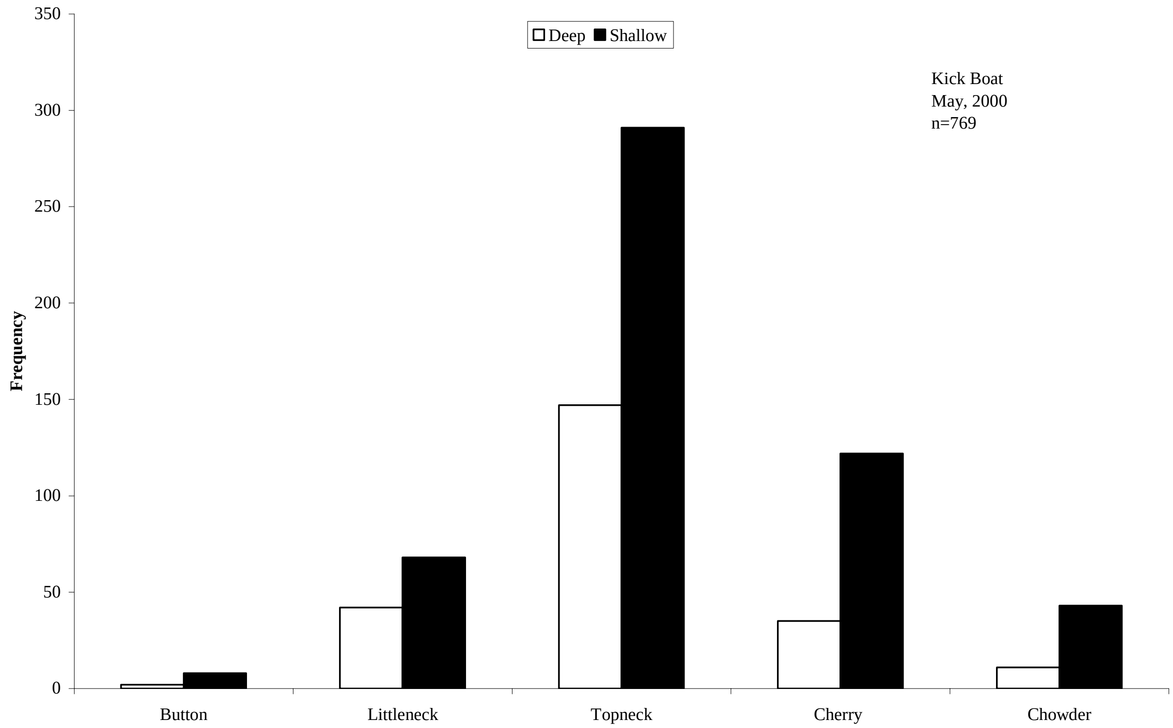

Figure 10.1. Frequency of hard clams by market size in the vicinity of Schooner Shoal, Pamlico Sound. DMF biological database.

The northern Core Sound area was established based on similar acreage and the amount of effort that historically occurred. The new area was opened for the first time in December of 2001. Division staff monitored the fishery for the first year and observed that on days of good weather, effort was concentrated in Pamlico Sound. During days of adverse weather, the majority of the effort was in Core Sound. Running time for those boats fishing in Pamlico Sound also decreased effort from eight hours a day to five or six hours a day. Most fishermen caught their 20-bag limit in Pamlico while those in Core were landing on average 15 bags a day (Figure 10.2). Near the end of the season, effort switched to fishing on chowder clams in Core Sound because of market demand (Figure 10.2). Market grade also varied between the two areas with topnecks and cherries harvested from Pamlico Sound and little necks, topnecks and chowders from Core Sound.

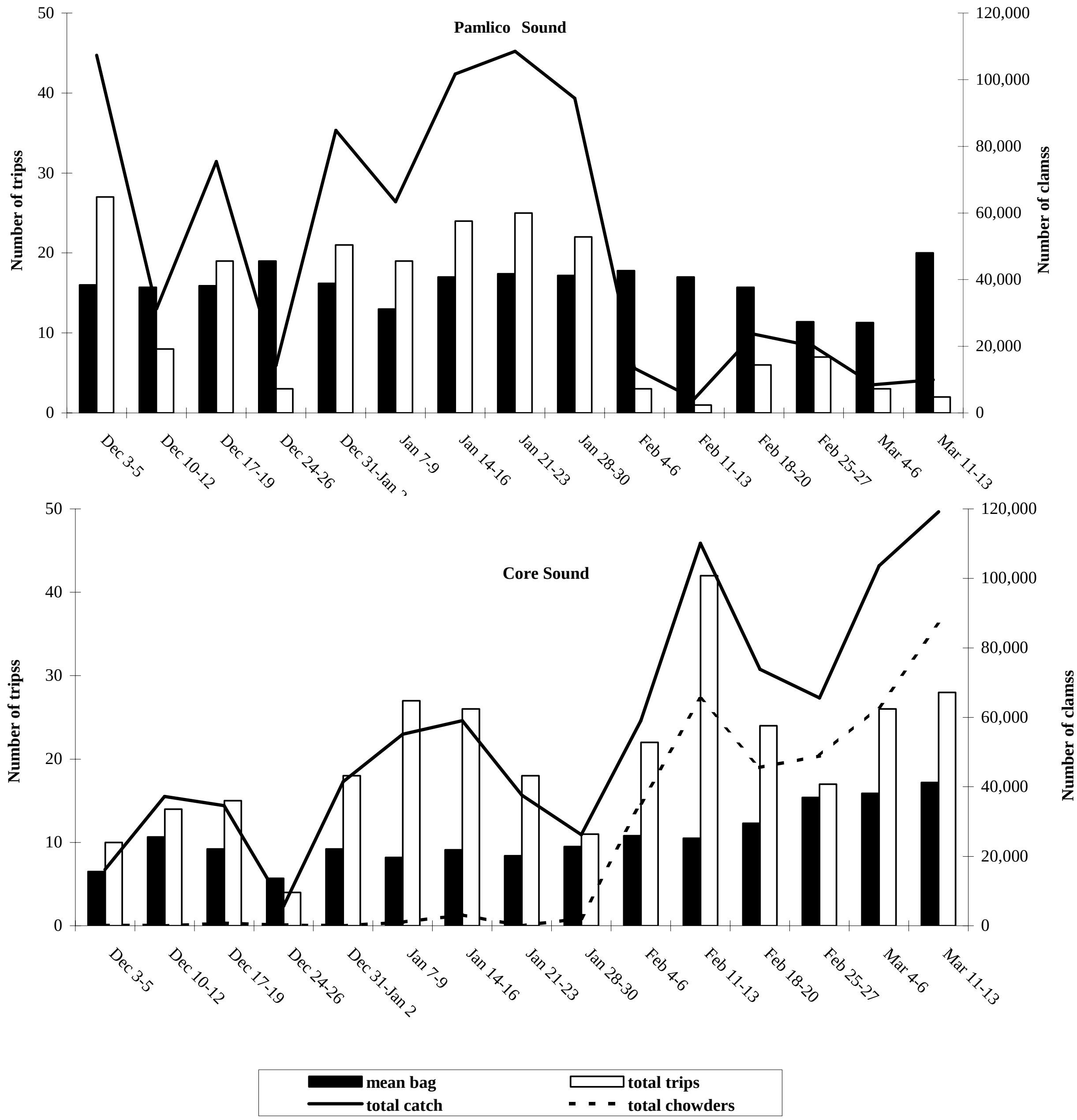

Figure 10.2. Weekly harvest trips and landings for the 2001/2002 mechanical harvest season in Southeast Pamlico Sound and Core Sound. DMF Trip Ticket Program

Vandenburgh and Goodwin (2006) assessed the Core Sound/Pamlico Sound Rotation plan in order to determine if it was successful in restoring the clam population in the northern Core Sound area without substantially decreasing the clam population in the Pamlico Sound area. They found in the closed portion of Core Sound (CE) catch per unit effort (CPUE) increased eight-fold by the end of the study period and the area of Core Sound that remained opened each harvest season (CC) increase three-fold (Figure 10.3). The CPUE in Pamlico Sound demonstrated more variability with the open area (PE) showing an overall decrease in CPUE and the closed area (PC) showing no change in CPUE (Figure 10.4).

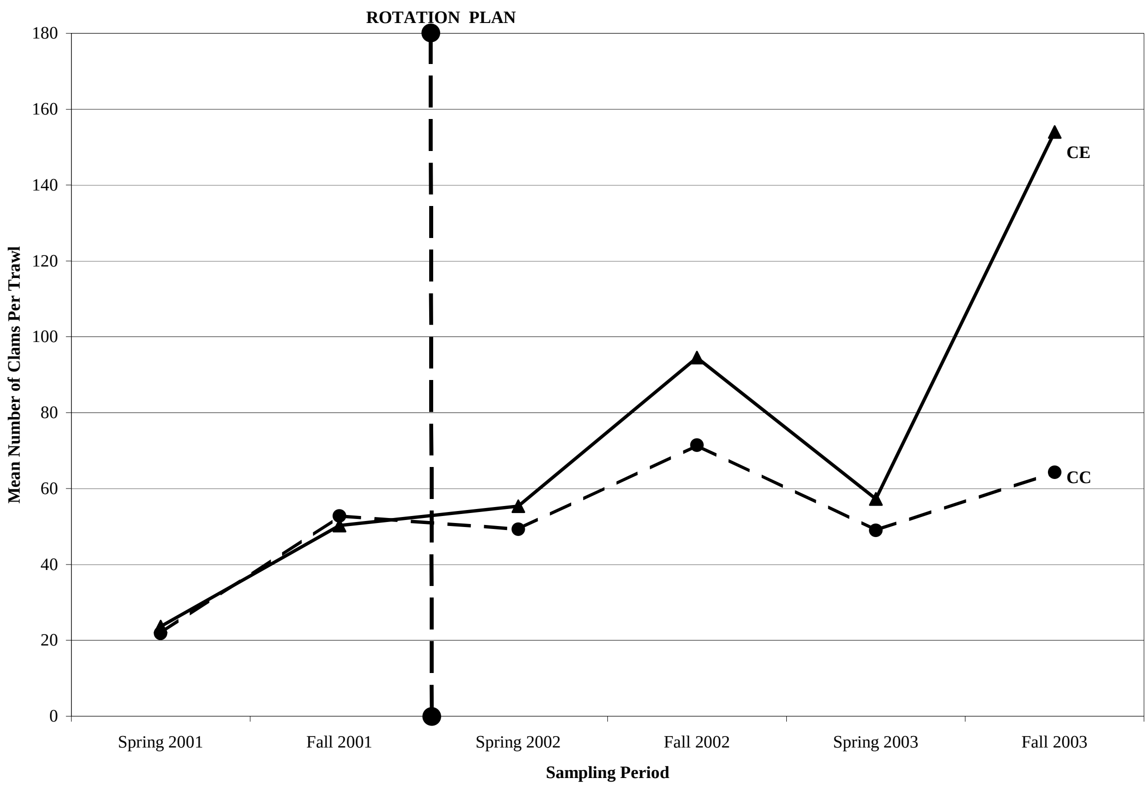

Figure 10.3. CPUE (mean number of clams per trawl) in Core Sound. (CC=opened area, CE=Closed area) (Vandenburgh and Goodwin 2006).

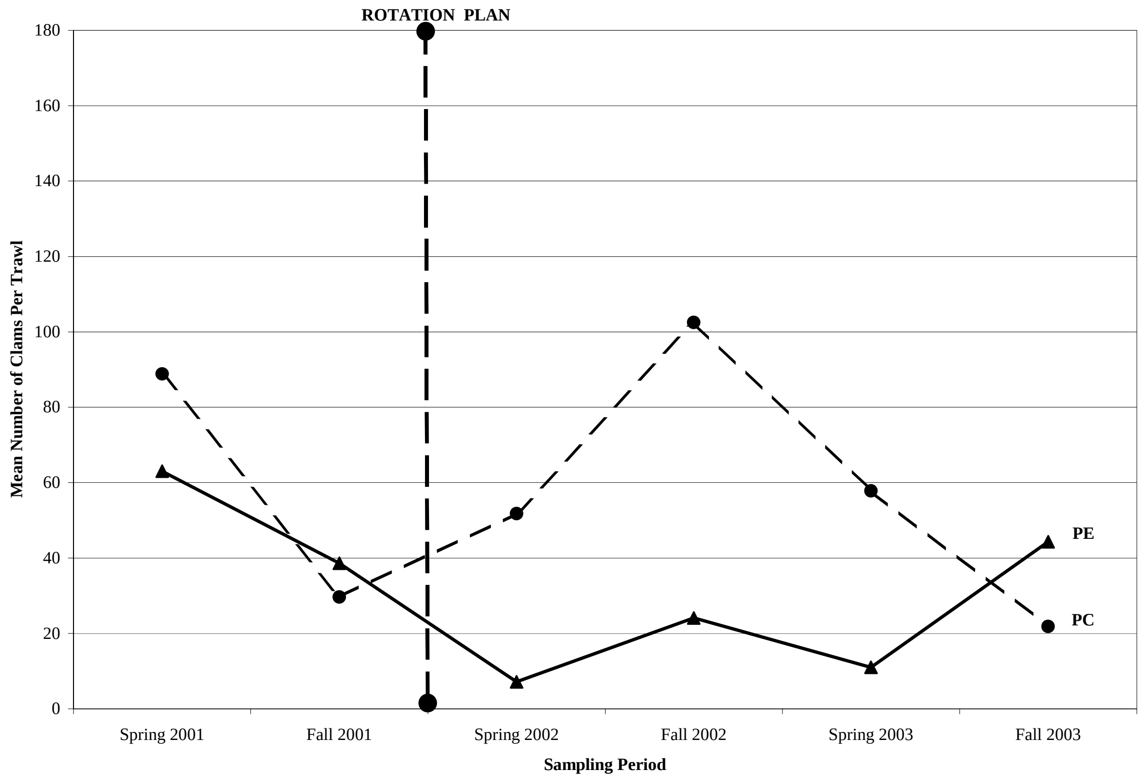

Figure 10.4. CPUE in Pamlico Sound (PE=Open area; PC=Closed area) (Vandenburgh and Goodwin 2006).

Although their study was limited in time and spatial variability, their results suggest that the rotation plan was a success in Core Sound but results are unclear regarding success in Pamlico Sound. However, decreasing CPUEs in Pamlico Sound coincide with the implementation of the rotation plan of this area.

CURRENT AUTHORITY

<u>North Carolina Fisheries Rules for Coastal Waters (15 A NCAC)</u>
03K .0302. Mechanical Harvest Season

DISCUSSION

During the first year of rotation (2001/2002), larger boats fished Pamlico Sound successfully with the average catch of 15 bags a trip though the majority of the fishermen were catching their 20 bag limit in the beginning of the season. There were 195 trips made in Pamlico Sound landing over 3,000 bags of clams (Figure 10.5). Core Sound was fished by smaller boats and was available to the larger boats during times of poor weather conditions. Catches also averaged 15 bags a day. There were 410 trips made in Core Sound landing over 5,000 bags of clams (Figure 10.5). The second year of the rotation plan (2002/2003) had much lower trips and lower landings in Pamlico Sound. Only 45 trips were made landing 700 bags of clams. Core Sound effort consisted of over 400 trips landing 5,600 bags of clams during the same season (Figure 10.5).

The opening of northern Core Sound for the 2003/2004 season yielded over 11,000 bags of clams in 785 trips and again averaged approximately 15 bags a trip. During the 2004/2005 season, 500 trips landed over 3,400 bags of clams (Figure 10.6). By the time of the start of the second rotation with Pamlico Sound, the channel by Wainwright Island had filled in making it impossible for the larger boats to get to the Pamlico Sound kicking area. There were no landings made from Pamlico Sound during the 2005/2006 season. The number of trips in Core Sound was also low at 113 trips landing 1,500 bags of clams (Figure 5).

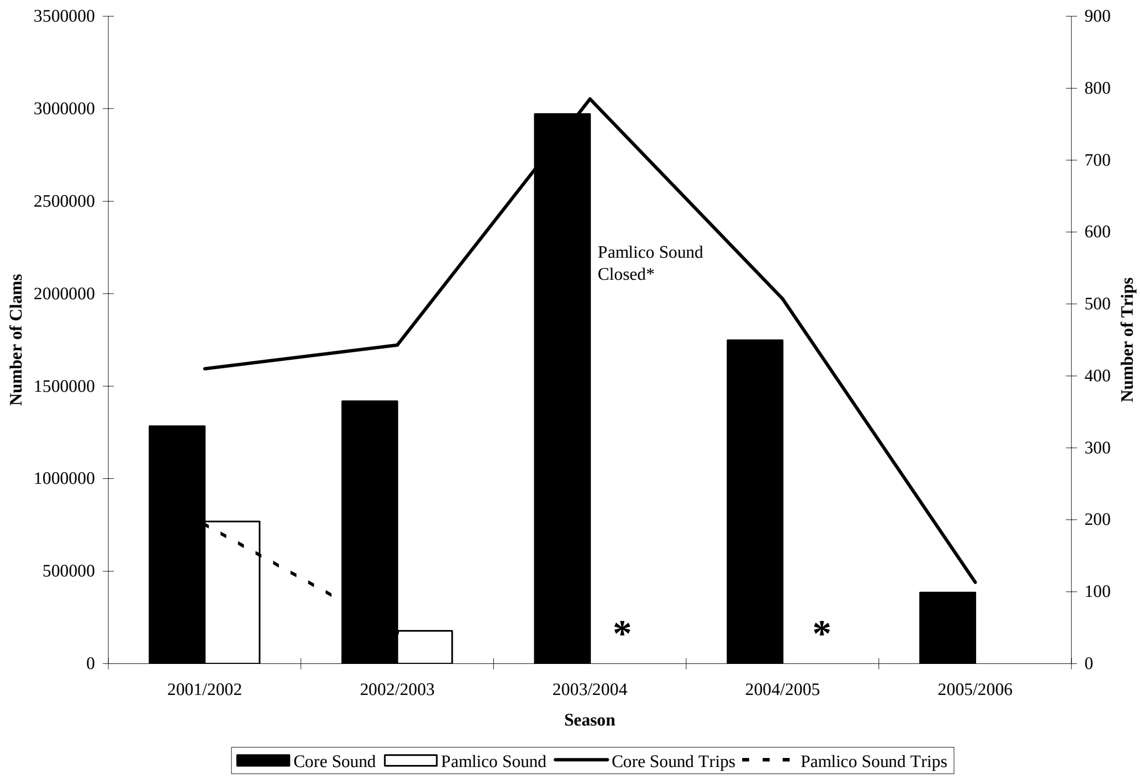

Figure 10.5. Number of clams and number of trips in the Core Sound and Pamlico Sound Mechanical Harvest area. DMF Trip Ticket Program.

The 2006/2007 season suffered from low clam prices and high fuel prices. Very few fishermen were reported mechanically harvesting this year. DMF Law enforcement officers reported two boats working in the Pamlico Sound area and two boats were working the Core Sound area.

The Pamlico Sound area will be closed to mechanical harvest during the next two harvest seasons. It has been questioned on whether this rotation schedule should continue. Current high fuel prices and low clam prices have curtailed mechanical harvest in both areas. However the distance fishermen must run to get to Pamlico Sound is an added cost to fishing the area. Deep water and weather conditions also limit the area to the larger vessels. Crab pot fishermen have also complained about impacts to the blue crab fishery in that area because of mechanical harvest. Wainwright slough dredging in 2007 is now completed to allow safer passage of boats to Pamlico Sound.

It has also been suggested that rotation occur every other year to coincide with the White Oak River/New River rotation in order to spread effort between vessels that are able in both Pamlico Sound and New River. The concerns of implementing this rotation scheme or closing Pamlico Sound completely is additional fishing pressure with little or no time for clam populations to recover. Vandenburgh and Goodwin (2006) suggest that the two-year duration provides maximum benefit to the clam population in the northern Core Sound area.

MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*
+ Possible increase in clam stocks in the Core Sound mechanical harvest area
- Possible decrease in clam stocks in the Pamlico Sound mechanical harvest area
- Low effort in Pamlico Sound because of vessel limitations, weather and access by fishermen
- Only part of Pamlico Sound mechanical harvest area can be used because of water depths

B. Discontinue rotation of Pamlico Sound with northern Core Sound
+ Possible increase in clam stocks in the Pamlico Sound area
+ Core Sound is not limited by vessel size, weather or access by fishermen
+ Possible improvement to crab pot fishing in the area
+ Continue proclamation authority to reopen the mechanical harvest area in Pamlico Sound if a modification to the rotation schedule is necessary to reduce effort in Core Sound
- Possible decrease in clam stocks in Core Sound mechanical harvest area

C. Modify rotation schedule of Pamlico Sound with northern Core Sound from every two years to every other year
+ Possible increase in clam stocks in Core Sound mechanical harvest area
+ Northern Core Sound available to fishermen every other year instead of every two years
+ Coincides with White Oak River/New River rotation plan
+ Continue proclamation authority to reopen the mechanical harvest area in Pamlico Sound if a modification to the rotation schedule is necessary to reduce effort in Core Sound
- Possible decrease in clam stocks in the Pamlico Sound mechanical harvest area
- Low effort in Pamlico Sound because of vessel limitations, weather and access by fishermen
- Only part of Pamlico Sound mechanical harvest area can be used because of water depths.

D. Discontinue rotation of Pamlico Sound and begin an annual rotation schedule within the Core Sound mechanical harvest area.

+ Possible increase in clam stocks in Pamlico Sound area
+ Possible increase in clam stocks in Core Sound mechanical harvest area
+ Core Sound is not limited by vessel size, weather access by fishermen
+ Continue proclamation authority to reopen the mechanical harvest area in Pamlico Sound if a modification to the rotation schedule is necessary to reduce effort in Core Sound
- Loss of bottom in Pamlico Sound to harvest

MANAGEMENT RECOMMENDATION

MFC Selected Management Options

- Discontinue rotation of Pamlico Sound with northern Core Sound.
- Institute a resting period within the mechanical clam harvest area in the northern part of Core Sound

AC and DMF

- Discontinue rotation of Pamlico Sound with northern Core Sound.
- Institute a resting period within the mechanical clam harvest area in the northern part of Core Sound

RESEARCH RECOMMENDATIONS

None

10.8 ENHANCING CLAM PRODUCTION[12]

ISSUE

Should the DMF create hard clam spawning sanctuaries, enhance hard clam stock, and/or enhance habitat for hard clams in order to increase production?

BACKGROUND

Enhancing shellfish resources is a popular method for increasing abundances of oysters and clams on public bottom and has been a popular management strategy for hard clams in other states such as New York and New Jersey. The public supports enhancement because it is seen as an active solution to low stock abundances and is favored by the fishermen over restrictive harvest limits (Kassner 1994). Oyster enhancement practices have occurred since the mid 1800s where oystermen transplant seed oysters to growout areas and plant cultch to

[12] Presented to the Plan Development Team on Mar. 12, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on Apr. 17, 2007.
Presented to the Management Review Team on June 6, 2007.

attract oyster spat. Oyster spawning sanctuaries have been established in North Carolina and rules allow for protection of both oysters and clams from harvest.

Shellfish enhancement is based on the theory that the environment is not at carrying capacity because of biological and/or environmental factors affecting recruitment of the stock. Enhancement increases the population by influencing these factors either by increasing the spawning output or increasing habitat availability. Unfortunately, those factors that may be causing low stock abundances may also affect the enhancement measure used. When natural abundances are high, enhancement may be successful, but, when natural abundances are low and enhancement is needed most, enhancement my not be successful (Kassner 1994).

Recommendations from the 2001 Hard Clam FMP included habitat enhancement by planting shell and other materials and to examine methodologies to potentially enhance clam populations by planting seed clams in combination with habitat enhancement. Through the Shellfish Rehabilitation Program, clam enhancement has occurred through oyster cultch plantings for enhancing oyster populations, especially in the southern area and a small study comparing oyster shell and surf clam shell for habitat enhancement for clams was completed in 2001. The DMF has not yet pursued any examination of methodologies of enhancement by planting seed clams.

CURRENT AUTHORITY

North Carolina General Statutes
113-204. Propagation of shellfish

DISCUSSION

There are several different methods of enhancement which can be achieved through hatchery reared seed or collection and redistribution of natural spatfall. Spawning sanctuaries and spawner transplant sanctuaries may be located in areas of historical importance that are protected from harvest and bottom disturbing gear.   Seeding and habitat enhancement within these sanctuaries using methods already established by the shellfish restoration program or in other shellfish management areas for clams is another strategy that may be utilized to enhance clam stock in an area.

The concept of spawning sanctuaries has been around since the early 1960s when spawning sanctuaries were established in Long Island Sound, New York. Sanctuaries have also been established in New Jersey.   Enhancement through spawner transplants of wild harvest stocks may be a viable option in order to enhance clam stocks in certain areas. Because of their high fecundity, large clams (chowders and cherries) are best suited for transplanting to spawning sanctuaries.   There are both biological and economical considerations when establishing a spawning sanctuary. Biological concerns include the ability to predict when clams are ready to spawn, in order to transplant at the appropriate time and selection of a suitable site that will insure settlement based on adequate circulation and dispersal of larvae. From an economical standpoint, it is difficult to determine whether the quantitative contribution from a spawner transplant is worth the time, effort and money. Because of high mortality of larvae and no consistent relationship between number of larvae and number of clams that survive to recruitment, contribution to the overall abundance of the clam population is possibly very low (Kassner and Malouf 1982; McCay 1988). Criteria for sanctuary locations should be addressed to lesson the impact to certain fisheries while still allowing brood stock to populate surrounding harvest locations. Sampling is needed to monitor sanctuaries and establish their ecological importance in the estuary.

Stock enhancement by seeding is another possible method for increasing the abundance of hard clam abundance in North Carolina. Currently, there are no state operated hatcheries for shellfish restoration. However, in 2005 state appropriations provided funding to investigate options for incorporating oyster hatcheries at the North Carolina Aquariums. The Division of Aquariums was designated the lead agency in planning construction of oyster hatcheries and developing complementary educational programs at each of the North Carolina aquariums. Although the hatcheries are still in the early planning stages, the 2007 Draft Bay Scallop Fishery Management Plan included a recommendation to the Oyster Hatchery Planning Advisory Team to consider multiple uses of the oyster hatchery facilities for different shellfish species and that consideration be given to designing shellfish hatcheries that are flexible and can be used for production of several species throughout the year.

Predation is the biggest cause of mortality in cultured hard clams. In order to exclude predators that occur in an aquaculture operation, habitat enhancement with materials such as shell, rock, or mesh covers are placed over the culture site to reduce predation. Even then, high mortality may still occur. However, it may be feasible to stock public bottom if the following variables are considered. These include the size of the seed clams, time of the plantings, density of the plantings and planting in proper habitat in traditionally productive sites. It may then be possible to minimize predation of the seed. Peterson et al. (1995) demonstrated 35% seed clam survival by stocking public bottom with large seed clams during the fall/winter at low densities (1 clam/meter^2) in shell hash or seagrass beds in traditionally productive areas.

Habitat enhancement alone may also be considered in increasing hard clam abundance. Increasing the amount of favorable clam habitat by planting shell could increase the amount of productive clam bottom. It is well known that clams prefer a sandy shell bottom type and also seagrass beds. The Shellfish Rehabilitation Program has been planting different shell types for oyster enhancement since 1947. Although the program was initially designed for oyster enhancement, clams have also benefited from the program. It has been observed that the use of surf clam shell (*Spisula solidissima*) increases hard clam abundances in Newport River (M. Marshall, DMF, personal communication). A pilot study comparing oyster cultch and surf clam cultch was initiated in 1999 by DMF staff to document this observation. Comparisons were made between surf clam cultch and oyster cultch for both clams and oysters in Cedar Island Bay and New River. A random block design consisting of oyster cultch, surf clam cultch and a control (no cultch) was set up at two sites each within Cedar Island Bay in shallow and deep water while a similar design was set up down stream and up stream in West Stones Bay and Courthouse Bay in New River. Sampling at all sites consisted of locating each block using GPS then haphazard random selection within the plot to be sampled. Hydraulic patent tongs with a grab size of 0.903 m^2 approximately 79.4 kg in weight were used to grab a bottom sample from each plot. Each grab was brought on board and sorted for clams and oysters. Total numbers of each shellfish were recorded and a subsample of 50 each was measured to the nearest millimeter. Shell length and shell thickness were recorded for clams and shell height was recorded for oysters. Bottom salinity (ppt), temperature (C^o) and dissolved oxygen (DO) (mg/L) were recorded at each site.

Results of density sampling in the New River sites indicated that there were no statistical differences between cultch types for hard clam density, but trends showed that clam densities increased in both sites in surf clam cultch treatments and oyster cultch treatments over time (Figures 10.6 and 10.7). Mechanical clam harvest landings in New River were between 85% and 95% of the 6,250 daily clam harvest limit during the study period (1999-2001) and may be an indication that stock abundance in the area was high enough for recruitment to occur into the sampling sites and demonstrates the possible value of enhancement of habitat in areas of good recruitment (Figures 10.6 and 10.7). Even without the statistical verification that planting different cultch types increased recruitment of hard clams, the increase in number and size of clams in the surf clam cultch treatments at site 4 indicate that positive effects may be detected in future sampling.

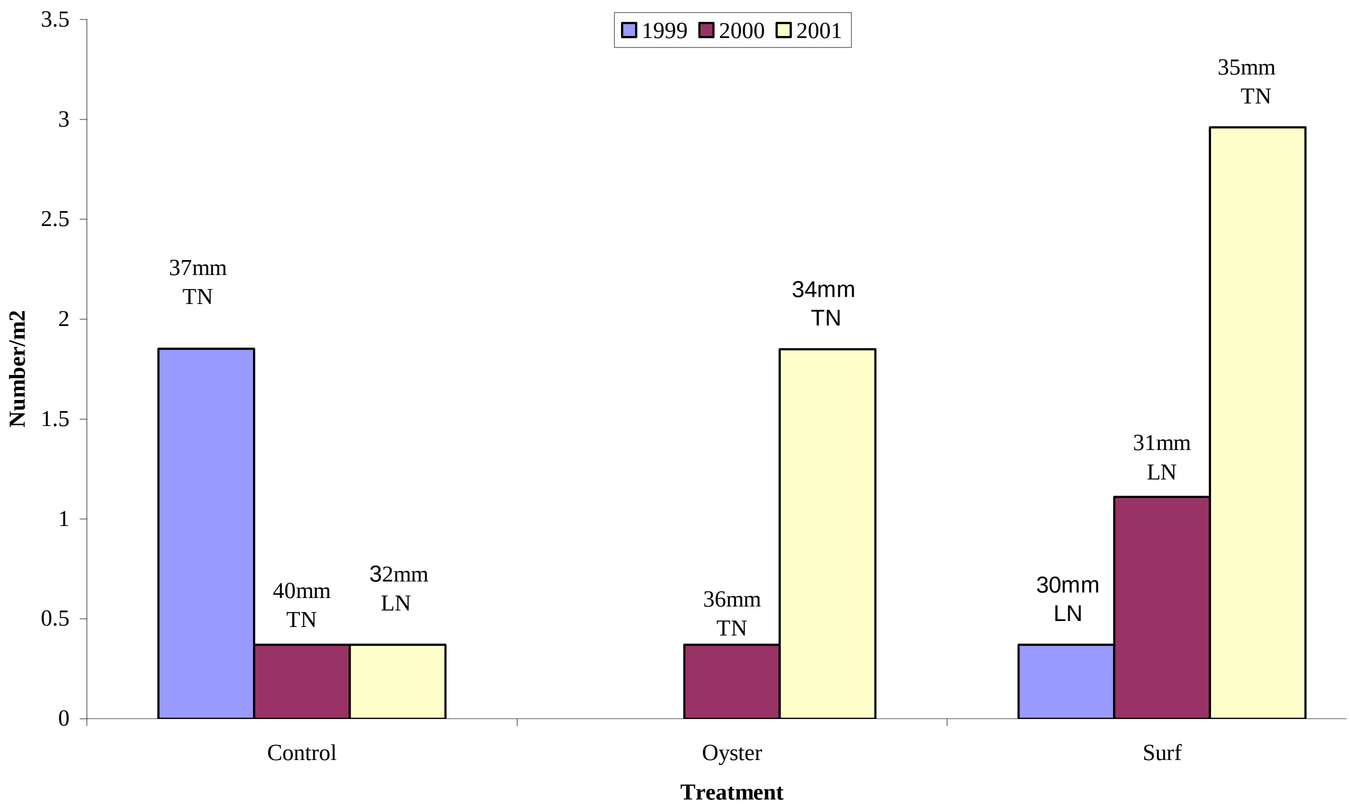

Figure 10.6. Density of hard clams in West Stones Bay in New River (Average shell thickness in mm above).

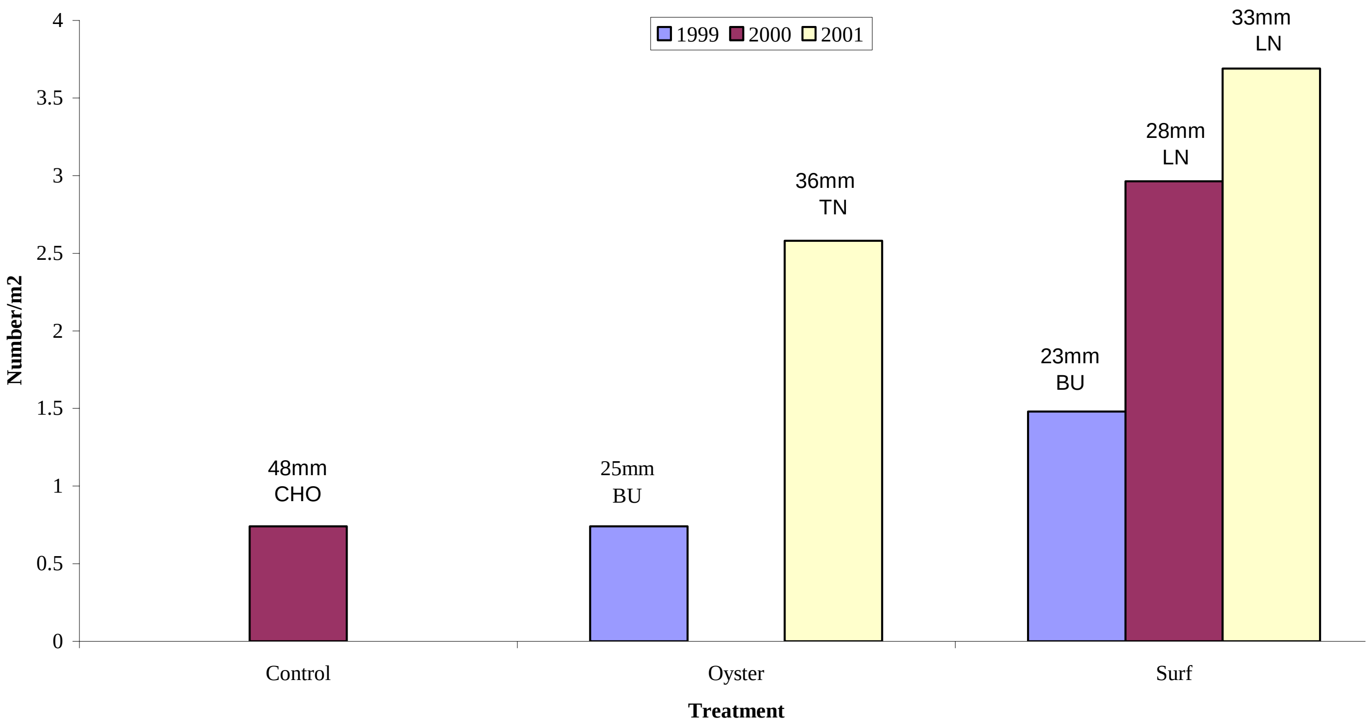

Figure 10.7. Density of hard clams in Courthouse Bay in New River (Average shell thickness in mm above).

Data analysis from the Cedar Island sites was inconclusive due to the low numbers of clams and small recruits (<25mm thickness) as well as a low number of oysters. Both sites experienced low DO during both sampling times, which may explain lack of recruitment of both clams and oysters. However, the lack of recruitment into the area may be an indication of recruitment limitation. There was anecdotal evidence as well as decreased hard clam landings by mechanical harvest for the past several years to infer a general lack of recruitment of hard clams in the upper Core Sound/Cedar Island area. Core Sound mechanical clam harvesters had landed approximately 40% of the 6,250 daily clam limits during the sampling time. Fishermen complained of both poor fishing and of seeing very few buttons (undersized clams) in the area, an indicator of poor recruitment. Unpublished data collected over a 20-year period in Back Sound, by UNC Institute of Marine Science (IMS) staff has shown a 40% decrease in annual recruitment of hard clams (DMF 2001a).

The variable or combination of variables that may be limiting recruitment in the area as in the case of Cedar Island Bay may also limit the recruitment to enhancement sites resulting in unsuccessful enhancement (Kassner 1994). However, in the case of New River where recruitment limitation may not be a problem, enhancement may be successful. Criteria for selecting enhancement sites need to consider the existing population in the proposed area.

MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*

+ No additional expenditure of state funds
+ Current restoration program for oysters is benefiting hard clam stocks
+ Current restoration program for oysters is increasing habitat for other commercially and recreationally important species
- No habitat enhancement program specifically for clams

B. Create clam spawning sanctuaries

+ Protects spawning individuals
+ Increases the abundance of spawning individuals
+ Increases the chance of reproductive success
+ Possibility of increasing stock abundance
+ Provide protected habitat for hard clams
- Site selection may be difficult until procedures are established
- Potential loss of traditional fishing grounds
- Increased Marine Patrol enforcement
- Need to mark and maintain marking of sanctuary area
- Possibility of not increasing stock abundance because poor environmental conditions may offset the gains from increased spawning
- Difficult to measure success

C. Stock enhancement by planting cultured seed clams

+ Possibility of increasing stock abundance
+ Method supported in other states
+ No take of wild stock for enhancement
- Expensive
- Site selection may be difficult until procedures are established
- Possibility of not increasing stock abundance because of high predation
- No state hatchery to produce seed
- Genetic diversity may decline
- Need to protect seed from predators
- Increased monitoring and maintenance

D. Examine methodologies to potentially enhance clam populations by planting cultured seed clams in combination with habitat enhancement

+ Possibility of increasing stock abundance
+ Popular with the public
+ Create additional habitat for other commercially and recreationally important species
+ No take of wild stock for enhancement
- Expensive
- Site selection may be difficult until procedures are established

- No state hatchery to produce seed
- Possibility of not increasing stock abundance because of poor environmental conditions
- Still may have high predation of seed
- Increased monitoring and maintenance

E. Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species.

+ Supports recommendation from the Bay Scallop FMP
+ Supports flexibility in hatchery use for other shellfish species
+ Provides a source of seed for clam enhancement in the future
- May affect genetic diversity
- May affect funding for oyster rearing

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Options

- *Status quo*
- Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species
- If clam seed grow out is initiated then the hatchery facility should work with the MFC Shellfish Advisory Committee and DMF to determine management criteria for uses of the clam seed stock

AC and DMF

- *Status quo*
- Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species
- If clam seed grow out is initiated then the hatchery facility should work with the MFC Shellfish Advisory Committee and DMF to determine management criteria for uses of the clam seed stock

RESEARCH RECOMMENDATIONS

Although numerous studies have been conducted regarding these types of enhancement strategies, more studies are needed. These include circulation studies, site selection studies (substrate type, water flow), and the effects of transplanting spawners. Assessments of the contribution of these enhancement types are imperative. Methodologies to reduce predation, increase seed planting efficiencies along with cost analysis are also needed.

10.9 STATUS OF PRE-DEALER SEED SHELLFISH SALES[13]

ISSUE

North Carolina General Statute 113-168.4. Sale of fish, states that it 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, Under Dock Oyster Culture (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 lease holders 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

<u>North Carolina General Statutes</u>
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.

<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>
03I .0101(b)(19) Aquaculture Operation.
03K . 0207 Oyster size and harvest limit exemption.

[13] Presented to the Plan Development team on Jan. 4, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Jan. 17, 2007.
Presented to the Management Review Team on June 6, 2007.

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. Change exemptions in 15A NCAC 03K .0305 and 03K .0207 to include 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
+ 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

MFC Selected Management Option
- 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

AC and DMF - 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

RESEARCH RECOMMENDATIONS

None

10.10 SHELLFISH DEPURATION PLANTS[14]

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 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 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.

[14] Presented to the Plan Development Team on Jan. 25, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Feb. 26, 2007.
Presented to the Management Review Team on June 6, 2007.

New Jersey, Connecticut, and 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, MFC 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, MFC 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 (C. Alexander, NJ Dept. of Health, personal communication).

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 Food and Drug Administration certified laboratories to process the substantial number of water and product samples required by state and federal rules (D. Wiggins, FDA, personal communication). 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. Rule change required.

\+ 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. Rule change required.

+ 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

MFC Selected Management Option
- *Status quo*, no change

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

DMF - *Status quo*, no change

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.

10.11 ALLOCATION OF AREAS FOR SHELLFISH LEASES[15]

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 fishermen 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 (G.S. 113-202) 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 10.8). 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 10.8).

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.

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[15] Presented to the Plan Development Team on Feb. 15, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on Mar. 26, 2007.
Presented to the Management Review Team on June 6, 2007.

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 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 know 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.

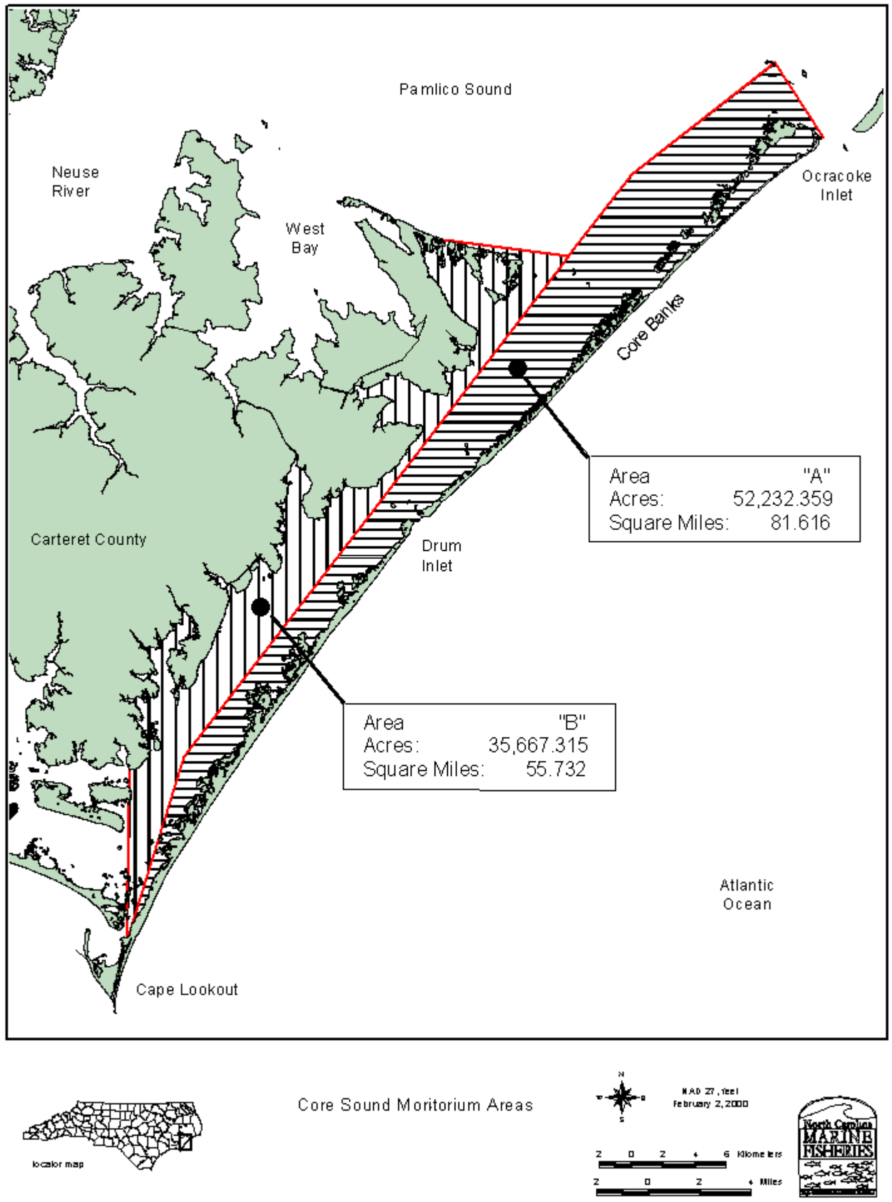

Figure 10.8. Core Sound shellfish lease indefinite moratorium Area A and restricted lease Area B.

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 are 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 an 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

MFC Selected Management Option

- Utilize user coordination plans for shellfish lease issuance coast wide

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

RESEARCH RECOMMENDATIONS

None

10.12 LEASEHOLDER EDUCATIONAL TRAINING[16]

ISSUE

The recommendation from the 2001 Oyster and Hard Clam FMPs 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 MFC 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 aquaculture 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 aquaculture 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

[16] Presented to the Plan development team on Mar. 12, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on Apr. 17, 2007.
Presented to the Management Review Team on June 6, 2007.

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 MFC 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 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 aquaculture 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 are 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, DCM, COE, N.C. Sea Grant, and the NC 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 CHPP, 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 NC 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 10.4). 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 aquaculture industry.

Table 10.4. Results of shellfish lease applications, 2001-2006. DMF Resource Enhancement.

Year	Applications	Results			
		Approved	Withdrawn	Denied	Pending
2001	1	1			
2002	8	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 an examination 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 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

+ 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 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

+ 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

MFC Selected Management Options

- Develop an independent education package as described in B. with mandatory completion of an examination with a passing score to meet education requirements
- Require the satisfactory completion of 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

AC and DMF
- Develop an independent education package as described in B. with mandatory completion of an examination with a passing score to meet education requirements
- Require the satisfactory completion of 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

RESEARCH RECOMMENDATIONS

None

10.13 TECHNICAL SUPPORT FOR SHELLFISH LEASEHOLDERS[17]

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.

BACKGROUND

In North Carolina, the stock status of the hard clam is "unknown," as little data on the species have been collected in North Carolina (DMF 2007b). Commercial landings, however, are

[17] Presented to the Plan Development Team on Mar.12, 2007.
Presented to the Oyster and Hard Clam FMP Advisory Committee on Apr. 17, 2007.
Presented to the Management Review Team on June 6, 2007.

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" (DMF 2007b). 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, O'Beirn 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 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). In 2006, there are 257 leases in the state for a total of 1,845 acres under cultivation, reflecting 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 adequately support private shellfish cultivation (Frankenburg 1995). State Fishery Management Plans (FMPs) for oysters and hard clams were adopted in August, 2001, by the MFC with recommendations regarding development of technical support services for shellfish leaseholders. 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 Cmmission.
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 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 (NCOHP 2007). 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 toward 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. 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 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. Most Canadian provinces have veterinary services for operators from a suite of aquaculture industries, not just shellfish (Animal Health Centre 2007). The services include 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 microanalysis suite for biological and environmental samples. Within the United States, the Marine Program of Cornell Cooperative Extension assists in aquatic disease diagnosis and referral (Rivera 1997). Within North Carolina, researchers at the NCSU, School of Veterinary Medicine, through a 2006 North Carolina FRG (Noga and Newman, unpublished 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

MFC Selected Management Options

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

AC - Develop public/private oyster larvae monitoring program

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

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

10.14 MOVEMENT OF CULTURED SEED SHELLFISH FROM POLLUTED WATERS[18]

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 NSSP's Guide for the Control of Molluscan Shellfish - Model Ordinance (see 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 AOP 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

<u>North Carolina General Statutes</u>
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

[18] Presented to the Plan Development Team on Apr. 17, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on May 7, 2007.
Presented to the Management Review Team on June 6, 2007.

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

MFC Selected Management Option

- *Status quo*

AC and DMF - *Status quo*

RESEARCH RECOMMENDATIONS

None

10.15 MODIFY SHELLFISH LEASE PROVISIONS[19]

ISSUE

During the 2001 planning process, the MFC identified several modifications to the statutory provisions of the Shellfish Lease Program that would provide for increased accountability and public acceptance.

[19] Presented to the Plan Development Team on Apr. 17, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on May 7, 2007.
Presented to the Management Review Team on June 6, 2007.

BACKGROUND

The MFC is on record in the 2001 North Carolina Oyster and Hard Clam 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 FMPs. 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 Committee’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 lease locations to be recorded in GPS coordinates (Lat./Long.) rather than requiring a registered land survey if compatible with state law.

   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.

   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

MFC Selected Management Options

- 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 requirements 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

AC and DMF
- 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 requirements 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

AC
- 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

RESEARCH RECOMMENDATIONS

None

10.16 COWNOSE RAY INTERACTIONS AND THEIR EFFECTS ON CLAMS AND OYSTERS[20]

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

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[20] Presented to the Plan Development Team on Jan. 25, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Feb. 26, 2007.
Presented to the Management Review Team on June 6, 2007.

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 (1974), 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

<u>North Carolina General Statutes</u>
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 (R. Myers, Dalhousie University, Canada, personal communication). 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 10.9). 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. Musick, Virginia Institute of Marine Science, personal communication).

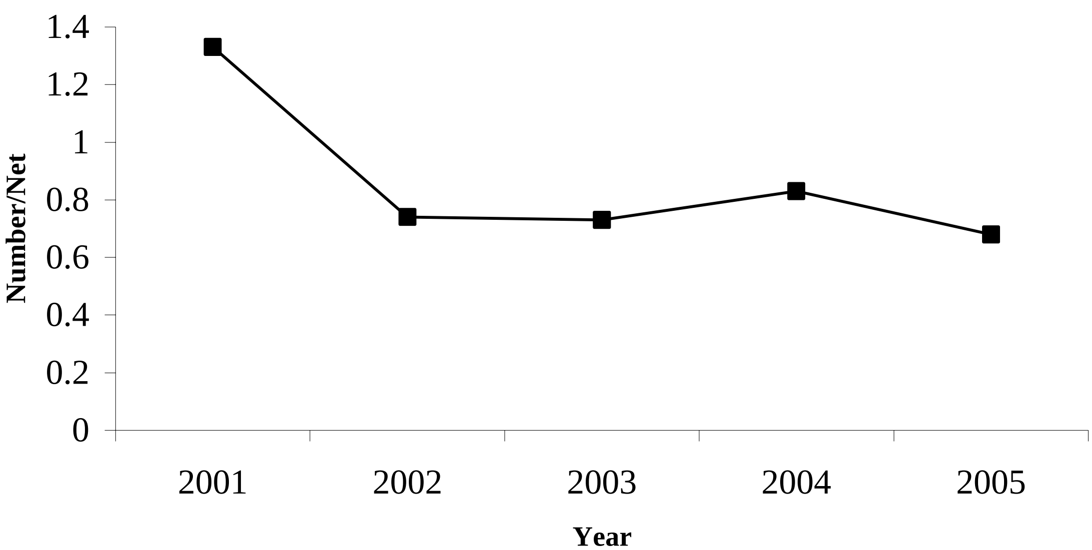

Figure 10.9. Average CPUE (number/net) of cownose rays in the independent gill net survey in Pamlico Sound. DMF biological sampling.

Major declines in sharks occurred in the 1980s, but some populations have rebounded to at least 50% of their former abundance (Jack Musick, Virginia Institute of Marine Science, personal communication). The DMF's 2007 stock status report designates sharks as concern because of great uncertainty about the large coastal shark complex. However, the small coastal shark complex is not overfished and although pelagics are unknown, they are assumed to not be overfished (DMF 2007).

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 (J. Smith, NMFS Beaufort Laboratory, personal communication). The food industry may benefit from cownose rays as both a protein source and a supplement source of chondroitin sulfate, glucosamine, and oil. For any ingredient to be pursued by a pet food manufacturer consistency of supply is crucial and ingredients that may vary by season are not often of interest. Pet food is the most highly regulated food product in the world; so stable inputs of quality ingredients are needed year round (N. Cook, Pet Food Institute, personal communication). Another concern would be if cownose rays would fit any of the current feed ingredient definitions used by the North Carolina Department of Agriculture (S. Jordan, North Carolina Department of Agriculture, personal communication).

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

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

MFC Selected Management Options

- *Status quo*
- Monitor seeded oyster sanctuaries for cownose ray predation

AC and DMF
- *Status quo*
- Monitor seeded oyster sanctuaries for cownose ray predation

RESEARCH RECOMMENDATIONS

Collect population information on cownose rays.

10.17 EDUCATION ON SHELLFISH HEALTH RISKS[21]

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.

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[21] Presented to the Plan Development Team on Apr. 17, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on May 7, 2007.
Presented to the Management Review Team on June 6, 2007.

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 NSSP governed by the ISSC of which DEH and DMF are voting members.

The NSSP is the federal/state cooperative program recognized by the 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 thus has the contact to disseminate educational materials.

There is limited educational information available for consumers from the Shellfish Sanitation Section linked within the DENR website on selling of raw shellfish (NC 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 *Vibrio vulnificus* (*Vv*)and *V. parahaemolyticus* (*Vp*). *Vv* is the most dangerous of the *Vibrios* and can cause serious infection in people with compromised immune systems. *Vv* can produce septicemia in immunosuppressed individuals and over 50% of patients with primary septicemia die. *Vp* 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 10.10).

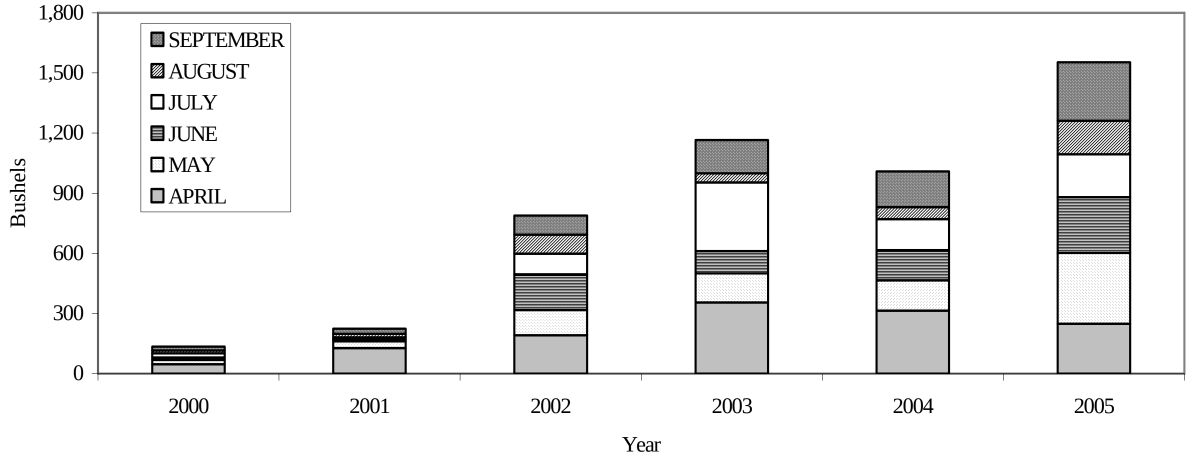

Figure 10.10. Commercial oyster harvest (bushels) from private leases during the closed oyster season (April – September), 2000-2005. DMF Trip Ticket Program.

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 North Carolina 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 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 Section 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

MFC Selected Management Options
- Encourage harvesters to take volunteer time and temperature control measures on their product
- Provide bilingual (English and Spanish) educational materials to consumers, leaseholders, UDOC permit holders, shellfish dealers, and other DENR state regulatory agencies

AC and DMF
- Encourage harvesters to take volunteer time and temperature control measures on their product
- Provide bilingual (English and Spanish) educational materials to consumers, leaseholders, UDOC permit holders, shellfish dealers, and other DENR state regulatory agencies

RESEARCH RECOMMENDATIONS

None

10.18 EFFECTS OF MECHANICAL CLAM HARVEST ON FISH HABITAT[22]

ISSUE

What are the effects of mechanical clam harvest on fish habitat and ways to minimize these effects?

BACKGROUND

There are numerous small fisheries that occur in North Carolina estuaries that utilize a dredge or a dredging type gear. These fisheries include the oyster dredge, the scallop dredge, the hydraulic escalator dredge and the clam trawl. These dredge types are highly managed using seasonal openings and closings that occur in certain areas of the state. The oyster dredge which consists of a metal framed basket weighing up to 100 lbs. with a toothed bar at the mouth is allowed only in the northeast portion of the state in certain areas based on criteria established in the 2001 Oyster FMP with the season occurring from November to March.

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[22] Presented to the Plan Development Team on Apr. 17, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on May 7, 2007.
Presented to the Management Review Team on June 6, 2007.

Scallop dredges can weigh no more than 50 lbs. and consist of a toothless bar so that impacts to SAV are minimized. Hydraulic escalator dredges as well as clam trawling "kicking" are allowed in certain areas that consist mostly of shallow sandy bottom areas and are also seasonally managed.

The use of mechanical gear to harvest clams began in 1949 in Core Sound with a method of dredging that involved loosening and washing bottom sediments with a boat propeller and towing an oyster dredge to harvest the clams that were uncovered. By the 1970s, this harvest method evolved into today's clam trawling or "kicking" where kick boats utilize deflector plates attached to the bottom of the boat to deflect prop wash toward the bottom, dislodging clams, which are captured in heavily chained trawl nets. The clam trawl is brought aboard and emptied on a culling tray where dead shell and other contents are culled through and discarded overboard in one place. In order for a kick boat to operate efficiently, the propeller must be within a few inches of the bottom. The use of hydraulic escalator dredges began in 1968 and utilizes jets of water provided by a high-pressure pump to remove bottom sediments covering the clams and to move the clams onto a conveyor, which brings the catch to the surface. Dead shells and other material remain on the conveyor after culling the clams and are immediately returned to the water where they are spread in a relatively thin layer on the bottom.

The harvest of clams by both of these methods is effective and efficient because it allows the harvest of clams that would otherwise not be harvested by hand because of water depth, weather, or bottom type. However, the ecological impacts of these gears on the bottom and their potential negative effects on hard clam recruitment, seagrass biomass, and benthic macroinvertebrates have been questioned (Peterson et al. 1987). Fisheries regulations prohibit the use of mechanical gear in SAV and live oyster beds because of the destructive nature of these gears. Fisheries regulations limit mechanical harvest season to the time period between December 1 and March 31 and only allow it in designated harvest areas between Ocracoke Inlet and Topsail Beach that do not contain significant SAV or oyster resources.

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

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

Damage from bottom-disturbing fishing gear varies with gear type, and habitat complexity and can be more severe where natural disturbance is least prevalent (Watling and Norse 1997). Soft bottom habitats have been considered the most appropriate bottom to use bottom-disturbing gear because of its lack of structure and complexity (DMF 1999). Areas of shallow sandy substrate located in places of high energy or tidal flow are regularly disturbed be natural physical processes and can recover quickly. A study conducted in North Carolina by Corbett et al. (2004) on the impact of trawling on the water column in a tributary of the Pamlico River found that sediment resuspension from wind over a large fetch was similar to trawling. During times when trawling was the dominant force, wind direction was over a small fetch.

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

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

Impacts from dredging and clam kicking in SAV may result in shearing of blades, shearing of seed and flowers, uprooting, and burial. Turbidity, which may cause a reduction in light for photosynthesis is also a concern. Below ground impacts are of great concern and can result from dredging and clam kicking in SAV beds. The resulting disturbances causes extensive damage to underground roots, rhizomes, and meristems that are essential for continued growth, nutrient uptake, and anchorage to the substrate (ASMFC 2000). Hydraulic dredges dig up all vegetation in a 3 ft. wide swath and have destroyed portions of SAV beds in Maryland and Virginia. It can also significantly increase local turbidity. Clam kicking in SAV beds results in increased loss of biomass and increased recovery time (ASMFC 2000).

Peterson et al. (1987) tested the impact of two different intensities (light and intense) of clam trawling and clam raking in a seagrass bed and in a sand flat. An obvious result from his study showed an immediate reduction of seagrass biomass as clam harvest intensity increased. Seagrass biomass fell 25% below controls in the raking and light clam kicking matrix, but full recovery occurred within a year. However, in seagrass beds where "intense" kicking was tested, seagrass biomass decreased by 65% of levels expected from controls. Recovery of seagrass in this matrix did not begin to occur until two years later. After four years, biomass was still 35% lower than predicted from controls. Bay scallop densities also declined with declining seagrass biomass across all harvest treatments. In the intense kicking matrices, there were even fewer scallops than predicted, probably due to the increase in patchiness of the remaining seagrass. There appeared to be no effects on densities or species composition of other macroinvertebrates in either the sand flat or the seagrass bed. This is because polychaetes that dominate both habitats have short life spans and can recover rapidly from disturbances. Effects on clam recruitment were somewhat ambiguous although recruitment in the sand flats was lower in the intense clam kicking matrices than in controls. There was no clear response of clam recruitment in the seagrass beds. It was concluded that hard clam fisheries should be managed to minimize the intensity of harvest within seagrass beds.

Hsiao et al. (1987) developed a simple open-access fishery model that demonstrated that clam kicking and clam raking had significant negative effects on the bay scallop fishery from 1961-1976. During this time mechanical harvest of clams was not constrained to specific areas as it is today and was allowed in all non-polluted waters. Therefore, mechanical harvest most likely did occur on oyster rocks and in SAVs. Beginning in 1978, mechanical areas were delineated in proclamations and have evolved over time to the current mechanical clam harvest areas.

The environmental effects of hydraulic dredges are not clear in that there has been little work on the potential effects on the bottom. Most studies have focused on subtidal bottoms with either vegetation or course sediment systems. High-pressure water jets can create a trench by penetrating the sediments to depths greater than 18". Trench duration and depth are generally a function of speed, operator skill, sediment type, water depth and local hydrological conditions. Shallower trenches with shorter duration times are typical of coarse sediments whereas trenches generated in muddy finer sediments are typically deeper and persist for extended durations (Coen 1995).

Burrell et al. (1991) evaluated the use of the hydraulic oyster escalator dredge used by South Carolina Department of Natural Resources to relay oysters to and from intertidal areas and found high oyster damage from harvest as well as nearly 100% mortality of those oysters transplanted during the summer. It was concluded that transplantation to upper intertidal areas was not viable. Transplant survival and growth was better in the lower intertidal areas during the winter and spring.

The environmental effects of a hydraulic clam dredge on intertidal beaches on Vancouver Island showed that clam mortality associated with the dredge was estimated to be as high as the harvest itself. Harvesting also resulted in deep trenches, mounds of side castings, and a redistribution of substrate material along with an overall instability of the beach (Adkins et al. 1983).

The recommendation from the 2001 Hard Clam FMP was to rotate current mechanical harvest areas with previously unopened areas. This was accomplished with the establishment of the Pamlico Sound mechanical harvest area, a previously unopened area. This area was rotated every two years beginning in 2001 with the northern Core Sound mechanical harvest area. This rotation is discussed in more detail in another issue within this plan.
At the time of the implementation of the 2001 Hard Clam FMP, the CHP was not adopted. The adoption of the CHPP in 2004 brought three 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 the Department of Environment and Natural Resources and other agencies and FMPs must now conform to CHPP standards for coastal habitat protection.

One of the recommendations of the CHPP is to protect SAV, shellbottom and hard bottom areas from fishing gear effects through improved enforcement, establishment of protective buffers around habitats and further restriction of mechanical shellfish harvesting. Modifying clam kicking and hydraulic dredging areas avoid all SAV and oyster beds and allow a buffer of 50-100 feet between mechanical shellfish gear and SAV and shell bottom is an implementation action of the CHPP.

CURRENT AUTHORITY

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
03K .0302 Mechanical Harvest Season
03K .0403 Dredges/Mechanical Methods Prohibited and Open Season

DISCUSSION

Current knowledge of fishing gear impacts indicates that mechanical clam harvest gear does have an effect on habitat. The use of mechanical harvest gear is prohibited on oyster rock, in SAV, in marshes and in Primary Nursery Areas. Current mechanical clam harvest areas are designated in proclamations and open the season beginning in December and close at the end of March. These areas are also posted by DMF staff to clearly mark those areas open to harvest. Over time, some of these areas have been encroached by SAV and oyster rocks. These areas are candidates for removal from mechanical harvest areas because of sensitive habitat. The DMF Shellfish Mapping Program may provide data for locations of oyster habitat in the different mechanical harvest areas. SAV mapping data from NOAA and Carraway and Priddy (1983) may provide historical distribution of SAV in mechanical harvest areas. A 2006 SAV mapping project by NOAA in Core Sound and Bogue Sound and a 2007 DENR mapping project for the state of North Carolina will also provide data for spatial distribution of SAV in the mechanical harvest areas and can be used to adjust lines.

Several mechanical harvest areas that may need adjustment to lines based on habitat include White Oak River, Newport River, North River, and Core Sound. North River lines were adjusted in February 2007 because of oyster rocks in the area (proclamation SF-3-2007).

White Oak and Newport rivers may also need adjustments to lines because of oyster rocks. The Core Sound harvest area is bordered by SAV on the eastern side and should be adjusted to avoid physical impacts to SAV.

Other areas open to mechanical harvest have not been fished because of low clam abundance. These areas are also candidates for removal from mechanical harvest areas. During 1987, a total of 350 Mechanical Clam Harvest Permits were issued. Since then, the number of mechanical harvesters has declined to less than 100 participants statewide. These declines are due to a combination of low clam abundance, high fuel prices, and low clam prices. Some areas within Core Sound, Newport River, Bogue Sound, and White Oak River are currently not harvested because of the lack of clam resources and lack of harvesters. Bogue Sound mechanical clam harvest has dropped from 13 participants in 1994 to less than four since 2000 with no one mechanically harvesting clams in Bogue Sound since 2004. White Oak River is rotated with New River with only 4 participants or less harvesting clams from the White Oak River. The southern sections of Core Sound are also not used anymore and may actually explain the SAV encroachment to that area. These areas may also be considered for closure by proclamation. Some fishermen fear that once an area is closed to fishing, it will never reopen. However, these areas are delineated in proclamations allowing for the flexibility of adjusting lines as conditions warrant.

Other ways to minimize the effects of mechanical clam harvest on bottom habitat include rotation of areas. The DMF currently rotates White Oak River with New River every other year. The northern portion of Core Sound is rotated with the Pamlico Sound harvest area every two years. These rotation schemes appear to work in these areas although it is not clear how successful rotation has been in Pamlico Sound. Shortening the season would also minimize the amount of impact to an area. Eliminating mechanical harvest would eliminate all harvest impacts with the exception of leases with mechanical harvest.

MANAGEMENT OPTIONS/IMPACTS

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

A. *Status quo*
+ No additional regulation
- Continued impacts on valuable benthic habitat (SAV, oyster rocks) in harvest areas along with possible impacts on species diversity of benthic fauna
- Does not support CHPP implementation goal

B. Modify mechanical harvest lines to exclude areas no longer fished but are currently open to mechanical clam harvest
+ Decrease in amount of habitat that could potentially be impacted by mechanical harvest
+ Meets CHPP implementation goal
- Loss of traditional mechanical harvest areas

C. Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information

+ Decrease the amount of habitat that is impacted by mechanical harvest
+ Meets CHPP implementation goal
- Larger number of boats in a reduced area could increase impacts to benthos

D. Shorten the mechanical harvest season

1. Limit the number of weeks

+ Shorter amount of time habitat is impacted
+ Longer amount of time habitat can recover
+ Reduced fishing effort on clam stocks
- Reduced income for mechanical harvesters

**Management options 2. and 3. were added after Marine Fisheries Commission review on 9/6/07 and considered by DMF and the AC in development of management recommendations in their final meeting on 10/29/07.

2. Further limit the number of days but allow harvesters to choose fishing days

+ Limits the amount of impacts to the habitat
+ Reduced fishing effort on clam stocks
- Reduced income for mechanical harvesters
- Reduced flexibility of mechanical harvesters
- No current infrastructure for implementing harvester-selected fishing days
- Increase burden on law enforcement

3. Limit the number of weeks and the number of days within each week

+ Shorter amount of time habitat is impacted
+ Longer amount of time habitat can recover
+ Limits the amount of impacts to the habitat
+ Reduced fishing effort on clam stocks
- Reduced income for mechanical harvesters
- Reduced flexibility of mechanical harvesters
- No current infrastructure for implementing harvest days
- Increase burden on law enforcement

E. Increase rotation of mechanical harvest in existing sites

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

F. Rotation of current mechanical harvest areas with previously unopened areas (Rule change required)

- \+ Increase in use of underutilized clam resources
- \+ Ability for closed portions of area to recover from mechanical harvest impacts
- \+ Unique research opportunity to study impacts of mechanical harvest
- \- Increase in overall amount of area impacted by mechanical harvest
- \- May create conflicts between hand harvesters and mechanical harvesters

G. Close all mechanical harvest areas

- \+ No further impacts by harvest gear on benthos
- \+ Reduced fishing effort on clam stocks
- \- Loss of income to mechanical harvesters

MANAGEMENT RECOMMENDATIONS

MFC Preferred Management Option

- Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information

AC

- Modify mechanical harvest lines to exclude areas no longer fished but are currently open to mechanical clam harvest
- Shorten the mechanical harvest season

AC and DMF

- Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information

RESEARCH RECOMMENDATIONS

Further research is needed on the impacts of clam trawls and escalator dredges on sandy bottom environments. More research is needed on the effects of clam recruitment and clam mortality in the mechanical harvest areas. Stock assessments are also needed in the waterbodies where mechanical harvest takes place.

10.19 EDUCATION ON PUBLIC HEALTH RISKS OF EATING SHELLFISH AND OVERBOARD DISCHARGE OF WASTE[23]

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 NSSP has mandated harvester education about overboard discharge. Currently, the DMF 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 ISSC of which the DEH and the DMF are voting members.

The NSSP is the federal/state cooperative program recognized by the 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

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[23] Presented to the Plan Development Team on Jan. 25, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Mar. 26, 2007.
Presented to the Management Review Team on June 6, 2007.

state program elements. Program requirements and guidelines are contained in the NSSP Model Ordinance. The FDA 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 Section classifies shellfish growing waters and certifies shellfish dealers in accordance with the guidelines of the NSSP Model Ordinance (NSSP 2003). The DMF is responsible for licensing shellfish harvesters and dealers and enforcing the rules of the MFC 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 Section 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 DMF 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

<u>Division of Environmental Health Rules (15A NCAC 18A)</u>
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 North Carolina 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. The 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

MFC Selected Management Option
- Provide educational materials to harvesters in license offices and webpage, through other training opportunities, through DMF Port Agent contact with harvesters and dealers, and include other state and federal regulatory agencies to reach all coastal waters users

AC and DMF - Provide educational materials to harvesters in license offices and webpage, through other training opportunities, through DMF Port Agent contact with harvesters and dealers, and include other state and federal regulatory agencies to reach all coastal waters users

RESEARCH RECOMMENDATIONS

None

10.20 WATER QUALITY DEGRADATION BY BIOLOGICAL CONTAMINATION OF SHELLFISH GROWING WATERS[24]

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 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.

[24] Presented to the Plan Development team on Feb. 15, 2007.
Presented to the Oyster and Hard Clam Advisory Committee Mar. 26, 2007.
Presented to the Management Review Team on June 6, 2007.

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 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 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 DEH 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 NSSP Guide For the Control of Molluscan Shellfish Model Ordinance. The NSSP is administered by the FDA, 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 DMF 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 DWQ is tasked with the developing these daily limits. The 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 DCM. 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 MF) and the CRC. This finding resulted in the production of the 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

<u>North Carolina General Statutes</u>

113-202	New and renewal leases for shellfish culture; termination of leases issue prior to January 1, 1966
143B-279.8	Coastal Habitat Protection Plans
143B-289.52	Marine Fisheries Commission - powers and duties

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 10.5). In 2006, Shellfish Sanitation reclassified 1,925 additional acres as Prohibited and 590 acres were reclassified from Conditionally Approved Open to Conditionally Approved Closed (DEH - Shellfish Sanitation unpublished data 2006).

The 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 Program 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 (T. Reeder, DWQ, personal communication).

Table 10.5. The ORW acreage opened and closed since Oct 1989. DEH, Shellfish Sanitation data.

ORW	Closure area	Closed	Acres	Opened	Acres
Masonboro Sound	Inlet Pt Harbor Marina	6/1998	1		
	Myrtle Grove Sound	5/1999	75		
	Inlet Pt Harbor Marina	5/2004	1		
	Hewletts Creek	12/2006	93		
Topsail/Middle Sound	Howe Creek	12/1991	130		
	Futch Creek	4/1993	50	5/1996	38
	Mill Creek	4/1993	73		
	Old Topsail Creek	4/1993	202		
Stump Sound	Turkey Creek	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 Sound	Archer Creek	7/1995	20		
	Sanders Creek	3/1996	77		
	Deer Creek	5/2000	60		
	Bogue Sound Yacht Club	5/2004	1		
	Hunting Island Creek			10/2004	15
	Sanders Creek			10/2004	30
	Cannonsgate Marina	6/2006	6		
Core/Back Sound	Marinas	7/1990	2		
	Cedar Creek	4/1994	40		
	Glover Creek	4/1994	25		
	Middens Creek	12/2006	5		
	Williston Creek	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

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 10.6).

Table 10.6. 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
Setback	30 ft	30 ft	30 ft
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 North Carolina (Table10.7). 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 10.7. 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 10,000 square feet land disturbance verses one acre or greater, a 30ft vegetated buffer verses a 50ft vegetated buffer and whether to exclude coastal marsh or all wetlands from the 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.

Some areas currently closed due to pollution may be suitable for leases because many of these closed areas are adequate growing areas and are near areas offering better opportunities for surveillance and access. Because of low existing shellfish resources these areas 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 unpublished data). 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 anddegradation 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 ISSC)

+ 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 shellfish beds are present and develop strategies to r 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 considered by DMF and the AC in development of management recommendations in their final meeting on 10/29/08.

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

MFC Selected Management Options

- 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
- Recommend a naturally vegetative buffer width of 50 feet
- Recommend the exclusion of all wetlands (coastal and non-coastal), from the built-upon area calculations

AC and DMF

- 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
- Recommend a naturally vegetative buffer width of 50 feet
- Recommend the exclusion of all wetlands (coastal and non-coastal),

from the built-upon area calculations

RESEARCH RECOMMENDATIONS

Continue research on means and methods for reduction of non-point source pollution and mitigation of pollutant effects in the estuary.

10.21 OYSTER ROCK MANAGEMENT OPTIONS[25]

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

[25] Presented to the Plan Development Team on Apr. 17, 2007.
Presented to the Oyster and Hard Clam Advisory Committee on May 7, 2007.
Presented to the Management Review Team on June 6, 2007.

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 SMAs 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 SAFMC (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 (MFC 2007).

Coen and Grizzle (2006) 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 CHPP contains a recommendation to greatly expand habitat restoration, including creation of subtidal oyster reef, no-take sanctuaries (Street et al. 2005).

CURRENT AUTHORITY

<u>North Carolina General Statutes</u>
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.

<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>
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 SMAs 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 Ward Creek issue is discussed in depth in the issue paper 10.22, Ward Creek Shellfish Management Area. Even though clam harvest appeared to be causing some damage to the oyster rocks, it happened during 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 oyster 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 eight 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, by many accounts, thousands of acres of potentially productive oyster bottom (Winslow 1889; Chestnut 1955a). 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 improving 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

MFC Selected Management Options

- *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

AC and DMF

- *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

RESEARCH RECOMMENDATIONS

None

10.22 WARD CREEK SHELLFISH MANAGEMENT AREA[26]

ISSUE

This is a review of the management SMAs in the central portion of the state. The impetus is an action taken in 1995 to protect oyster rocks in Ward 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 Ward Creek were being destroyed by clam harvesters using rakes and tongs prompted an investigation by the 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 Ward 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

<u>North Carolina General Statutes</u>
Taking shellfish from certain areas forbidden; penalty.

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[26] Presented to the Plan Development Team on Jan. 25, 2007.
Presented to the Hard Clam and Oyster Advisory Committee on Feb. 26, 2007.
Presented to the Management Review Team on June 6, 2007.

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 Ward 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 Ward 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 Ward 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 Ward 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

MFC Selected Management Option
- *Status quo* – leave current measures in place

AC and DMF - *Status quo* – leave current measures in place

RESEARCH RECOMMENDATIONS

None

11.0 RECOMMENDED MANAGEMENT STRATEGIES AND RESEARCH NEEDS

11.1 MANAGEMENT STRATEGIES

The management strategies and research needs listed below are organized according to the General Problem Statements (Section 5.2) as recommended by the MFC. Each strategy is followed by a reference to the Principal Issue(s) and Management Options from Section 10.0 and indicated in parentheses that supports it, followed by which Objective(s) it addresses from Subsection 4.1. An overall discussion of the environmental factors is in Section 9.0 with recommended management strategies for habitat and water quality found in Subsection 9.5.

11.1.1 INSUFFICIENT DATA

Many areas of hard clam biology and factors influencing their population dynamics are unknown and should be investigated prior to attempting more advanced stock assessment techniques. DMF will only be able to approximate management that prevents overfishing and achieves sustainable harvest until necessary data are collected. Data are lacking from both the recreational and commercial hard clam fisheries to provide a stock assessment. Socioeconomic surveys for the recreational hard clam fisheries are necessary to determine the economic impacts and demographics of the user groups.

[(Subsection6.4, subsection 7.2, subsection 8.3, section 9.0, Issue 10.1), (Objectives 1, 3, and 7)]

11.1.1.1 ISSUE: NO DATA ON THE RECREATIONAL HARVEST OF SHELLFISH

MANAGEMENT OPTIONS

A. *Status quo*
B. Institute a survey with limited sampling universe
   1. Intercept survey
   2. Phone survey
   3. Survey fishermen that use commercial licenses for recreational harvest
   4. Marine patrol survey
C. Require recreational shellfish harvesters to be licensed to provide a sampling universe for surveys
D. Require recreational shellfish harvesters to be permitted to provide a sampling universe for surveys

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- *Status quo,* no change

AC - *Status quo,* no change

DMF - Recommend requiring recreational shellfish harvesters to be licensed to provide a sampling universe for surveys

11.1.2 MANAGEMENT

The hard clam fishery is managed through harvest and size limits and gear and area restrictions. The management program needs to be evaluated and modified as information becomes available. Rules specific to hard clam management should be periodically reviewed to clarify the intent and reflect changes concurrent with new information.

[(Section 9.0 and Issues 10.2 to 10.10), (Objectives 1, 2, 4, 6, 7, and 8)]

11.1.2.1 ISSUE: OPEN OCEAN AREA FOR HARVEST OF CLAMS

MANAGEMENT OPTIONS

A. *Status quo*
B. Rescind the proclamation but keep authority to open if and when necessary
C. Place current proclamation in rule

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- Rescind the proclamation but keep authority to open if and when necessary

AC and DMF - Rescind the proclamation but keep authority to open if and when necessary

11.1.2.2 ISSUE: RECREATIONAL AND WEEKEND SHELLFISH HARVEST PROVISIONS

MANAGEMENT OPTIONS

A. *Status quo*
B. Adopt the rule changes as proposed
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

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Options
- Define recreational 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

AC and DMF - Define recreational 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

11.1.2.3 ISSUE: MECHANICAL HARVEST OF OTHER SHELLFISH MANAGEMENT OPTIONS

A. *Status quo*

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

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- 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

AC and DMF - 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

11.1.2.4 ISSUE: EFFECTS OF AN OPEN HARVEST LICENSE ON SHELLFISH FISHERIES

MANAGEMENT OPTIONS

A. *Status quo*
B. License cap
C. Eliminate the shellfish license and require a SCFL with a shellfish endorsement for shellfish harvest
D. Limit shellfish license holders to hand harvest only

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- *Status quo*, no change

AC and DMF - *Status quo*, no change

11.1.2.5 ISSUE: REQUIRE ALL SHELLFISH (OUT-OF-STATE) AT DEALER LEVEL TO BE TAGGED

MANAGEMENT OPTIONS

A. Status quo
B. Amend current rule 03K .0101 to require tags on all shellfish including from out-of-state.
C. Remove all shellfish tagging requirements

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- Require all shellfish to be tagged at the dealer level

AC and DMF - Require all shellfish to be tagged at the dealer level

11.1.2.6 ISSUE: ROTATION OF SOUTHEAST PAMLICO SOUND WITH CORE SOUND

MANAGEMENT OPTIONS

A. *Status quo*
B. Discontinue rotation of Pamlico Sound with northern Core Sound
C. Modify rotation schedule of Pamlico Sound with northern Core Sound from every two years to every other year
D. Discontinue rotation of Pamlico Sound and begin an annual rotation schedule within the Core Sound mechanical harvest area

MANAGEMENT RECOMMENDATION

MFC Selected Management Option
- Discontinue rotation of Pamlico Sound with northern Core Sound
- Institute a resting period within the mechanical clam harvest area in the northern part of Core Sound

AC and DMF - Discontinue rotation of Pamlico Sound with northern Core Sound
- Institute a resting period within the mechanical clam harvest area in the northern part of Core Sound

11.1.2.7 ISSUE: ENHANCING CLAM PRODUCTION

MANAGEMENT OPTIONS

A. *Status quo*
B. Create clam spawning sanctuaries
C. Stock enhancement by planting cultured seed clams
D. Examine methodologies to potentially enhance clam populations by planting cultured seed clams in combination with habitat enhancement
E. Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species.

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Options

- *Status quo*
- Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species
- If clam seed grow out is initiated then the hatchery facility should work with the MFC Shellfish Advisory Committee and DMF to determine management criteria for uses of the clam seed stock

AC and DMF

- *Status quo*
- Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species
- If clam seed grow out is initiated then the hatchery facility should work with the MFC Shellfish Advisory Committee and DMF to determine management criteria for uses of the clam seed stock

11.1.3 PRIVATE CULTURE

Periodical review of the lease program is necessary to make the system more productive. Improvements in the lease program including technical support to leaseholders may reduce conflict between leaseholders and other user groups. Educational information on the enhancement and restoration activities could improve public perception of shellfish enhancement.

[(Subsection 7.1.2.5 and 7.1.2.6, and Issues 10.11 through 10.18), (Objectives 1, 2, 4, 5, 6, 7, and 8)]

11.1.3.1 ISSUE: STATUS OF PRE-DEALER SEED SHELLFISH SALES

MANAGEMENT OPTIONS

A. *Status quo*
B. Change exemptions in 15A NCAC 03K .0305 and 03K .0207 to include 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
C. Enforce current rules and statutes

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option

- 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

AC and DMF - 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

11.1.3.2 ISSUE: SHELLFISH DEPURATION PLANTS

MANAGEMENT OPTIONS

A. *Status quo*
B. Change DMF rules to allow harvest of shellfish from polluted areas for processing in depuration facility. Rule change required.
C. Amend DMF rules to allow harvest of shellfish from shellfish leases and franchises in polluted areas for processing in depuration facilities. Rule change required.
D. Establish state-operated depuration facilities within the state Hatchery Program' three new hatcheries.

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- *Status quo*, no change

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

DMF - *Status quo*, no change

11.1.3.3 ISSUE: ALLOCATION OF AREAS FOR SHELLFISH LEASES

MANAGEMENT OPTIONS

A. *Status quo*
B. Establish predetermined shellfish lease sites
C. Utilize user coordination plans for shellfish lease issuance coast wide
D. Propose repeal of the session laws restricting shellfish lease activity and utilize user coordination plans for shellfish lease issuance
E. Enact a prohibition on issuance of new shellfish leases in all NC coastal fishing waters

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- Utilize user coordination plans for shellfish lease issuance coast wide

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

11.1.3.4 ISSUE: LEASEHOLDER EDUCATIONAL TRAINING

MANAGEMENT OPTIONS

A. *Status quo*
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
C. Develop an independent education package as described in B. with mandatory completion of an examination with a passing score to meet education requirements
D. Require the satisfactory completion of 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
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
F. 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

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Options

- Develop an independent education package as described in B. with mandatory completion of an examination with a passing score to meet education requirements
- Require the satisfactory completion of 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

AC and DMF

- Develop an independent education package as described in B. with mandatory completion of an examination with a passing score to meet education requirements
- Require the satisfactory completion of 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

11.1.3.5 ISSUE: TECHNICAL SUPPORT FOR SHELLFISH LEASEHOLDERS

MANAGEMENT OPTIONS

A. *Status quo*
B. Increase number and/or geographic distribution of SOMAs
C. Allow oyster growers to plant cultch in SOMAs for relay to private leases
D. Expand state oyster larval monitoring services to annual spatfall assessment for all plant sites
E. Develop public/private oyster larvae monitoring program
F. Support construction of an integrated system of shellfish hatcheries and remote-setting sites
G. Develop a subsidized, fee-for-service disease diagnosis program

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Options
- Support construction of an integrated system of shellfish hatcheries and
- Develop a subsidized, fee-for-service disease diagnosis program
- Support private oyster larvae monitoring programs

AC - Develop public/private oyster larvae monitoring program

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

11.1.3.6 ISSUE: MOVEMENT OF CULTURED SEED SHELLFISH FROM POLLUTED WATERS

MANAGEMENT OPTIONS

A. *Status quo*
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
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

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- *Status quo*

AC and DMF - *Status quo*

11.1.3.7 ISSUE: MODIFY SHELLFISH LEASE PROVISIONS

MANAGEMENT OPTIONS

A. *Status quo*
B. Adopt the recommendations as proposed
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)

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Options
- 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 requirements 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

AC and DMF
- 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 requirements 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

AC - 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

11.1.3.8 ISSUE: COWNOSE RAY INTERACTIONS AND THEIR EFFECTS ON CLAMS AND OYSTERS

MANAGEMENT OPTIONS

A. *Status quo*
B. Construction of fencing or stockades around the most productive beds
C. Educate leaseholders about construction of fencing/stockades and covering leases
D. Explore options for water column use by leaseholders during cownose ray migration
E. Transplantation of oysters and/or clams from areas where high numbers of cownose
rays congregate to areas with little or no cownose rays
F. Development of a commercial cownose ray fishery
G. Development of a recreational cownose ray fishery

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- *Status quo*
- Monitor seeded oyster sanctuaries for cownose ray predation

AC and DMF
- *Status quo*
- Monitor seeded oyster sanctuaries for cownose ray predation

11.1.3.9 ISSUE: EDUCATION ON SHELLFISH HEALTH RISKS

MANAGEMENT OPTIONS
A. *Status quo*
B. Eliminate out of season oyster harvest from leases
C. Provide educational materials to consumers, leaseholders, UDOC permit holders, and shellfish dealers

D. Red tag summer oysters with consumer advisory.
E. Encourage harvesters to take volunteer time and temperature control measures on their product

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- 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

AC and DMF
- 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

11.1.4 HABITAT AND WATER QUALITY CONCERNS

Suitable and adequate habitats are critical elements in the ecology and productivity of hard clams. Water quality conditions causing polluted waters and health risks associated with shellfish are explored. The gear issues deal with the use of bottom disturbing fishing gears used in the hard clam fishery that have the potential to destroy or damage SAV or oyster beds. Fishery restrictions already exist for most of the gears used in North Carolina that are potentially damaging to SAV and oyster beds.

[(Section 9.0 and Issues 10.19 through 10.22), (Objectives 3, 4, 6, and 8)]

11.1.4.1 ISSUE: HABITAT

MFC Selected Management Options, AC and DMF -

Strategic Habitat Areas

1. Identify and delineate Strategic Habitat Areas that will enhance protection of clam habitats; research physical factors influencing clam abundance predictably.
2. Coordinate SHAs with land-based conservation and restoration activities such as One North Carolina Naturally and DENR’s green infrastructure planning.

Shell bottom and SAV

3. Ensure oyster and SAV habitat definitions are consistent across regulating agencies.
4. Completely map all structured habitat (i.e., shell bottom, SAV) in North Carolina, including the deep, subtidal rocks on Pamlico Sound.

5. Remap structured habitats to assess changes in distribution and abundance over time.
7. Restore historical distribution and acreage of oysters and SAV where possible; coordinate with land-based protection and restoration efforts.
8. Balance protection of oyster beds and SAV (as habitat) with harvest provisions; expand oyster sanctuary planting and designation.
9. Monitor biological/ecological condition and effectiveness of oyster sanctuaries and restored SAV beds.
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 and SAV habitat.
11. Develop permit application survey protocols for shellfish and SAV habitats for CAMA applicants.
12. Evaluate and adjust as necessary dredging and trawling boundaries to protect and enhance oyster and SAV habitat.
13. Seek additional resources to enhance enforcement of and compliance with expanded bottom disturbing fishing gear restrictions that protect oyster and SAV habitat.
14. Evaluate making conservation leasing available to non-government organizations for the purpose of oyster restoration and sanctuary development.

11.1.4.2 ISSUE: WATER QUALITY

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 SAV growth and clam production.
2. Seek 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.
3. Target productive shellfish resources in conditionally approved closed areas for land-based protection and restoration efforts. This could include designation as Strategic Habitat Are or Use-Restoration Water.

11.1.4.3 ISSUE: EFFECTS OF MECHANICAL CLAM HARVEST ON FISH HABITAT

MANAGEMENT OPTIONS

A. *Status quo*
B. Modify mechanical harvest lines to exclude areas no longer fished but are currently open to mechanical clam harvest
C. Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information
D. Shorten the mechanical harvest season

    1. Limit the number of weeks

**Management option 2. and 3. were added after Marine Fisheries Commission review on 9/6/07 and considered by DMF and the AC in development of management recommendations at their last meeting on 10/29/08.

2. Further limit the number of days but allow harvesters to choose fishing days
3. Limit the number of weeks and the number of days within each week

E. Increase rotation of mechanical harvest in existing sites
F. Rotation of current mechanical harvest areas with previously unopened areas (Rule change required)
G. Close all mechanical harvest areas

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information

AC
- Modify mechanical harvest lines to exclude areas no longer fished but are currently open to mechanical clam harvest
- Shorten the mechanical harvest season

AC and DMF
- Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information

11.1.4.4 ISSUE: EDUCATION ON PUBLIC HEALTH RISKS OF EATING SHELLFISH AND OVERBOARD DISCHARGE OF WASTE

MANAGEMENT OPTIONS

A. Status quo
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.
C. Develop “No Discharge Zones” in all approved shellfish growing areas.

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- 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

AC and DMF - 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

11.1.4.5 ISSUE: WATER QUALITY DEGRADATION BY BIOLOGICAL CONTAMINATION OF SHELLFISH GROWING WATERS

MANAGEMENT OPTIONS

A. *Status quo*
B. Continue use of existing statutory authority (permit comments, CHPP development)
C. Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation
D. Change operational policy and rules to increase shellfish lease use of marginal polluted areas
E. Accept closures and develop new standards for shellfish consumption (Recommend changes through the Interstate Shellfish Sanitation Conference)
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
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
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

**Management option I. was added after Habitat and Water Quality Committee review on 8/13/07 and considered by DMF and the AC in development of management recommendations at their last meeting on 10/29/08.

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.

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option

- 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
- 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

AC and DMF
- 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
- 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

11.1.4.6 ISSUE: OYSTER ROCK MANAGEMENT OPTIONS

MANAGEMENT OPTIONS

A. *Status quo* (Harvest of oysters and clams allowed except on designated areas)
B. Eliminate clam harvest on all designated oyster rocks
C. Eliminate all shellfish harvest from oyster rock habitat (assumes all bottom disturbing gear as well)
D. Eliminate all shellfish harvest from oyster rock habitat and replace production Through oyster culture
E. Recommend repeal of G.S. 113-207 (a) and (b)
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

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- *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

AC and DMF - *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

11.1.4.7 ISSUE: WARD CREEK SHELLFISH MANAGEMENT AREA

MANAGEMENT OPTIONS

A. *Status quo* – leave current measures in place
B. Modify proclamation to prohibit hand rakes and tongs year-round
C. Rescind the proclamation and designation of Shellfish Management Area

MANAGEMENT RECOMMENDATIONS

MFC Selected Management Option
- *Status quo* – leave current measures in place

AC and DMF - *Status quo* – leave current measures in place

11.2 SUMMARY OF RESEARCH RECOMMENDATIONS

The following research recommendations were compiled from the Socioeconomic Status of the Hard Clam Fishery (Section 8.0), Environmental Factors (Section 9.0) and issue papers listed in the Principal Issues and Management Options (Section 10.0). Proper management of the hard clam resource cannot occur until some of these research needs are met.

1. Standardize monitoring metrics and methodologies with other researchers when possible
2. Validation of ageing methods in North Carolina.
3. Investigating the role of adult dispersion patterns in spawning success.
4. Determining fecundity of clams at each age.
5. Determining the importance of flushing rates and larval predation on larval survival.
6. Identifying factors influencing settlement success.
7. Identifying source and sink areas.
8. Describing spatial and temporal patterns of larvae and juveniles.
9. Investigating the role of lateral movement of juveniles in recruitment.
10. Determining the effects of harvest methods on juvenile settlement and survival.
11. Development of an adult abundance index.
12. Noting regional changes in abundance.
13. Determining natural mortality estimates.

14. Identifying factors influencing hard clam growth in North Carolina.
15. Collecting recreational landings data.
16. Survey recreational participants for demographic and spending data
17. Determine the effect of shellfish filtering capacities on water quality parameters, such as bacteria, nutrients and sediments
18. Support collaborative research to more efficiently track bacterial sources for land-based protection and restoration efforts
19. Quantify the impact of current fishing practices on clam habitat suitability in North Carolina
20. 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
21. Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units (i.e., docks, bulkhead sections)
22. Utilize standardized monitoring metrics and methodologies with other researchers for clam restoration when possible
23. Investigate clam larval dispersal and transport
24. Determine the hydrodynamics of the areas for increasing clam production
25. Investigate areas of sanctuary placement (shallow/deep), size, and impacts to the local fishing grounds.
26. Study the effects of transplanting spawners
27. Determine methodologies to reduce predation
28. Increase seed planting efficiencies
29. Cost analysis of various enhancement approaches
30. Stock assessments of clams and oysters located within polluted areas
31. Review of current depuration programs in other states
32. Review of current DEH rules and possibly updating the rules may be necessary to fully reflect current technologies.
33. Explore new technologies for off-bottom culturing methods
34. Further develop new types of biomarkers that can be used to select more effectively for disease-resistant genetic stock
35. Develop disease-resistant or fast-growing strains of shellfish
36. Establish a brood stock (hard clam and oyster) development program
37. Develop methods to determine health of shellfish stocks to various diseases
38. Assess survival and productivity of relayed oysters vs. natural recruitment on planted cultch
39. Investigate timing of oyster spatfall, larval dispersal and transport
40. Determine the hydrodynamics of the areas for restoration and culture activities
41. Collect population information on cownose rays
42. Further research on the impacts of clam trawls and escalator dredges on sandy bottom environments
43. Further studies on the effects of clam recruitment and clam mortality in the mechanical harvest areas
44. Stock assessments are also needed in the waterbodies where mechanical harvest takes place
45. Continue research on means and methods for reduction of non-point source pollution and

mitigation of pollutant effects in the estuary

11.3 REVIEW CYCLE

As provided in the Fisheries Reform Act of 1997, the Hard Clam FMP will be reviewed and revised at least every five years with the support of advisors. This document is a review of the Hard Clam 2001 FMP.

12.0 LITERATURE CITED

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13.0 APPENDICES

13.1 SUMMARY OF MANAGEMENT AND RESEARCH RECOMMENDATIONS FROM THE 2001 HARD CLAM FMP

Tier 1 - Management recommendations requiring no additional funding or reallocation of funds/personnel required.

MANAGEMENT STRATEGY	OBJECTIVES	OUTCOME
Insufficient Data		
1. Support adoption of a mechanism that would provide data on recreational shellfish harvest and add “pleasure” category to the existing Shellfish License.	3, 6, and 8	New recreational fishing license does not include shellfish
Management Strategies		
2. Rotate southeast Pamlico Sound area with Core Sound.	1, 2, 3, 4, and 6	Accomplished Began in 2002 by proclamation and defined area in Rule 03K .0302(b)
3. Lower the bag limit in Core Sound to 20 bags. Pamlico Sound area bag limit would also be 20 bags.	1, 2, 3, 4, and 6	Accomplished By proclamation since 2001.
4. Continue to allow all NC residents to purchase a shellfish license.	3 and 8	No action required
5. Status quo on nighttime unloading rule.	6	No action required
Private Culture		
6. Change operational policy to increase use of marginal polluted areas for shellfish leases.	6 and 8	No action
7. Inform public about Department of Agriculture and Department of Environment and Natural Resources roles concerning shellfish culture.	6	No action
8. Formalize and amplify current policy on transfers on out-of-state shellfish into NC waters.	6	Accomplished
9. Recommend adoption of a statutory policy statement supporting shellfish culture insofar as it does not interfere with traditional fishing practices	6	Accomplished G. S. 113-201
10. Amend shellfish lease production rule to require harvest and sale of 10 bushels of shellfish per acre per year and planting of 50 bushels of cultch or 25 bushels of seed per acre per year to maintain lease production.	1, 6, and 8	Accomplished Rule 03O .0201 in 2003.
11. Status quo on opportunities for riparian landowners to culture shellfish.	1 and 6	No action required
12 Recommend water column lease fees change to an amount ten times the fee for bottom leases ($100 per acre according to current recommendations).	6 and 8	Accomplished G. S. 113-203

Tier 1 - Management recommendations requiring no additional funding or reallocation of funds/personnel required.

MANAGEMENT STRATEGY	OBJECTIVES	OUTCOME
Private Culture		
13. Continue to record clam production units as bushels.	6	No action required
14. Recommend adoption of a statutory requirement for shellfish culture training certification for new applicants for shellfish leases. Training for existing leaseholders meeting production requirements would not be required.	6 and 8	Accomplished G. S. 113-201
15. Recommend shellfish lease fees be set as follows: application fee - $200 renewal application fee - $100, rental fee - $10 per acre per year. Also recommend a change in the term of the lease contract to expire July 1 to facilitate proper renewals.	6 and 8	Accomplished G. S. 113-202
16. Apply Fisheries Reform Act requirements to a revised, organized, upgraded permit system.	3, 6, and 8	Accomplished Rule 030 .501
Habitat and Water Quality		
17. Increase use of existing statutory authority (permit comments, CHPP development) to reverse the trends in closure of shellfish waters to harvest.	6 and 7	In progress under CHPP
18. Develop strategies to restore water quality of Conditionally Approved harvest area and maintain water quality of Approved harvest areas by:	1, 6, and 7	Accomplished
- Classifying Conditionally Approved Open shellfish waters Partially Supporting		MFC letter
- Classifying Conditionally Approved Closed shellfish waters as Not Supporting		
- Adopting standards that limit total impervious cover immediately adjacent to SA waters to 10 percent		Accomplished MFC letter
- Requiring mitigation that results in water quality enhancements in permanently closed areas.		Implemented by policy
19. Recommend specific changes to DWQ and EMC.	1, 6, and 7	

Tier 2 - Management recommendations requiring reallocation of personnel/funds required at Division level; no additional funding required.

MANAGEMENT STRATEGY	OBJECTIVES	OUTCOME
Management Strategies		
1. Continue to relay oysters as normal and increase the intensity of the recent clam relay schedule.	5, 6, and 8	No action
Private Culture		
2. Continue the statutory shellfish lease program and increase relaying to public bottom to address concerns over use of public resources.	6 and 8	No action, affected by funding cuts
3. Designate and plant cultch on managed seed beds for use on leases and franchises.	1, 5, 6, and 8	Cultch planted on Bay River Seed Oyster Management Area
Habitat and Water Quality		
4. Implement additional experimental closures of oyster areas based on habitat value for both oysters and clams.	2 and 4	No action
5. Enhance clam habitat by planting shell and other material.	5 and 9	No action
6. Examine methodologies to potentially enhance clam populations by planting seed clams in combination with habitat enhancement.	2 and 5	No action

Tier 3 - Management recommendations requiring additional funding required.

MANAGEMENT STRATEGY	OBJECTIVE	OUTCOME
Insufficient Data		
1. Expand Shellfish mapping program.	1 and 3	Funding approved in 2006 NCGA budget: 4 pos. $87,000
2. Expand catch/effort sampling of hard clam catches.	1 and 3	Began fishery dependent sampling in 1999. Have a total of 366 samples from 1999-2005. Investigating data at present for current FMP.
3. Develop a fishery independent sampling program to determine population abundance.	1 and 3	In progress. Still considered a pilot study.
Private Culture		
4. Develop and utilize user coordination plans to assess areas or shellfish leasing.	3, 6, and 8	No additional funding
5. Request funding research, disease, and education centers for shellfish culture.	2, 5, 9, and 10	No additional funding
6. Recommend increased funding to Shellfish Sanitation.	7	No action; Must be approved Legislatively

Summary of research recommendations from the 2001 Hard Clam FMP

RESEARCH RECOMMENDATION	OUTCOME
Insufficient Data	
1. Determine which regions in North Carolina have discreet populations.	No action
Management	
2. Evaluate the amount of harvest that can occur without affecting spawning stock in areas harvested with mechanical gear.	No action
3. Evaluate effects and recovery of areas opened to mechanical gear.	No action
4. Analysis of trends in the license universe and trip ticket data to indicate increases in effort	In progress for upcoming FMP update
Private Culture	
5. Quantify effects of shellfish habitat and the benefits of establishing shellfish sanctuaries.	No action
6. Examine the cost:benefit ratio of relaying shellfish to public	No action
7.Examine recovery rates of harvested relay areas for different areas of the coast.	No action
8. Determine the effects of relay on hard clam mortality.	No action
9. Expand human use mapping and shellfish mapping to provide coastwide data.	Funding approved in 2006 NCGA budget: 4 pos. $87,000
10. Determine areas for block leasing by user coordination studies in various areas.	No additional funding
11. Develop a protocol for defining BMP's among water bodies with differing production capacities and differing hydrological dynamics.	
12. Determine ecological benefits from shellfish aquaculture activities.	No action
13. Develop an Internet or correspondence training course for certification or re-certification of shellfish culturists.	No action
14. Determine most effective seedbed shell planting areas, timing of plants and protocol for shellfish larvae and spatfall.	No action
15. Research and develop appropriate extensive and intensive shellfish culture methods, improve genetics and disease resistance of cultured stocks and perform biological monitoring and support services to growers	FRG by Mark Hooper.00-AM-01
16. Stock assessments of clams located in polluted areas geographically to determine if a depuration operation would be feasible and aid in sizing the facility.	No action
17. Review current depuration programs in other states.	No action
Habitat and Water Quality	
18. Continue research on means and methods for reduction of non-point source pollution and mitigation of pollutant effects in the estuary.	Research by other agencies ongoing
19. Develop better databases and database management to enable to quantify use ratings	Refer to #18 in Tier 1 Management Recommendations
20. Determine impacts of clam trawls and escalator dredges on sandy bottom environments.	No action

Summary of research recommendations from the 2001 Hard Clam FMP

RESEARCH RECOMMENDATION	OUTCOME
Habitat and Water Quality	
21. Determine effects of clam recruitment and clam mortality by mechanical harvests.	No action
22. Determine water circulation in different waterbodies studies.	No action
23. Evaluate site selection protocols for best planting sites	No action
24. Determine effects of transplanting spawners.	No action
25. Determine contribution of different enhancement strategies	No action
26. Examine methodologies to reduce predation, increase seed planting efficiencies	No action
27. Perform cost analyses as needed.	No action

13.2 OVERVIEW OF THE MFC REGIONAL COMMITTEES RECOMMENDATIONS OF THE DRAFT OYSTER AND HARD CLAM FMPS WITH PUBLIC COMMENT

	Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**		**Public**
BOTH FMPs								
All CHPP Habitat and Water Quality Recommendations pertaining to Oysters (22) and Hard Clams (17)	Support all Habitat and Water Quality recommendations	Same as DMF	AC/DMF	AC/DMF	AC/DMF **NOTE: One member was upset that a WQ recommendation suggests giving funding to local communiities for not keeping in compliance with their waste and water systems*	Habitat recs.: AC/DMF *except exlude the recommendation to encourage hand harvest over mechanical harvest methods until the group discusses it in more detail in the issue paper*. WQ recs: AC/DMF *with an amendment to change the recommendation stating "provide additional funds" to read instead "seek additional funds".*		No comments

* *Additional recommendations or comments from the committees in italics and underlined*

** Items underlined in AC or DMF recommendations to show variation between the two

*****Items in the AC and DMF recommendations in bold indicate changes after the public comment period**

Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**	**Public**
Open Harvest License Effects	Status quo	Same as DMF	*Explore approaches to document the landings that are not being accounted for on Trip Tickets.*	AC/DMF	AC/DMF	AC/DMF	No comments
Recreational and Weekend Shellfish Harvest	Define recreational gear; No sale of weekend **recreational** shellfish harvest except from leases; and Propose repeal of 113-169.2 license exemption and set recreational limits in rule and proclamation	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments
Require out-of-State Shellfish to be Tagged	Require all shellfish to be tagged at the dealer level	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments
Mechanical Harvest of Other Shellfish (other than clams, oysters, scallops, and rangia clams)	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	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments

Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**	**Public**
Shellfish Depuration Plants	Status quo	<u>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</u>	DMF; <u>*Explore which changes are necessary to allow depuration.*</u>	DMF; <u>*Explore which changes are necessary to allow depuration in the research recommendations.*</u>	DMF; <u>*Follow through on the research recommendations to investigate how to proceed with depuration in NC.*</u>	AC	Mr. Brad Scott attended the Southeast and Central meetings to express his support to allow depuration in NC from leases
Allocation of Shellfish Lease areas/Human use Mapping and User Coordination Plans	Utilize user coordination plans for shellfish lease issuance coast wide	Same as DMF	AC/DMF	No position	AC/DMF	AC/DMF	No comments
Technical Support for Shellfish Leaseholders	Support construction of an integrated system of shellfish hatcheries and remote-setting sites; and <u>Develop a subsidized, fee-for-service disease diagnosis program</u>	Support construction of an integrated system of shellfish hatcheries and remote-setting sites; and <u>Develop a public/private oyster larvae monitoring program;</u> **Develop a subsidized, fee-for-service disease diagnosis program**	DMF	No position	AC and DMF	DMF	The CCA attended the Inland meeting and supports AC recommendation
Cownose Ray Interaction with Clam and Oyster Populations	Same as AC	Status quo; and Monitor seeded oyster sanctuaries for cownose ray predation	AC/DMF	AC/DMF	AC/DMF	AC/DMF	The CCA attended the Inland meeting and supports AC/DMF recommendation

Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**	**Public**
Status of Pre-Dealer Seed Shellfish Sales	Propose an exemption from G.S. 113-168.4(b)(1) when the sale of seed is to lease, UDOC permit, or Aquaculture Operations Permit holders for further rearing	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments
Leaseholder Education Training	Develop an education package with mandatory completion of **an examination** with a passing score to meet education requirements; 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 agencies such as the Oyster Hatchery Program and N.C. Sea Grant conduct shellfish lease training as part of their educational and outreach activities; and 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	Same as DMF	AC/DMF **NOTE: One member asked what about franchises?*	AC/DMF	AC/DMF	AC/DMF *and include a wording change that they must pass an exam/test rather than the requirement for training.*	No comments

Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**	**Public**
Modify Shellfish Lease Provisions	DMF selected all the recommendations except (2), which are: (1)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; (3)Limit acreage per shellfish lease application to 5 acres; (4)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; (5)**Require Lat./Long. coordinates on lease corner locations as part of the requirement of a registered land survey**; (6)Develop regional lease acreage caps based on established use of water bodies; (7)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	The AC selected all the recommendations, which are: (1)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; (2)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; (3)Limit acreage per shellfish lease application to 5 acres; (4)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; **(5)Require Lat./Long. coordinates on lease corner locations as part of the requirement of a registered land survey;** (6)Develop regional lease acreage caps based on established use of water bodies; (7)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	AC	DMF *with modifications to #5 to comply with state laws. *NOTE: #5 is confusing in that a state law requires a registered land survey for leases whether the lease has GPS coordinates or not. The intent is still continue the required land survey and additional GPS coordinates as written just somewhat confusing in the wording.*	DMF	DMF	The CCA attended the Inland meeting and supports the AC recommendation

Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**	**Public**
Education on Shellfish Health Risks	Same as AC	Provide bilingual (English and Spanish) educational materials to consumers, leaseholders, UDOC permit holders, shellfish dealers, and other DENR state regulatory agencies; and Encourage harvesters to take volunteer time and temperature control measures on their product	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments
Movement of Cultured Seed Shellfish from Polluted Areas	Status quo	Same as DMF	*Adopt federal guidelines for aquaculture of seed shellfish.*	AC/DMF	AC/DMF	AC/DMF	Mr. Brad Scott attended the Southeast and Central meetings to express his support to allow movement of seed shellfish from polluted waters.
No Data on Recreational harvest of shellfish	Recommend requiring recreational shellfish harvesters to be licensed to provide a sampling universe for surveys	Status quo	DMF	*Recommend a permit be issued to recreational shellfish harvesters to capture information on recreational shellfish harvest.*	*Add shellfish as an endorsement to the CRFL at no extra charge.*	*Recommend shellfish as part of the CRFL.*	The CCA attended the Inland meeting and supports the DMF recommendation

Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**	**Public**
Biological Contamination of Shellfish Growing Waters	Same as AC	Support DWQ's efforts to improve stormwater rules through permit comments and CHPP implementation and co-ordinate with sister agencies; Recommend DWQ 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 the EMC adopt a lower threshold of 10,000 square feet of land disturbance to activate 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 calculation**	AC/DMF	AC/DMF *NOTE: 2-yes and 2-abstained; concern that not enough science has justified the proposed impervious surface requirements*	AC/DMF	AC/DMF	No comments

Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**	**Public**
Education on Public Health Risks	Same as AC	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	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments
Ward Creek Shellfish Management Area	Status quo	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments
Oyster Rock Management Measures	Status quo (Harvest of oysters and clams allowed except in designated areas); Recommend repeal of G.S. 113-207 (a) and (b); and 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	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments

Recommendations							
Issue/Section	**DMF**	**AC**	**Southeast**	**Central**	**Northeast**	**Inland**	**Public**
HARD CLAM ISSUES ONLY							
Ocean Open Area for Harvest of Clams	Rescind the proclamation but keep authority to open if and when necessary	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments
Rotation of Southeast Pamlico Sound with Core Sound	Discontinue rotation of Pamlico Sound with northern Core Sound **and institute a resting period within the mechanical clam harvest area in the northern part of Core Sound**	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF *and develop a rotation plan within the Core Sound mechanical clam harvest area*	No comments
Enhancing Clam Production	Status quo; and Support the recommendation by the MFC that the Shellfish Hatchery Planning Advisory Team consider multiple uses of the demonstration shellfish hatchery facilities for different shellfish species. If clam seed grow out is initiated then the hatchery facility should work with the MFC Shellfish AC and DMF to determine management criteria for the uses of the clam seed stock.	Same as DMF	AC/DMF	AC/DMF	AC/DMF	AC/DMF	No comments
Effects of Mechanical Clam Harvest on Fish Habitat	Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information.	Modify mechanical harvest lines to exclude areas no longer fished but are currently open to mechanical clam harvest; and Modify mechanical harvest lines to exclude areas currently open to mechanical harvest where oyster habitat and SAV habitat exist based on all available information; and Shorten the mechanical harvest season.	DMF	Status quo	DMF: **NOTE: One vote for no*	DMF **NOTE: vote was yes-8 and no-1*	The CCA attended the Inland meeting and supports the AC recommendation

13.3 RULES NECESSARY TO IMPLEMENT HARD CLAM FMP AMENDMENT 1 RECOMMENDATIONS

Issue: **10.3- Recreational and weekend shellfish harvest provisions**

15A NCAC 03I .0101is proposed for amendment as follows:

.0101 DEFINITIONS (Partial)

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

(b) The following additional terms are hereby defined:

(1) Commercial Fishing Equipment or Gear. All fishing equipment used in coastal fishing waters except:

(A) Seines less than 30 feet in length;

(B) Collapsible crab traps, a trap used for taking crabs with the largest open dimension no larger than 18 inches and that by design is collapsed at all times when in the water, except when it is being retrieved from or lowered to the bottom;

(C) Spears, Hawaiian slings or similar devices which propel pointed implements by mechanical means, including elastic tubing or bands, pressurized gas or similar means;

(D) A dip net or scoop having a handle not more than eight feet in length and a hoop or frame to which the net is attached not exceeding 60 inches along the perimeter;

(E) Hook-and-line and bait-and-line equipment other than multiple-hook or multiple-bait trotline;

(F) A landing net used to assist in taking fish when the initial and primary method of taking is by the use of hook and line;

(G) Cast Nets;

(H) Gigs or other pointed implements which are propelled by hand, whether or not the implement remains in the hand; ~~and~~

(I) Up to two minnow ~~traps.~~ traps; and

(J) Hand operated tongs, hand operated rakes no more than 12 inches wide and weighing no more than 6 pounds, and taking shellfish without the use of harvest tools.

(2) Fixed or stationary net…………………………………………….

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 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)~~ <u>(a)</u> It is unlawful to take oysters or clams <u>from public bottoms</u> on Sundays, and scallops <u>from public bottoms</u> on Saturdays and Sundays except:

(1) during open seasons, and

(2) ~~in accordance with limits outlined in G.S. 113-169.2.~~ <u>for recreational purposes.</u>

<u>(b) It is unlawful to possess, for recreational purposes, more than:</u>

<u>(1) ten conchs or whelks per person per day, not to exceed 20 conchs or whelks per vessel per day, and</u>

<u>(2) 100 mussels per person per day, not to exceed 200 mussels per vessel per day, and</u>

<u>(3) 100 clams per person per day, not to exceed 200 clams per vessel per day.</u>

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: **10.6- Require all shellfish (out-of-state) 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 except as provided in G. S. 113-169.2 (i) 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 dealers 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 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) 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 dealers 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: **10.4-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: **10.12-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 amendment 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.
<u>(e) Within six months after transfer of ownership, the transferee shall complete shellfish cultivation lease training as specified in 15A NCAC 03O .0202(d).</u>

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: <u>**10.15**</u>-<u>**Modify shellfish lease provisions**</u>

A statutory change making the shellfish bottom lease term 5 years instead of 10 years is required to implement this proposed rule change.

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.

(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.

(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.

~~(b)~~ (c) 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)~~ (d) The following standards shall be applied to determine compliance with Subparagraphs (1) and (2) of Paragraph ~~(b)~~ (c) 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.

13.4 STATUTE CHANGES NECESSARY TO IMPLEMENT HARD CLAM FMP AMENDMENT 1 RECOMMENDATIONS

Issue: **10.3**- **Recreational and weekend shellfish harvest provisions**

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: **10.9**- **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: **10.12**- **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: **10.15**-**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: **10.21**-**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.