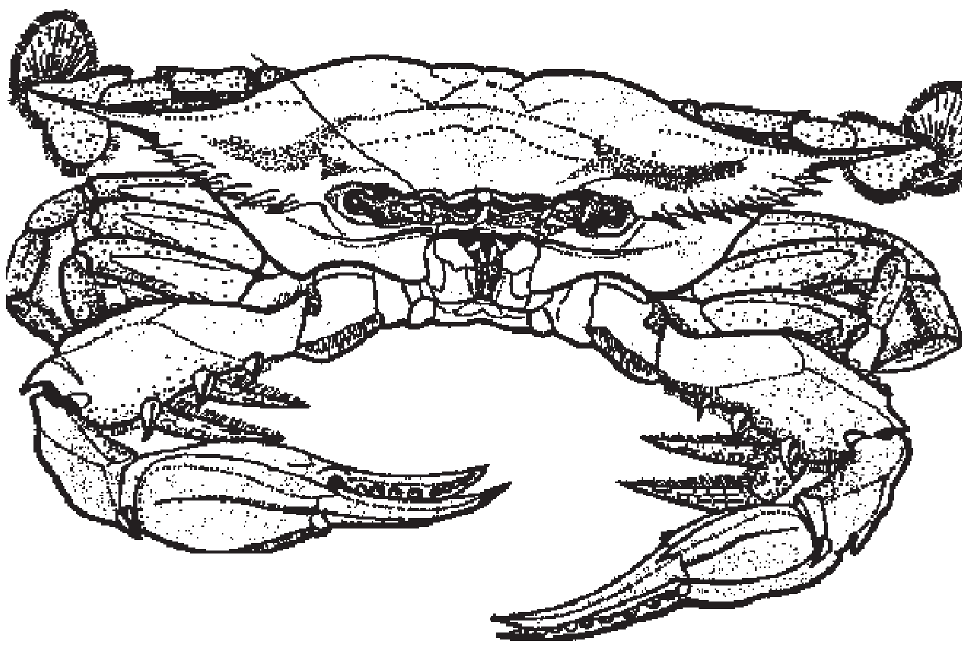
North Carolina
Fishery Management Plan

Amendment 2
Blue Crab



November 2013

North Carolina
Blue Crab (*Callinectes sapidus*)
Fishery Management Plan

Amendment 2

By

North Carolina Division of Marine Fisheries

North Carolina Department of Environment and Natural Resources
North Carolina Division of Marine Fisheries
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November 2013

July 2009	Timeline begins
February 2011	Convene AC
October 2011	Internal review with NCDMF comments
October 2011	Revised with AC comments
November 2011	MFC approval for public comment
December 2011	Public meetings and comments
February 2012	MFC selects preferred management options
March 2012	Reviewed by DENR Secretary
March 2012	Reviewed by the Joint Legislative Commission on Governmental Operations
May 2013	Draft rules approved for Notice of Text
November 2013	Plan amendment and rules adopted by the MFC
April 2014	Rules in effect

DEDICATION

We dedicate this Blue Crab Fishery Management Plan – Amendment 2 in honor of


Lynn T. Henry and **Sean McKenna**

Lynn Henry and Sean McKenna retired from NC Division of Marine Fisheries during the completion of Amendment Two to the Blue Crab Fishery Management Plan (BCFMP). These two individuals were the architects of many NCDMF blue crab studies and provided the intellectual framework for the initial and subsequent BCFMPs. The BCFMP was the first one specified for completion in the 1997 Fisheries Reform Act legislation. Lynn and Sean took the bull by the horns and lead the process through fruition as the first BCFMP was adopted in December 1998 and Amendment One was adopted in 2004. Their influence on blue crab management within North Carolina can not be overstated and we are forever indebted to them.

Lynn T. Henry graduated from N.C. State University in 1978 with a degree in Zoology with a Marine Science background. He started his career with the Division of Water Quality developing his deep appreciation and conservation awareness both at work and enjoying his favorite pastime of fishing the surrounding waters of northeastern North Carolina. In 1984, Lynn joined Marine Fisheries as a biologist in the striped bass program. In 1993, he became the crab biologist in the northern district and started a crab sampling program collecting carapace lengths and other biological data. Lynn was the state co-lead on blue crabs up to his retirement in March 2013. Lynn served on many committees, was the state's representative for blue crabs, and was always thorough if not meticulous in all his dealings.

Sean McKenna holds a Masters Degree from Tennessee Tech and came to the Division in October 1986 at the Washington NC, Pamlico District office. He progressed through the ranks from a temporary technician to a Biologist II in 1988. In this role he implemented the Division's bycatch gear reduction device research, the oyster shoal survey, as well as updating the editorial guidelines for Division reports. Along with Lynn, he crafted the template for FMPs which was used in the 1998 BCFMP and all subsequent amendments. In 1999 Sean was promoted to the Pamlico District Biologist Supervisor. For BCFMP Amendment Two Sean was instrumental in introducing the "Traffic Light" as our present day method for blue crab management. Sean was a friend and advocate for the commercial industry until his retirement in October 2012.

1.0 ACKNOWLEDGEMENTS

Amendment 2 to the North Carolina (NC) Blue Crab Fishery Management Plan (FMP) was developed by the NC Department of Environment and Natural Resources (NCDENR) North Carolina Division of Marine Fisheries (NCDMF) under the direction of the NC Marine Fisheries Commission (MFC) with the advice of the Blue Crab Advisory Committee (AC). Deserving special recognition are the members of the Blue Crab AC, Plan Development Team (PDT), and Laura Lee who contributed their time and knowledge to this effort.

Blue Crab Advisory Committee

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2.0 TABLE OF AMENDMENTS

MANAGEMENT STRATEGY ACTIONS	OBJECTIVES	OUTCOME
10.1 ENVIRONMENTAL ISSUES		
10.1.1 Habitat		
Action 1:The identification, maintenance, and enhancement of habitats critical to the life cycle of the blue crab should be a priority of efforts by the DENR and the MFC and its committees, in developing CHPPs as outlined in the Fisheries Reform Act of 1997.	1, 3, 6, 7, and 8	Accomplished (CHPP adopted in 2005)
Action 2: Management Actions as outlined in the Vital Habitats Plan of the Albemarle - Pamlico Estuarine Study Comprehensive Conservation and Management Plan (EPA and DEHNR 1994) should receive priority for funding and be completed in a timely manner (see FMP Appendix 3).	1, 3, 6, 7, and 8	Limited action
Action 3: Management Actions as outlined in the Vital Habitats Plan of the Albemarle - Pamlico Estuarine Study Comprehensive Conservation and Management Plan (EPA and DEHNR 1994) should be expanded to all river basins that drain to North Carolina's coastal region (FMP Appendix 3).	1, 3, 6, 7, and 8	Limited action
Action 4: Advocate stronger regulatory programs and enforcement of regulations protecting blue crab critical habitat [marshes, SAVs, shell bottom, and soft bottom (riverine, subtidal and intertidal bottom)].	1, 3, 6, 7, and 8	Ongoing
Action 5: Continue to make recommendations on all state, federal, and local permits to insure minimal impacts to critical habitat areas.	1, 3, 6, 7, and 8	Ongoing
Action 6: Develop and maintain accurate maps and records of critical habitat areas for blue crabs (marshes, SAVs, shell bottom, and soft bottom (riverine, subtidal and intertidal bottom).	1, 3, 6, 7, and 8	Ongoing: NCDMF Shellfish Mapping Program, SAV mapping (ECSU, NOAA, NCDMF)
Action 7: Enhance existing efforts to restore the functions and values of degraded blue crab habitat (marshes, SAVs, shell bottom, and soft bottom (riverine, subtidal and intertidal bottom).	1, 3, 6, 7, and 8	Part of CHPP implementation plan
Action 8: Identify, research, and map shallow detrital areas important to blue crabs.	1, 3, 6, 7, and 8	Limited work by NCSU/ (BCRP/Sea Grant)
Action 9: Identify, research and designate additional areas as Primary Nursery Areas that may be important to blue crabs as well as other fisheries.	1, 3, 6, 7, and 8	Ongoing
Action 10: Develop criteria to designate critical SAV habitat areas.	1, 3, 6, 7, and 8	Part of CHPP implementation plan
Action 11: Designate Critical SAV areas based on developed criteria.	1, 3, 6, 7, and 8	Part of CHPP implementation plan
Action 12: Request that EMC and CRC prohibit dredging or channelization in designated SAV areas.	1, 3, 6, 7, and 8	Ongoing
Action 13: Complete mapping of SAVs throughout the state.	1, 3, 6, 7, and 8	DMF/ECSU SAV Survey 2007-2008
Action 14: Support follow-up mapping of previously mapped SAVs.	1, 3, 6, 7, and 8	NCDMF/ECSU SAV Survey 2007-2008

MANAGEMENT STRATEGY ACTIONS	OBJECTIVES	OUTCOME
Action 15: Solicit and acquire resources to update and complete shellfish bottom mapping of oyster reefs.	1, 3, 6, 7, and 8	Funding provided by General Assembly in 2006
Action 16: Solicit and acquire resources to supplement resource enhancement for cultch plantings.	1, 3, 6, 7, and 8	Ongoing NCDMF Oyster Shell Recycling Program
Action 17: Develop a protocol for identification and designation of oyster rock/shell bottom as critical fisheries habitat where fishing activities would be restricted.	1, 3, 6, 7, and 8	No action. Part of CHPP implementation plan
Action 18: Utilize the existing authority of the MFC for adoption of blue crab spawning areas as critical habitat.	1, 3, 6, 7, and 8	No proposed action
Action 19: Develop criteria to be used to delineate crab spawning sanctuaries as critical habitat.	1, 3, 6, 7, and 8	No action. Part of CHPP implementation plan
Action 20: Continue to support mapping of spawning sanctuaries through the Fisheries Resource Grant and Blue Crab Research Program.	1, 3, 6, 7, and 8	Ongoing
Action 21: Support and conduct research and mapping of other inlet areas that may be significant to spawning.	1, 3, 6, 7, and 8	No action
10.1.2 Water Quality		
Action 1:The identification, maintenance, and enhancement of water quality critical to the life cycle of the blue crab should be a priority of the NCDENR and the MFC and its committees, in developing Coastal Habitat Protection Plans as outlined in the Fisheries Reform Act of 1997.	1, 3, 6, 7, and 8	Accomplished (CHPP adopted in 2005)
Action 2: Management Actions as outlined in the Water Quality Plan of the Albemarle - Pamlico Estuarine Study Comprehensive Conservation and Management Plan (EPA and DEHNR 1994) should receive priority for funding and be completed in a timely manner (see FMP Appendix 3).	1, 3, 6, 7, and 8	Limited action
Action 3: Management Actions as outlined in the Water Quality Plan of the Albemarle - Pamlico Estuarine Study Comprehensive Conservation and Management Plan (EPA and DEHNR 1994) should be expanded to all river basins that drain to North Carolina's coastal region (FMP Appendix 3).	1, 3, 6, 7, and 8	Limited action
Action 4: Work with the permitting and commenting agencies to enhance protection of water quality. The MFC should fully utilize its permit commenting authority outlined in G.S. 143B-289.52.	1, 3, 6, 7, and 8	Ongoing
Action 5: Additional research is needed on the extent, causes, and impacts of hypoxia and anoxia on blue crab behavior and population abundance in North Carolina's estuarine waters.	1, 3, 6, 7, and 8	Limited research by NC universities (BCRP, FRG, and Sea Grant projects)
Action 6: The MFC should strive for accomplishment of the management strategies as outlined in the coastal basinwide water quality management plans and water quality recommendations of Fisheries Moratorium Steering Comm.	1, 3, 6, 7, and 8	Ongoing

MANAGEMENT STRATEGY ACTIONS	OBJECTIVES	OUTCOME
Action 7: Request that the North Carolina EMC review "Nutrient Sensitive Waters", "High Quality Waters", and "Outstanding Resource Waters" designations for the coastal river basins and implement additional strategies as needed.	1, 3, 6, 7, and 8	Ongoing
Action 8: Conduct research on the water quality impacts of crab pot zincs, bait discard, and alternative crab baits in the pot fishery.	1, 3, 6, 7, and 8	No action. Alternative bait study (BCRP/Sea Grant)
Action 9: Conduct education efforts on problems associated with the use of chlorine pot antifoulants (HTH®) and the surface water discharge of these solutions, which is prohibited by federal and state laws.	1, 3, 6, 7, 8, and 9	No action
Action 10: Conduct additional research to document and quantify the influences of significant weather events on water quality and assess impacts on the blue crab resource and fishery.	1, 3, 6, 7, and 8	Some research by universities (BCRP, FRG, and Sea Grant projects), and 2007 NCDMF hurricane impacts report
Action 11: Conduct research on the interaction between water quality and habitat.	1, 3, 6, 7, and 8	No action. Limited information from FRG
10.2 STOCK PROTECTION		
10.2.1 Spawning Stock Management		
Action 1: Establish a seasonal maximum size limit of 6.75 inches (with a 5 percent tolerance) for mature females from September 1 through April 30, if the adjusted CPUE (spawner index) of mature females captured in Program 195 (Pamlico Sound Fishery Independent Trawl Survey) during the September cruise falls below the lower 90% confidence limit (CL) for two consecutive years. This management measure will be removed when the September adjusted CPUE of mature females rises above the lower 90% confidence limit for two consecutive years.	1, 4, 6, and 8	Accomplished by MFC Rule 15A NCAC 03L.0201 (c) (1) (approved June 2005)
Action 2: Conduct surveys of existing sanctuary areas to determine population levels and to determine if these areas function as spawning grounds.	1, 4, and 6	Previous and ongoing research (BCRP)
Action 3: Modify current spawning sanctuary boundaries.	1, 4, 6, and 8	No proposed action
Action 4: Conduct tagging studies to determine exploitation rates of different life history stages, movement on and off the spawning grounds, and other life history parameters of female blue crabs.	1, 4, 6, and 8	2008 NCDMF Hurricane Grant Report, BCRP and FRG projects

MANAGEMENT STRATEGY ACTIONS	OBJECTIVES	OUTCOME
10.2.2 Peeler/Soft Crab Harvest		
Action 1: Establish a seasonal maximum size limit of 5.25 inches (with a 3 percent tolerance) for female peeler crabs from September 1 through April 30, if the adjusted CPUE (spawner index) of mature females captured in Program 195 (Pamlico Sound Fishery Independent Trawl Survey) during the September cruise falls below the lower 90% confidence limit (CL) for two consecutive years. This management measure will be removed when the September adjusted CPUE of mature females rises above the lower 90% confidence limit for two consecutive years.	1, 4, 6, and 8	Accomplished by MFC Rule 15A NCAC 03L.0201 (c) (2) (approved June 2005)
Action 2: Determine shedding mortality rates by size, area, and season.	1, 4, 6, and 8	No action
Action 3: Develop more effective harvest, handling, and shedding practices to minimize mortality.	1, 2, 4, 6, and 8	Previous, ongoing and future research (BCRP)
Action 4: Promote educational efforts and information transfer for various issues impacting the shedder industry (i.e., peeler mortality, harvest, handling, and shedding practices).	1, 2, 4, 6, 8 and 9	BCRP and FRG projects
Action 5: Evaluate the economic impact of implementing a minimum size limit.	1, 4, 6, and 8	No action
Action 6: Determine peeler harvest rates by size, sex, area, and season.	1, 4, 6, and 8	Ongoing NCDMF sampling and BCRP projects
10.3 WASTEFUL OR DAMAGING FISHING PRACTICES		
10.3.1 White-Line Peeler Harvest		
Action 1: (A.) Prohibit the sale of white-line peelers, but allow possession by the licensee/harvester for use in the licensee's permitted shedding operation. (B.) White-line peeler crabs must be separated from pink and red-line peeler crabs where taken and placed in a separate container, with a of 5% tolerance allowed for white-line peelers in the pink/red-line peeler catch.	1, 2, 4, 6, and 8	(A.) Accomplished by MFC Rule 15A NCAC 03L.0206 (c) and (d) (B.) Accomplished by MFC Rule 15A NCAC 03L.0201 (b) (approved June 2005)
Action 2: Increase education efforts, targeting harvesters/shedders, on the mortality associated with the shedding of white-line peeler crabs.	1, 2, 6, 8 and 9	Some information is available (BCRP and FRG)
Action 3: Increase education efforts on the handling of peelers.	1, 2, 6, 8 and 9	Some information is available (BCRP and FRG)
10.3.2 Ghost Pots		
Action 1: Extend the pot cleanup period by nine days.	1, 5, 6, and 8	Accomplished by MFC Rule 15A NCAC 03J .0301 (a) (1)
Action 2: Shorten attendance period from 7 to 5 days.	1, 2, 5, 6, and 8	Accomplished by MFC Rule 15A NCAC 03I .0105 (b)
Action 3: Investigate ways to provide for dockside disposal of old crab pots.	1, 2, 5, 6, and 8	No action
Action 4: Require biodegradable panels in crab pots, if warranted, once current studies are completed.	1, 2, 5, 6, 7, and 8	No proposed action
Action 5: Marine Patrol should continue to document the number of abandoned pots collected during the pot clean-up period.	1, 2, 5, and 6	Ongoing

MANAGEMENT STRATEGY ACTIONS	OBJECTIVES	OUTCOME
Action 6: NCDMF should educate fisherman and the general public about efforts to remove abandoned gear and encourage them to notify Marine Patrol of locations of said gear.	1, 2, 5, 6, 8 and 9	Ongoing
10.3.3 Crab Pot Finfish Bycatch		
No action is required for this issue.	6, 7, 8 and 9	No action required
10.3.4 Crab Trawl Bycatch		
Action 1: Require a 4 inch stretched mesh tailbag for crab trawls in western Pamlico Sound, including Pamlico, Pungo, Bay, and Neuse rivers.	1, 2, 4, 6, and 8	Accomplished by MFC Rule 15A NCAC 03L.0202 (b) (approved June 2005)
Action 2: Collect fishery dependent data from the peeler crab and shrimp trawl fisheries.	1, 2, 4, and 6	No peeler trawl data; limited shrimp trawl data
Action 3: Investigate the economic and social impacts of the crab trawl fishery.	1, 4, 6, and 8	No action
Action 4: Separate hard and peeler crab trawl landings on trip tickets.	1, 4, 6, and 8	Completed beginning in March 2010
10.3.5 Protected Species Interactions with the Crab Fishery		
Action 1: Test the effectiveness of inverted bait wells to alleviate the bait stealing behavior of bottlenose dolphin.	4, 5, and 7	No action. Some work in Georgia; positive results
Action 2: Develop sea turtle proof crab pots.	4, 5, and 7	FRG study; has potential
Action 3: Determine the extent of sea turtle bycatch in crab trawls.	4, 5, and 7	No action. Limited strandings data
Action 4: Compile data on diamondback terrapin distribution.	4, 5, and 7	No action. Limited data from BCRP and FRG
Action 5: Problem assessment of crab pot diamondback terrapin bycatch and mortality by season, area, and gear (hard and peeler pots).	4, 5, and 7	Data from other states, NCDMF, and BCRP/FRG; crab pots are major source of mortality
Action 6: Determine the effect that terrapin excluders have on peeler and terrapin catches in peeler pots.	4, 5, and 7	Some information is available from BCRP/FRG
Action 7: Test the effectiveness of cable ties for excluding terrapins from crab pots.	4, 5, and 7	No action
Action 8: Compile and distribute information on current distribution of diamondback terrapins and methods to eliminate diamondback terrapin bycatch in crab pots.	4, 5, 7, and 9	No action. Some information is available (BCRP and FRG)
10.3.6 Channel Net Harvest of Blue Crabs		
Action 1: Modify the CHANNEL NET rule (15A NCAC 3J .0106) to incorporate limited blue crab bycatch provisions identical to those for shrimp trawls (rule 15A NCAC 3J .0104 (f) (2) TRAWL NETS).	2, 4, and 6	Accomplished by MFC Rule 15A NCAC 03J. 0106 (h) (approved June 2005)
Action 2: Collect crab harvest data from channel nets.	4, and 6	No action
10.4 COMPETITION AND CONFLICT WITH OTHER USERS		
10.4.1 Conflict		
Action 1: Shorten the unattended pot rule from 7 to 5 days.	1, 2, 5, 6, and 8	Accomplished by MFC Rule 15A NCAC 03I .0105 (b)

MANAGEMENT STRATEGY ACTIONS	OBJECTIVES	OUTCOME
Action 2: Modify the existing “User Conflict” rule to resolve user conflicts on a regional basis.	5, and 6	Accomplished by MFC Rule 15A NCAC 03J .0301 (j) (A-C) (approved June 2005)
Action 3: Develop guidelines for the NCDMF, MFC, and regional advisory committees to assist in the resolution of user conflict issues.	5, 6, and 9	NCDMF has developed a process to address disputes through mediation.
10.4.2 Utilization of Non-Pot Areas by Proclamation		
Action 1: Take proposed rule change to public hearings (i.e., Allow crab pots in all designated long haul areas in Hyde, Beaufort, and Pamlico counties from June 1 through November 30.).	4, 5, and 6	Accomplished by MFC Rule 15A NCAC 03J .0301 (a) (2) (B) and 15A NCAC 03R .0107 (b) (approved June 2005)
10.4.3 Time Change for Placing Crab Pots in Designated Pot Areas		
Action 1: Take proposed rule change to public hearings. (i.e., Change the dates for designated crab pot areas from May 1 through October 31 to June 1-November 30.).	4, 5, and 6	Accomplished by MFC Rule 15A NCAC 03J .0301 (a) (2) (approved June 2005)
10.4.4 Designated Pot Areas		
Action 1: Take proposed rule change to public hearings. [i.e., (A.) Change the designated pot area boundary descriptions to a standardized 6 foot depth contour for many areas in Hyde, Beaufort, Pamlico, and Craven counties. (B.) Prohibit the use of trawl nets in designated pot areas opened to the use of pots by 15A NCAC 03J .0301 (a) (2) and within an area bound by the shoreline to the depth of six feet.]	4, 5, and 6	(A.) Accomplished by MFC Rule 15A NCAC 03J .0301 (a) (2) (A) and 15A NCAC 03R .0107 (a) (approved June 2005) (B.) Accomplished by MFC Rule 15A NCAC 03J .0104 (b) (6) (approved June 2005)
10.5 INSUFFICIENT ASSESSMENT DATA		
Action 1: Prioritize research needs and implement actions to secure funding and accomplish research. Biological research needs are outlined in the 2004 BCFMP Section 10.5.2 (pages 5-7). Management and social and economic research needs are outlined in the 2004 BCFMP Sections 10.7.4, and 10.7.6 (pages 7-8).	1, 2, 3, 7, and 8	Ongoing through the BCRP and FRG
10.6 PUBLIC EDUCATION		
Action 1: Incorporate links from the NCDMF Web site to other blue crab websites maintained by other groups (i.e., Chesapeake Bay Foundation, Maryland Sea Grant, www.blue-crab.org).	2, 3, 5, 6, 7, and 9	No action
Action 2: Work with agencies and groups such as NC Sea Grant, NC Wildlife Resources Commission, colleges and universities, to publish articles and place information on their website.	2, 3, 5, 6, 7, and 9	No action
Action 3: Provide fact sheets about certain issues to fishermen when buying licenses (white bellies, protected species, escape rings, ghost pots, trip ticket data, shedding system mortality, and peeler handling).	2, 5, 6, 7, 8, and 9	Fact sheets on white belly crabs, shedding, and peeler handling published by Sea Grant. No action on other issues.
Action 4: Develop an educational display spotlighting varying crabbing issues.	2, 3, 5, 6, 7, 8, and 9	No action

MANAGEMENT STRATEGY ACTIONS	OBJECTIVES	OUTCOME
Action 5: Continue to send out news releases about various issues as needed.	9	Ongoing

3.0 TABLE OF CONTENTS

3.1 LIST OF TABLES

3.2 LIST OF FIGURES

3.3 LIST OF ACRONYMS

AC – Advisory Committee

AEC – Areas of Environmental Concern

ALDS – Angler License Directory Survey

ALWTRP – Atlantic Large Whale Take Reduction Plan

ALWTRT – Atlantic Large Whale Take Reduction Team

APAIS – Access-Point Angler Intercept Survey

ASMFC – Atlantic States Marine Fisheries Commission

BDTRT – Bottlenose Dolphin Take Reduction Team

BMP – Best Management Practices

BOD – Biological Oxygen Demand

BRD – Bycatch Reduction Device

CAHA – Cape Hatteras National Seashore

CAMA – Coastal Area Management Act

CEIP – Coastal Energy Impact Program

CHPP – Coastal Habitat Protection Plan

CHTS – Coastal Household Telephone Survey

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

CW – Carapace Width

DCM – North Carolina Division of Coastal Management

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

DENR – North Carolina Department of Environment and Natural Resources

DO – Dissolved Oxygen

DOT – North Carolina Department of Transportation

DWQ – North Carolina Division of Water Quality

E – Endangered

EDC – Endocrine Disrupting Chemicals

EEP – Ecosystem Enhancement Program

EEZ – Exclusive Economic Zone

EFH – Essential Fish Habitat

EMC – North Carolina Environmental Management Commission

EPA – United States Environmental Protection Administration

ESA – Endangered Species Act

FDA – United States Food and Drug Administration

F – Fishing Mortality

F_{Max} – The level of fishing mortality (rate of removal by fishermen) that produces the greatest yield from the fishery

FMP – Fishery Management Plan

FRA – Fishery Reform Act

FRG – Fishery Resource Grant

FSC – Federal Species of Concern

GIS – Geographical Information System

GS – General Statute

HQW- High Quality Waters

ICW – Intracoastal Waterway

IGNS – Independent Gill Net Study

ITP – Incidental Take Permit

JHA - Juvenile Hormone Analogs

JLCSA – Joint Legislative Commission for Seafood and Aquaculture

M – Natural Mortality

MAFMC – Mid Atlantic Fisheries Management Council

MFC – North Carolina Marine Fisheries Commission

MMPA – Marine Mammal Protection Act

MRFSS – Marine Recreational Fisheries Statistical Survey

MRT – Management Review Team

MSY – Maximum Sustainable Yield

NC – North Carolina

NCAC – North Carolina Administrative Code

NCDACS – North Carolina Department of Agriculture and Consumer Services

NCDMF – North Carolina Division of Marine Fisheries

NCPARC – North Carolina Partners in Amphibian and Reptile Conservation

NCSU – North Carolina State University

NCTTP – North Carolina Trip Ticket Program

NEFSC – Northeast Fisheries Science Centers

NMFS – National Marine Fisheries Service

NOAA – National Oceanic and Atmospheric Administration

NPDES – National Pollutant Discharge Elimination System

NSW – Nutrient Sensitive Waters

NYDEC – New York Department of Environmental Conservation

ORW – Outstanding Resource Waters

OTC –Over the Counter

PAH – Polycyclic Aromatic Hydrocarbons,

PCB – Polychlorinated Biphenyls

PDT – Plan Development Team

PNA – Primary Nursery Area

PPI – Producer Price Index

PPT – Parts Per Thousand

PSE – Proportional Standard Error

PSGNRA – Pamlico Sound Gill Net Restricted Area

RAT – Rules Advisory Team

RCGL – Recreational Commercial Gear License

RDD – Random Digit Dialing

RSCFL – Retired Standard Commercial Fishing License

SAFMC – South Atlantic Fishery Management Council

SAV – Submerged Aquatic Vegetation

SC – Species of Concern

SCAR – Scientific Council on Amphibians and Reptiles

SCFL – Standard Commercial Fishing License

SHA – Strategic Habitat Area

SNA – Secondary Nursery Area

SSNA – Special Secondary Nursery Area

SSR – Stock Status Report

STAC – Sea Turtle Advisory Committee

STSSN – Sea Turtle Stranding and Salvage Network

T – Threatened

TED – Turtle Excluder Device

TRP – Take Reduction Plan

TRT – Take Reduction Team

TSS – Total Suspended Solids

TTP – North Carolina Division of Marine Fisheries Trip Ticket Program

UNC – University of North Carolina

UNC-CH – University of North Carolina, Chapel Hill

UNCW – University of North Carolina, Wilmington

URW – Use Restoration Waters

USACE - United States Army Corps of Engineers

USFWS – United States Fish and Wildlife Service

USGS - United States Geological Survey

WRC – North Carolina Wildlife Resources Commission

WS – Water Supply

Z – Total Mortality

4.0 EXECUTIVE SUMMARY

This document is Amendment 2 to the North Carolina Blue Crab Fishery Management Plan (BCFMP). The initial BCFMP was adopted in 1998 and Amendment 1 was completed in 2004.

Goals and Objectives: The goal of the North Carolina Blue Crab FMP is to manage the blue crab fishery in a manner that promotes its ecological and economic value, and the long-term viability of the resource through sustainable harvest. The following objectives will be utilized to achieve this goal.

1. Utilize a management strategy that provides resource protection and sustainable harvest, promotes blue crab ecological and economic value, provides opportunity for resource utilization, and considers the needs of all users.
2. Promote harvesting practices that minimize waste of the resource and environmental damage.
3. Promote the protection, restoration, and enhancement of habitats and environmental quality necessary for the perpetuation of the blue crab resource.
4. Maintain a clear distinction between conservation goals and allocation issues.
5. Minimize conflicts among and within user groups, including non-crabbing user groups.
6. Identify and promote research to improve the understanding and management of the blue crab resource.
7. Promote education and public information to help users understand the causes and nature of problems for blue crabs in North Carolina, its habitats and fisheries, and the rationale for efforts to address resource management.

Status of the Fisheries: Over the last sixteen years (1994–2009), North Carolina has ranked 2nd among blue crab producing states in the country accounting for 22% of the total commercial harvest nationwide. Numerous recreational fishermen and coastal waterfront landowners harvest blue crabs for personal consumption. Overall, recreational landings and effort are unknown. However, recreational harvest is likely less than one percent of the commercial harvest.

Socioeconomic Status of the Blue Crab Fishery: Hard blue crabs are the most valuable seafood product landed in North Carolina, yielding 32% of the total value in 2009. There has been a declining trend in participation in the blue crab fishery with a drastic drop by more than 40% since 1999. Processing facilities ("picking houses") have declined 50% from 1998 to 2009.

General Problem Statement: Results of the current stock assessment suggest the North Carolina blue crab stock is not overfished. The stock status of blue crabs is still considered to be of concern because of declining landings and evidence of reduced adult and recruit abundance. Even though there is now a more robust assessment of the stock condition, overfishing cannot be determined. The purpose of Amendment 2 is to manage for the long-term viability of the blue crab stock to sustain its economic and ecological value. Areas addressed in the management of the North Carolina's blue crab fishery are: 1) environmental factors, 2) stock protection, 3) user conflicts, 4) clarification of rules, and 5) harvest practices.

Environmental Factors: Maintenance and improvement of suitable estuarine habitat and water quality are probably the most important factors in providing a sustainable blue crab stock. Habitat and water quality are critical elements linked in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat or water quality may have a corresponding impact elsewhere. Various management strategies (Table 4.1.1) are recommended for habitat and water quality based on recommendations from the 2010 North Carolina Coastal Habitat Protection Plan (CHPP)

Stock Protection: The blue crab population in any given year relies on the number of adults available in the population to reproduce. Environmental conditions (winter mortality, drought, hypoxia, hurricanes, and effects from human development), diseases, predation, and cannibalism are all natural mortality issues of concern. With increasing concerns over fluctuating blue crab landings and reductions in effort in the fishery, there have been requests to further protect the North Carolina blue crab stock. Therefore, an adaptive management framework based on the Traffic Light Stock Assessment is recommended for sustainable management of the blue crab resource. Moderate and elevated management level options are proposed for recruit abundance, adult abundance, and production characteristics. Management actions will only be implemented when either the adult abundance or production characteristics reach the Traffic Light management trigger of 50% red or greater for three consecutive years. The recruit abundance characteristic will be used as a supplement to further direct conservation management actions, if deemed necessary. Adaptive management measures would be implemented through the Fisheries Director's proclamation authority (expanded under the adaptive management framework proposal). Review by the Crustacean Advisory Committee would be maintained to consider management options, evaluate their merits, and gain Marine Fisheries Commission approval before the Director's proclamation authority would be used to implement any changes to the fisheries. Based on this adaptive management recommendation, the current female stock conservation management trigger adopted in 2004 will be repealed and existing sampling programs should be continued to maintain baseline information for the Traffic Light Stock Assessment method.

User Conflicts: Minimizing conflicts between user groups was identified in two issue papers and specifically dealt with space allocation of crab potters in southern Bogue Sound and allowing pots in eight non-pot areas in the Pungo River that have not been used by the long haul fishery in many years.

Clarification of Rules: Rules specific to blue crabs need to be evaluated on a regular basis to determine whether they are still applicable to the current fisheries, clear to the public, and facilitate consistent enforcement practices. Several issue papers were developed to put longstanding proclamations into rule, make the rules clearer, and match harvest practices.

Harvest Practices: Gear modifications to address gear use practices and reduce wasteful or damaging harvest practices were evaluated in four issue papers.

A synopsis of the blue crab management issues, management strategy recommendations, applicable FMP objectives, and actions developed through the FMP process are contained in Table 4.1.1. Summary papers describing each issue, management options, and recommendations are contained in FMP Sections 11.0 and 12.0.

4.1 SYNOPSIS OF MANAGEMENT RECOMMENDATIONS

Table 4.1.1 Marine Fisheries Commission selected management strategy, applicable FMP objectives, and required actions.

FMP SECTION and ISSUE	MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
Stock Protection			
11.1 Adaptive management framework for the North Carolina blue crab stock	1. Repeal the current female stock conservation management trigger.	1	Rule change to 03L .0201
	2. Continue existing sampling programs to maintain baseline information for the Traffic Light Stock Assessment method.	1 and 6	No action required.
	3. Adopt the adaptive management framework based on the Traffic Light Stock Assessment and the proposed moderate and elevated management levels for recruit abundance, adult abundance, and production characteristics. Initial management action will only be implemented when either the adult abundance or production characteristic reach the management trigger of 50% red or greater for three consecutive years. The recruit abundance characteristic will be used as a supplement to further direct conservation management actions, if deemed necessary.	1 and 6	Rule change to 03L .0201, 03L .0203, 03L .0204, 03L .0205, 03L .0206, 03L .0209, and 03J .0301.
User Conflicts			
11.2 Crab pot limit for southern Bogue Sound	Status quo, continue with no crab pot limit in southern Bogue Sound.	1, 4, and 5	No action required.
11.3 Consider allowing non-pot areas in the Pungo River area to be re-designated as open to pots	Open the non-pot (long haul net) areas all the time by rule in the Pungo River and keep status quo in the Long Point area on the Pamlico River.	1, 4, and 5	Rule change to 03R .0107.
Clarification of Rules			
11.4 Incorporate the lower Broad Creek closure of pot area into rule	Modify the rule to include the lower Broad Creek area that is closed to crab pots from June 1 through November 30.	1, 4, and 5	Rule change to 03R .0107.
11.5 Clarify crab dredging restrictions	Amend the rule to match harvest management for crab dredging.	2	Rule change to 03L .0203.
11.6 Incorporate the Pamlico Sound crab trawling proclamation into rule 15A NCAC 03L .0202	Modify Rule 15A NCAC 03L .0202 to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four inch mesh crab trawl line), and retain the Director's proclamation authority to restrict crab trawl mesh size.	1 and 2	Rule change to 03L .0202

Table 4.1.1 Marine Fisheries Commission selected management strategy, applicable FMP objectives, and required actions.

FMP SECTION and ISSUE	MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
Clarification of Rules			
11.7 Explore options for escape ring exemptions in hard crab pots to harvest peeler crabs	1. Amend the current rule to redefine criteria for exempting escape rings in crab pots from the 1½-inch pot mesh size to unbaited pots and pots baited with a male crab.	1, 2, and 5	Rule change to 03J .0301 and 03L .0301.
	2. Repeal the proclamation authority that allows for exempting the escape ring requirement in order to allow the harvest of peeler crabs.	1 and 5	Rule change to 03J .0301.
11.8 Convert crab pot escape ring proclamation exemptions for mature females into rule	Adopt the no trawl line along the Outer Banks in Pamlico Sound as the new boundary in Pamlico Sound, and the Newport River boundaries as delineated in the proposed rule as new boundaries for the area where closure of escape rings to take small mature females is allowed.	1 and 4	Rule change to 03J .0301. Add new rule 03R .0118.
11.9 Correction of peeler trawl exception rule	Modify Rule 15A NCAC 03J .0104 (b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation.	1 and 2	Rule change to 03J .0104.
11.10 Blue crab size limit and culling tolerance	Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs.	1	Rule change to 03L .0201.
Harvest Practices			
11.11 Allow floating crab pot lines in areas where obstructions exist	Status quo, continue with non-floating line on crab pots.	1, 2, and 5	No action required.
11.12 Diamondback terrapins interactions with the blue crab fishery in North Carolina	1. Establish proclamation authority for requiring terrapin excluder devices in crab pots.	2 and 5	Rule change to 03L .0204.
	2. Establish a framework for developing proclamation use criteria and terrapin excluder specifications which may extend until after adoption of the amendment. The strategy is contingent on: a. Consultation with the Crustacean Advisory Committee on developing criteria; and b. No use of the proclamation authority until criteria is approved by the Marine Fisheries Commission.	2 and 5	Develop proclamation use criteria for terrapin excluder use in consultation with the Crustacean Advisory Committee with approval by the Marine Fisheries Commission.

Table 4.1.1 Marine Fisheries Commission selected management strategy, applicable FMP objectives, and required actions.

FMP SECTION and ISSUE	MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
Harvest Practices			
11.13 Multiple pots to a single buoy	Status quo, do not allow multiple pots to a single buoy.	1 and 5	No action required.
11.14 Pot loss and ghost pot bycatch mortality	1. Encourage crab potters in areas of high pot loss to incorporate methods to reduce pot loss. Develop and provide information on potential methods to reduce pot loss.	6 and 7	Develop and provide information on potential methods to reduce pot loss.
	2. Encourage crab potters in areas of high pot loss to incorporate escape panel designs in pots to reduce potential ghost fishing impacts. Develop and provide information on potential methods and materials to reduce ghost fishing impacts.	6 and 7	Develop and provide information on potential methods and materials to reduce ghost fishing impacts.
Environmental Factors			
10.4 Habitat	1. Identify and designate Strategic Habitat Areas that will enhance protection of the blue crab.	1, 3, and 6	Existing authority through the Coastal Habitat Protection Plan (CHPP).
	2. Identify, research, and designate additional areas as Primary Nursery Areas that may be important to blue crabs as well as other fisheries.	1, 3, and 6	Existing authority through the CHPP.
	3. Continue to map blue crab spawning areas and evaluate any that need to adjust or expand the boundaries or restrictions of the crab spawning sanctuaries based on recent research.	1, 3, and 6	Existing authority through the CHPP.
	4. Remap and monitor submerged aquatic vegetation in North Carolina to assess distribution and change over time.	3 and 6	Existing authority through the CHPP.
	5. Restore coastal wetlands to compensate for previous losses and enhance habitat and water quality conditions for the blue crab.	3 and 6	Existing authority through the CHPP.
	6. Work with Coastal Resource Commission to revise shoreline stabilization rules to adequately protect riparian wetlands and shallow water habitat and significantly reduce the rate of shoreline hardening.	3	Existing authority through the CHPP.

Table 4.1.1 Marine Fisheries Commission selected management strategy, applicable FMP objectives, and required actions.

FMP SECTION and ISSUE	MANAGEMENT STRATEGY	OBJECTIVES	REQUIRED ACTION
Environmental Factors			
10.4 Habitat	7. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to submerged aquatic vegetation, wetland edge, and other habitat important to blue crab.	3	Existing authority through the CHPP.
	8. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.	3 and 6	Existing authority through the CHPP.
	9. Support oyster shell recycling and oyster sanctuary programs to provide areas of enhanced or restored shell bottom habitat.	3	Existing authority through the CHPP.
	10. Consider if prohibition of crab dredging is advisable.	2	Existing authority through the CHPP.
	11. Protect “recruitment bottlenecks”, like inlets for the blue crab, from trawling or other impacts including natural channel modification using hardened structures like groins and jetties.	2 and 3	Existing authority through the CHPP.
	12. Shallow areas where trawling is currently allowed should be re-examined to determine if additional restrictions are necessary.	2	Existing authority through the CHPP.
10.4 Water Quality	1. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.	3	Existing authority through the CHPP.
	2. Increase on-site infiltration of stormwater through voluntary or regulatory measures.	3	Existing authority through the CHPP.
	3. Provide more incentives for low-impact development.	3	Existing authority through the CHPP.
	4. Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading.	3	Existing authority through the CHPP.
	5. Provide proper disposal of unwanted drugs, prevent the use of harmful JHA insecticides near-surface waters or in livestock feed, and develop technologies to treat wastewater for antibiotics and hormones.	3, 6, and 7	Existing authority through the CHPP.

5.0 INTRODUCTION

5.1 LEGAL AUTHORITY FOR MANAGEMENT

Fisheries management includes all activities associated with maintenance, improvement, and utilization of the fisheries resources of the coastal area, including research, development, regulation, enhancement, and enforcement.

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

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

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

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

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

d. Specify a time period, not to exceed two years from the date of the adoption of the plan, for ending overfishing. This subdivision shall only apply to a plan for a fishery that is not producing a sustainable harvest.

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

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

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

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.”

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

5.2 RECOMMENDED MANAGEMENT PROGRAM

5.2.1 GOALS AND OBJECTIVES

The goal of the North Carolina Blue Crab FMP is to manage the blue crab fishery in a manner that promotes its ecological and economic value, and the long-term viability of the resource through sustainable harvest. The following objectives will be utilized to achieve this goal.

1. Utilize a management strategy that provides resource protection and sustainable harvest, promotes blue crab ecological and economic value, provides opportunity for resource utilization, and considers the needs of all users.

2. Promote harvesting practices that minimize waste of the resource and environmental damage.

3. Promote the protection, restoration, and enhancement of habitats and environmental quality necessary for the perpetuation of the blue crab resource.

4. Maintain a clear distinction between conservation goals and allocation issues.

5. Minimize conflicts among and within user groups, including non-crabbing user groups.

6. Identify and promote research to improve the understanding and management of the blue crab resource.

7. Promote education and public information to help users understand the causes and nature of problems for blue crabs in North Carolina, its habitats and fisheries, and the rationale for efforts to address resource management.

5.2.2 SUSTAINABLE HARVEST

The Traffic Light method was used for the current assessment of the blue crab stock. The Traffic Light Stock Assessment method is capable of synthesizing a variety of information to provide a description of the stock condition. The nature of the Traffic Light method does not allow for a quantitative assessment of sustainable harvest for the North Carolina blue crab stock since overfishing cannot be calculated.

The blue crab stock is considered overfished when the proportion of red in the production characteristic of the Traffic Light method is greater than or equal to the third quartile ($\geq$0.75) for three consecutive years. Based on this definition, the results of the current assessment suggest the North Carolina blue crab stock is not overfished.

Though the overfished definition is based only on the production characteristic, it is also recommended to evaluate the adult abundance and recruit abundance characteristics for warning signs that the stock may be approaching an unfavorable state. If a series of negative trends is evident in the Traffic Light representation in adult abundance and production characteristics for three consecutive years, management should consider implementing actions so as to reduce the unfavorable condition of the stock. Only the adult abundance and production characteristics will be utilized to trigger management actions, and the recruit abundance characteristic will be used as a supplement to further direct conservation management actions, if deemed necessary. A review by the Crustacean Advisory Committee would be maintained to consider management options, evaluate their merits, and gain Marine Fisheries Commission approval before the Director’s proclamation authority (expanded under the adaptive management framework proposal) would be used to implement any changes to the fisheries.

5.2.3 MANAGEMENT MEASURES AND RULES

The preferred management strategies from the MFC are summarized in Section 4.1 for review by the secretary of DENR and the Joint Legislative Commission on Governmental Operations. Draft rules to implement the preferred management strategies are provided in Appendix 14.7.

5.2.4 MONITORING REQUIREMENTS

The preferred adaptive management of blue crabs relies on the Traffic Light Stock Assessment as the tool to provide information on the relative condition of the stock. The base years (1987 to 2009) for assigning the signals in the Traffic Light Stock Assessment will remain constant until the next amendment of the FMP. The Traffic Light Stock Assessment will be updated annually by July of each year. Data will be verified and ready for analysis no later than April 1 to extend the time series.

New monitoring requirements are in addition to existing blue crab monitoring programs to maintain the baseline information for the Traffic Light Stock Assessment.

5.3 DEFINITION OF THE MANAGEMENT UNIT

The management unit includes the blue crab (*Callinectes sapidus*) and its fisheries in all coastal fishing waters of North Carolina.

5.4 GENERAL PROBLEM STATEMENTS

Issues that are addressed in the management of North Carolina's blue crab stock include: 1) environmental factors; 2) stock protection; 3) user conflicts; 4) clarification of rules; and 5) harvest practices.

5.4.1 ENVIRONMENTAL FACTORS

Blue crabs rely on adequate and sufficient habitat and water quality of various types during their different life cycle stages. Loss or degradation of spawning, nursery, and molting areas, and reduced deep-water habitat and crowding in shallow habitats due to low dissolved oxygen levels may have long-term impacts on the blue crab population. Minor or short-term habitat disruptions, such as bottom disturbing activities (i.e. trawling, dredging, etc.) may have significant, but hard to measure impacts on the blue crab stock. Specific issues, options and potential actions are outlined in Sections 10.0 and 12.0 and follow the Coastal Habitat Protection Plan (NCDMF 2010).

5.4.2 STOCK PROTECTION

With increasing concerns over fluctuating blue crab landings and reductions in effort in the fishery, there have been requests to further protect the North Carolina blue crab stock. The blue crab population in any given year relies on the number of adults available in the population to reproduce. Environmental conditions (winter mortality, drought, hypoxia, hurricanes, and effects from human development), diseases, predation, and cannibalism are all natural mortality issues of concern. Specific issues, options and potential actions are outlined in Sections 11.0 and 12.0.

5.4.3 USER CONFLICTS

As the human population expands in North Carolina more frequent user conflicts over fishing space between crab potters (full and part-time), other fisheries (trawlers, long haulers, etc.), recreational activities (swimming, fishing, boating, etc.), and property owners near the water will occur. Conflicts can include: damage to vessels encountering gear; gear being moved, damaged, destroyed, or stolen; and space allocation issues for water activities. Specific issues, options and potential actions are outlined in Sections 11.0 and 12.0.

5.4.4 CLARIFICATION OF RULES

Rules need to be evaluated on a regular basis to determine whether they are still applicable to the current fisheries, clear to the public, and facilitate consistent enforcement practices. Proclamation authority is a flexible management tool used to implement regulations for variable conditions, but there are several long-standing proclamations in use specific to blue crabs that have remained unchanged for many years. The NCDMF has a policy which recommends moving long-standing proclamations that have remained static into rule. Specific issues, options and potential actions are outlined in Sections 11.0 and 12.0.

5.4.5 HARVEST PRACTICES

Wasteful and damaging fishing practices associated with the blue crab fishery can impact the blue crab resource as well as other non-targeted species. Gear modifications are sometimes necessary to reduce impacts on the resource as well as provide ways for fishermen to fish in a more efficient manner or reduce conflicts with other users. Specific issues, options and potential actions are outlined in Sections 11.0 and 12.0.

5.5 EXISTING PLANS, STATUTES, AND RULES

5.5.1 PLANS

There are no federal or interstate FMP's that apply specifically to the blue crab fishery in North Carolina. In December 1998, a state FMP for blue crabs was approved for North Carolina. The FMP was amended in 2004 (see Table of Amendments in Section 2.0 for a summary of actions taken). The Blue Crab FMP will be reviewed and updated at least every five years.

5.5.2 STATUTES

All management authority for North Carolina's blue crab fishery is vested in the State of North Carolina. Statutes that have been applied to the crab fishery include:

- Definitions relating to resources. G.S.113-129.
- Definitions relating to activities of public. G.S.113-130.
- Jurisdiction of fisheries agencies. G.S.113-132.
- It is unlawful for any person without the authority of the owner of the equipment to take fish from said equipment. G.S. 113-268 (a).
- It is unlawful for any vessel in the navigable waters of the State to willfully, wantonly, and unnecessarily do injury to any seine, net or pot. G.S. 113-268 (b).
- It is unlawful for any person to willfully destroy or injure any buoys, markers, stakes, nets, pots, or other devices or property lawfully set out in the open waters of the state in connection with any fishing or fishery. G.S. 113-268 (c).

5.5.3 MARINE FISHERIES COMMISSION RULES

Definitions

Blue Crab Shedding. The process whereby a blue crab emerges soft from its former hard exoskeleton. A shedding operation is any operation that holds peeler crabs in a controlled environment. A controlled environment provides and maintains throughout the shedding process one or more of the following: (i) food, (ii) predator protection, (iii) salinity, (iv) temperature controls, or (v) water circulation, utilizing technology not found in the natural environment. A shedding operation does not include transporting pink or red-line peeler crabs to a permitted shedding operation. 15A NCAC 03I .0101 (2) (c).

Peeler Crab. A blue crab that has a soft shell developing under a hard shell and having a white, pink, or red-line or rim on the outer edge of the back fin or flipper. 15A NCAC 03I .0101 (2) (f).

Commercial Fishing Equipment or Gear. All fishing equipment used in coastal fishing waters except: (i) Cast nets; (ii) 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; (iii) Dip nets or scoops 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; (iv) Gigs or other pointed implements which are propelled by hand, whether or not the implement remains in the hand; (v) Hand operated rakes no more than 12 inches wide and weighing no more than six pounds and hand operated tongs; (vi) Hook and line and bait and line equipment other than multiple hook or multiple bait trotline; (vii) Landing nets used to assist in taking fish when the initial and primary method of taking is by the use of hook and line; (viii) Minnow traps when no more than two are in use; (ix) Seines less than 30 feet in length; (x) Spears, Hawaiian slings or similar devices, which propel pointed implements by mechanical means, including elastic tubing or bands, pressurized gas or similar means. 15A NCAC 03I .0101 (3) (c).

Mesh Length. The diagonal distance from the inside of one knot to the outside of the other knot, when the net is stretched hand-tight. 15A NCAC 03I .0101 (3) (k).

Size Limit and Culling Tolerance

Hard crab minimum size limit of 5 inches measured from tip of spike to tip of spike, except that mature females, soft, and peeler crabs are exempt. Male crabs to be used as peeler bait are exempt from the 5 inch size limit from March 1 through October 31. All crabs less than the legal size except mature females, soft, and peelers shall immediately be returned to the water from which taken. Peeler crabs shall be separated where taken and placed in a separate container. White-line peeler crabs shall be separated from pink and red-line peeler crabs where taken and placed in a separate container. A culling tolerance of not more than five percent by number shall be allowed for white-line peelers in the pink and red-line peeler container. The Director, may by proclamation, impose a maximum size limit for mature female blue crabs (6¾ inches from tip of spike to tip of spike) and female peeler crabs (5¼ inches from tip of spike to tip of spike) from September 1 through April 30 when the spawner index falls below the lower 90 percent confidence limit for two consecutive years. 15A NCAC 3L .0201 (a) (b) (c) (1) (2).

Spawning Sanctuaries

It is unlawful to set or use trawls, pots, and mechanical methods for oysters or clams or take crabs with the use of commercial fishing equipment from crab spawning sanctuaries [3R .0110 (1) (2) (3) (4) (5)] from March 1 through August 31. During the remainder of the year the Director may, by proclamation, close these areas and may impose any or all of the following restrictions: number of days, areas, means and methods which may be employed in the taking, time period, and limit the quantity. 15A NCAC 3L .0205 (a) (b) (1) (2) (3) (4) (5).

Peeler and Soft Crabs

- It is unlawful to bait peeler pots, except with male blue crabs. Male blue crabs to be used as peeler bait and less than the legal size must be kept in a separate container, and may not be landed or sold. NCAC 3L .0206 (a).
- It is unlawful to possess male white line peelers from June 1 through September 1. 15A NCAC 3L .0206 (b).
- It is unlawful to sell white-line peelers. NCAC 3L .0206 (c).
- It is unlawful to possess white-line peelers unless they are to be used by the harvester in the harvester's permitted blue crab shedding operation. NCAC 3L .0206 (d).
- Peeler crabs shall be separated where taken and placed in a separate container. NCAC 3L .0206 (e).
- It is unlawful to possess more than 50 blue crabs in a shedding operation without first obtaining a Blue Crab Shedding Permit from the Division of Marine Fisheries. 3O .0503 (c).

Recreational Harvest

- Blue crabs may be taken without a license if the following gears are used; cast nets, collapsible crab traps with the largest open dimension no larger than 18 inches, a dip net having a handle not more than 8 feet in length and a hoop or frame to which the net is attached not exceeding 60 inches along the perimeter; single bait-and-line equipment, or seines less than 30 feet. 15A NCAC 3I .0101 (3) (c) (i) (ii) (iii) (vi) (ix)
- Recreational crab pot buoys must be any shade of hot pink in color, and be no less than 5 inches in diameter and length and be engraved with the owner's last name and initials. If a vessel is used the buoy must also be engraved with the gear owners current motorboat registration number or owner's U.S. vessel documentation name. 15A NCAC 3J .0302 (a) (1) (2).
- It is unlawful for a person to use more than one crab pot attached to the shore along privately owned land or to a privately owned pier without possessing a valid Recreational Commercial Gear License. 15A NCAC 3J .0302 (b).
- It is unlawful to use multiple hook or multiple bait trotlines for recreational purposes unless such trotlines are marked by attaching to them at each end one floating buoy, any shade of hot pink in color, which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. The owner shall always be identified on the buoy by using an engraved buoy or by attaching engraved metal or plastic tags to the buoy. Such identification shall include owner's last name and initials and if a vessel is used, one of the following: (1) Gear owner's current motor boat registration number, or (2) Owner's U.S. vessel documentation name. 3J .0305 (1) (2).
- It is unlawful to possess more than 50 blue crabs per person per day, not to exceed 100 blue crabs per vessel per day. 15A NCAC 03L .0209.
- One seine 30 feet or over in length but not greater than 100 feet with a mesh length less than 2 1/2 inches when deployed or retrieved without the use of a vessel or any other mechanical methods. A vessel may be used only to transport the seine. 15A NCAC 3O .0302 (a) (1).
- One shrimp trawl with a headrope not exceeding 26 feet in length per vessel. 15A NCAC 3O .0302 (a) (2).
- Up to five crab pots may be used by holders of the Recreational Commercial Gear License. 15A NCAC 3O .0302 (a) (3).
- Peeler pots are not permitted to be used by holders of the Recreational Commercial Gear License. 15A NCAC 3O .0302 (a) (3).
- One multiple hook or multiple bait trotline up to 100 feet in length may be used to harvest blue crabs. Trotlines must be marked at both ends with solid buoyant buoys. 15A NCAC 3O .0302 (a) (4).

Trawls

- It is unlawful to possess aboard a vessel while using a trawl in internal waters more than 500 pounds of finfish from December 1 through February 28 and 1,000 pounds of finfish from March 1 through November 30. 15A NCAC 3J .0104 (a).
- The Fisheries Director may, by proclamation, close any area to trawling for specific time periods in order to secure compliance with this Rule. 15A NCAC 3J .0104 (g).
- It is unlawful to use trawl nets in internal coastal waters, from 9:00 p.m. on Friday through 5:00 p.m. on Sunday. 15A NCAC 3J .0104 (b) (1).
- It is unlawful to use trawl nets in Albemarle Sound, Currituck Sound, and their tributaries. 15A NCAC 3J .0104 (b) (3).

- It is unlawful to use trawl nets from December 1 through February 28 from one hour after sunset to one hour before sunrise in portions of the Pungo, Pamlico, Bay, Neuse, and New river's. 15A NCAC 3J .0104 (b) (5) (A) (B) (C) (D) (E).
- It is unlawful to use trawl nets in designated pot areas opened to the use of pots and within an area bound by the shoreline to the depth of six feet. 15A NCAC 3J .0104 (b) (6).
- The Director may by proclamation, require bycatch reduction devices or codend modifications in trawl nets to reduce the catch of finfish that do not meet size limits or are unmarketable as individual foodfish by reason of size. 15A NCAC 3J .0104 (d).
- It is unlawful to use shrimp trawls for the taking of blue crabs in internal waters, except that it shall be permissible to take or possess blue crabs incidental to commercial shrimp trawling provided that the weight of the crabs shall not exceed; 50 percent of the total weight of the combined crab and shrimp catch; or 300 pounds, whichever is greater. For individuals using shrimp trawls authorized by a Recreational Commercial Gear License, 50 blue crabs, not to exceed 100 blue crabs if two or more Recreational Commercial Gear License holders are on board. The Fisheries Director may, by proclamation, close any area to trawling for specific time periods in order to secure compliance with this rule. 15A NCAC 3J .0104 (f) (2) (A) (B) (g).
- It is unlawful to use nets from June 15 through August 15 in the waters of Masonboro Inlet or in the ocean within 300 yards of the beach between Masonboro Inlet and a line running 138° through the water tank on the northern end of Wrightsville Beach, a distance parallel with the beach of 4,400 yards. It is unlawful to use trawls within one-half mile of the beach between the Virginia line and Oregon Inlet. 15A NCAC 3J. 0202 (1) (2).
- From December 1 through March 31 it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish; except that trawlers working south of Bogue Inlet may keep up to 300 pounds of kingfish, regardless of their shrimp or crab catch weight. 15A NCAC 3J .0202 (5) (a) (b).
- It is unlawful to use trawl nets upstream of the Highway 172 Bridge in New River from 9:00 P.M. through 5:00 A.M. when opened by proclamation from August 16 through November 30. 15A NCAC 3J .0208.
- It is unlawful to take or possess crabs aboard a vessel in internal waters except in areas and during such times as the Fisheries Director may specify by proclamation. 15A NCAC 3L .0202 (a).
- It is unlawful to take crabs with crab trawls with a mesh less than three inches, except that the Director may, by proclamation, increase the minimum mesh length to no more than four inches. 15A NCAC 3L .0202 (b).
- It is unlawful to use trawls with a mesh length less than two inches or with a combined total headrope length exceeding 25 feet for taking soft or "peeler" crabs. 15A NCAC 3L .0202 (c).
- It is unlawful to possess striped bass on a vessel with a trawl net on that vessel in internal coastal waters except during transit from ocean fishing grounds to port during any open striped bass trawl season in the Atlantic Ocean established by proclamation. Striped bass so possessed must meet the minimum size limit set by proclamation. It is unlawful to possess striped bass on a vessel in the Atlantic Ocean with a trawl net on that vessel except during any open striped bass trawl season in the Atlantic Ocean established by proclamation. 15A NCAC 03M .0205 (a) (b).
- It is unlawful to use a trawl net in any primary or permanent secondary nursery area. 15A NCAC 3N .0104, 3N .0105 (a), 3R .0103 and 3R .0104.

- It is unlawful to use trawl nets for any purpose in any of the special secondary nursery areas, except that the Fisheries Director, may, by proclamation, open any or all of the special secondary nursery areas, or any portion thereof to crab trawling from August 16 through May 14. 15A NCAC 3N .0105 (b), 15A NCAC 3R .0105, 15A NCAC 03L .0100 and .0200.
- It is unlawful to use trawl nets in areas listed in 15A NCAC 3R .0106, except that certain areas may be opened to peeler trawling for single-rigged peeler trawls or double-rigged boats whose combined total headrope length does not exceed 25 feet. 15A NCAC 3J .0104 (b) (4); 15A NCAC 3R .0106 (6).

Crab pots

- It is unlawful to leave pots in any coastal fishing waters for more than five consecutive days, when such pots are not being employed in fishing operations, except upon a timely and sufficient showing of hardship. 15A NCAC 3I .0105 (b) (1) (2) (A) (B) (3) (c).
- All pots shall be removed from internal waters from January 15 through February 7. Areas may be reopened, by proclamation, to the use of pots after January 19 if it is determined that such areas are free of pots. 15A NCAC 3J .0301 (a) (1).
- From June 1 through November 30 the use of crab pots is restricted in certain areas north and east of the Highway 58 Bridge at Emerald Isle. To allow for the variable spatial distribution of crustacea and finfish, the Fisheries Director may, by proclamation, specify time periods for or designate the areas described in 15A NCAC 03R .0107(b); or any part thereof, for the use of pots. From May 1 through November 30 in the Atlantic Ocean and west and south of the Highway 58 Bridge at Emerald Isle in areas and during time periods designated by the Fisheries Director by proclamation.15A NCAC 3J .0301 (a) (2) (A) (B) (3) and 3R .0107(a) (b).
- It is unlawful to use pots in any navigation channel maintained and marked by State or Federal agencies. 15A NCAC 3J .0301 (b) (1).
- It is unlawful to use pots in any turning basin maintained and marked by the North Carolina Ferry Division. 15A NCAC 3J .0301 (b) (2).
- It is unlawful to use pots in a commercial fishing operation unless each pot is marked by attaching a floating buoy which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. Buoys may be any color except yellow or hot pink or any combination of colors that include yellow or hot pink. The pot owner’s N.C. motorboat registration number, or U.S. vessel documentation name, or last name and initials shall be engraved in the buoy, or on a metal or plastic tag attached to the buoy. 15A NCAC 3J .0301(c) (1) (2) (3).
- It is unlawful to use crab pots in coastal fishing waters unless each pot contains no less than two unobstructed escape rings that are at least 2 5/16 inches inside diameter and located in the opposite outside panels of the upper chamber of the pot. Peeler pots with a mesh size less than 1 1/2 inches shall be exempt from the escape ring requirement. The Fisheries Director may, by proclamation, exempt the escape ring requirement in order to allow the harvest of peeler crabs or mature female crabs and may impose any or all of the following restrictions: (1) Specify areas, and (2) Specify time. 15A NCAC 3J .0301 (g).
- It is unlawful to use more than 150 pots per vessel in the Newport River.15A NCAC 3J .0301(h).
- It is unlawful to remove crab pots from the water or remove crabs from pots between one hour after sunset and one hour before sunrise. 15A NCAC 3J .0301(I).

- The Fisheries Director may, with the prior consent of the Marine Fisheries Commission, by proclamation close any area to the use of pots in order to resolve user conflict. 15A NCAC 3J .0301(j).
- It is unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating. 15A NCAC 3J .0301(k).

Crab dredging

- It is unlawful to use any dredge weighing more than 100 lb except in the Atlantic Ocean. 15A NCAC 3J .0303 (a).
- It is unlawful to use more than one dredge per vessel to take crabs or to use any dredges between sunset and sunrise. 15A NCAC 3J .0303 (b).
- It is unlawful to take crabs with dredges except from January 1 through March 1 in portions of Pamlico Sound. 15A NCAC 3L .0203 (a) (1) and 15A NCAC 3R .0109.
- Crabs may be taken incidental to lawful oyster dredging provided the weight of the crabs shall not exceed 50% of the total weight of the combined oyster and crab catch; or 500 lb, whichever is less. 15A NCAC 3L .0203 (a) (2) (A) (B).
- It is unlawful to take crabs with dredges between sunset and sunrise and between sunset on any Saturday and sunrise on the following Monday, except in the Atlantic Ocean. 15A NCAC 3L .0203 (b).

Miscellaneous

- It is unlawful to possess, sell, or purchase fish under four inches in length except for use as bait in the crab pot fishery in North Carolina with the following provision: such crab pot bait shall not be transported west of U.S. Interstate 95 and when transported, shall be accompanied by documentation showing the name and address of the shipper, the name and address of the consignee, and the total weight of the shipment. 15A NCAC 3M .0103 (1).
- It is unlawful to set a trotline within 100 yards of a pound net from February 1 through May 31 in the Chowan River and its tributaries. 15A NCAC 3J .0203 (5).
- The Fisheries Director in order to address issues involving user conflicts may, by proclamation, close areas to the use of specific fishing gear between the Friday before Easter through December 31 in the following areas: All or part of the Atlantic Ocean, up to one-half mile from the beach; Up to one-half mile in all directions of Oregon Inlet; Hatteras Inlet; Ocracoke Inlet; Cape Lookout Rock Jetty; fishing piers open to the public; State Parks; and marinas as defined by the Coastal Resources Commission. 15A NCAC 03J .0401 (a) (b).
- In Dare County commercial fishing gear may not be used within 750 feet of licensed fishing piers when opened to the public. Commercial fishing gear may not be used in the Atlantic Ocean off of portions of Onslow, Pender, and New Hanover counties during specified time frames. 15A NCAC 3J .0402 (a) (1) (A) (ii) (2) (A) (B) (i) (ii) (3) (A) (B) (i) (ii) (iii).
- In the Pamlico River commercial fishing gear may not be used from the Friday before Easter through December 31 within 150 feet of the shoreline of Goose Creek State Park boundaries and within the marked channel from Dinah Landing to the mouth of Upper Goose Creek. NCAC 3J .0402 (4).

5.5.4 NORTH CAROLINA WILDLIFE RESOURCE COMMISSION RULES FOR BLUE CRABS

Manner of Taking Nongame Fish Purchase and Sale

- Nongame fish may be taken by hook and line or by grabbling; no fish may be taken by snagging. Special devices may be used to take nongame fish with proper licenses in those counties and waters with open seasons. 15A NCAC 10C .0401 (a).
- Blue crabs shall have a minimum carapace width of five inches (point to point) and it is unlawful to possess more than 50 crabs per person per day or to exceed 100 crabs per vessel per day. 15A NCAC 10C .0401 (a) (1).
- No trotlines or set-hooks shall be used in the impounded waters located on the Sandhills Game Land or in designated public mountain trout waters. 15A NCAC 10C .0401 (a) (4).
- Blue crab taken by hook and line, grabbling or by licensed special devices may not be sold. 15A NCAC 10C .0401 (c).

Taking Nongame Fish, Crustaceans, and Mollusks for Bait or Personal Consumption

- Nongame fishes, crustaceans, and mollusks may be taken for bait or personal consumption only with the equipment listed below, and an appropriate inland fishing license is required. 15A NCAC 10C .0402 (a).
  - A dip net not greater than six feet across. 15A NCAC 10C .0402 (a) (1).
  - A seine not greater than 12 feet in length with a bar mesh measure of not more than 1/4 inch. Exception: In Lake Waccamaw any length seine may be used to collect bait fishes. 15A NCAC 10C .0402 (a) (2).
  - A cast net. 15A NCAC 10C .0402 (a) (3).
  - Minnow traps under immediate control and attendance of the operator and not exceeding 12 inches in diameter, with funnel openings not exceeding one inch in diameter. 15A NCAC 10C .0402 (a) (4).
  - Hand-held lines with single baits attached to each. 15A NCAC 10C .0402 (a) (5).
  - A single, multiple bait line for taking crabs not to exceed 100 feet in length that is under the immediate control and attendance of the user and is limited to one line per person and no more than one line per vessel. The line is required to be marked on each end with a solid float no less than five inches in diameter and bearing legible and indelible identification of the user's name and address. 15A NCAC 10C .0402 (a) (6).
  - A collapsible crab trap with the largest opening not greater than 18 inches and which, by design, collapses at all times when in the water, except when being retrieved or lowered to the bottom. 15A NCAC 10C .0402 (a) (7).
- Nongame fishes, crustaceans (crayfish and blue crabs), and mollusks taken for bait or personal consumption may not be sold. 15A NCAC 10C .0402 (b).
- No more than 50 crabs per person, per day or 100 per vessel, per day with a minimum carapace width of five inches (point to point) from inland fishing waters or in designated waterfowl impoundments located on game lands. 15A NCAC 10C .0402 (d) (3).

Special Device Fishing

- Special fishing devices, which may be licensed for the taking of nongame fishes, include the following: bow and arrow (except crossbows), seines, cast nets, gill nets, dip nets, bow nets, reels, gigs, spear guns, baskets, fish pots, eel pots, traps (excluding crab traps and automobile tires), and hand-crank electrofishers where authorized by local law. 15A NCAC 10C .0404 (a), (b), (c), (d), (f), (g).

- Special fishing devices may only be used in waters having designated seasons. 15A NCAC 10C .0404.
- It is unlawful to use crab pots in inland fishing waters, except by persons owning property adjacent to the inland fishing waters of coastal rivers and their tributaries who are permitted to set two crab pots to be attached to their property and not subject to special device license requirements. 15A NCAC 10C .0404 (e).
- Each user of a special device must have his own license in possession or readily available for inspection, except that a bow net or dip net may be used by another person who has the owner's license in his possession or readily available for inspection. 15A NCAC 10C .0405
- When using drag seines authorized for taking nongame fishes at beaches on inland fishing waters where there are migratory saltwater fishes (herring or mullet), only the principal owner and operator is required to be licensed. 15A NCAC 10C .0405.

Trotlines, Set-hooks, and Jug-hooks

- It is unlawful to use live bait with trotlines, set-hooks or jug-hooks. 15A NCAC 10C .0206.
- Trotlines (a line with multiple hooks) must be set parallel to the nearest shore in all public waters, where their use is authorized. 15A NCAC 10C .0206.
- Each trotline, set-hook and jug-hook shall have attached the name and address of the user legibly inscribed. 15A NCAC 10C .0206.
- Each trotline shall be conspicuously marked at each end, and each set-hook shall be conspicuously marked at one end with a prominent flag or floating object. 15A NCAC 10C .0206.
- Metal cans and glass containers cannot be used as markers. 15A NCAC 10C .0206.
- The number of jug-hooks that may be fished is limited to 70 per boat. 15A NCAC 10C .0206.
- Trotlines, throwlines, set-hooks and jug-hooks must be fished daily, and all fish must be removed daily. 15A NCAC 10C .0206.
- Untended trotlines, set-hooks and jug-hooks, as evidenced by the absence of bait, may be removed from the water by wildlife enforcement officers. 15A NCAC 10C .0206.

Trawls and Dredges

It is unlawful to use a trawl or clam dredge in any inland fishing waters. 15A NCAC 10C .0406.

5.5.5 OTHER STATES BLUE CRAB RULES AND REGULATIONS

See Appendix 14.3 and 14.4 for a list of rules and regulations for other blue crab producing states.

5.5.6 FEDERAL REGULATIONS

Pursuant to Title 33 United States Code Section 3, the United States Army Corps of Engineers has adopted regulations which restrict access to and activities within certain areas of coastal and inland fishing waters. Federal Rules codified at 33 CFR 334.410 through 334.450

designate danger zones and restricted areas, within North Carolina coastal waters. These areas are designated in 15A NCAC 03R .0102. Only the applicable military commanders listed in the federal regulations have authority to authorize navigation or fishing access to these designated areas. 15A NCAC 3I .0110 (a).

6.0 STATUS OF THE STOCK

6.1 GENERAL LIFE HISTORY

6.1.1 GEOGRAPHICAL DISTRIBUTION

In the United States the blue crab (*Callinectes sapidus,* family Portunidae) (Rathbun 1896) ranges from Maine south ward to the Gulf of Mexico and are most common from Cape Cod, Massachusetts to the most southern end of Texas (Hay 1905; Guillory et al. 2001). Distribution of the genus *Callinectes* occurs regularly in waters where peak temperatures reach at least 20^{o}C (Norse 1977). The blue crab is common to all North Carolina coastal waters, but the largest aggregations tend to live in the Albemarle and Pamlico sounds and the tributaries associated with these regions.

6.1.2 REPRODUCTIVE BIOLOGY

Male and female blue crabs are easily identified by the shape of the apron on their abdomen. A mature male crab is called a "jimmy" and is easily recognized by the blue shading on his shell and claws and T-shaped apron on its underside (Figure 6.1.1 A). Female crabs are either called "sooks" as adults or "she-crabs" when immature. The immature female apron is triangular-shaped and held tightly against the abdomen (Figure 6.1.1 B). The mature female’s apron becomes rounded and can be easily pulled away from the body after the final molt (Figure 6.1.1 C). Molting is a process of growth in blue crabs that requires shedding the hard exoskeleton. The "sponge crab" is a female that has an egg mass on her abdomen (Figure 6.1.1 D).

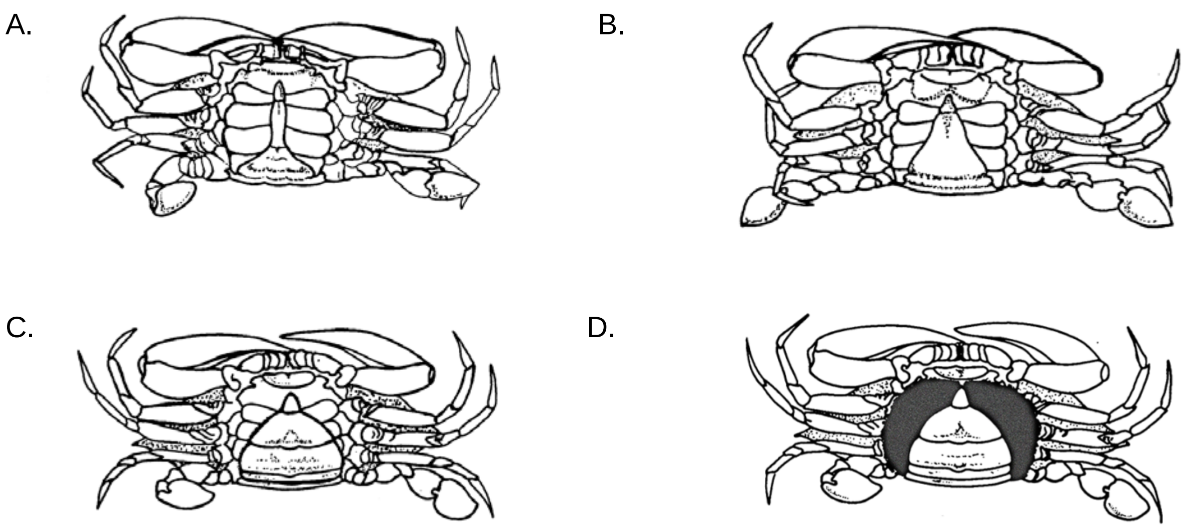

Figure 6.1.1 Apron shape differences between male and female blue crabs and immature and mature female blue crabs. A. “Jimmy” – male blue crab. B. “She-crab” – immature female blue crab. C. “Sook” – mature female blue crab. D. “Sponge crab” – Egg bearing mature female blue crab. http://www.ncdmf.net/bluecrab/index.html.

Blue crabs mature at approximately 12 to 18 months of age. Mating occurs in brackish areas of the estuary and lower portions of the rivers from late spring to early fall, and spawning occurs in the high-salinity waters near the ocean inlets (Whitaker 2006). Males may mate after their third or fourth intermolt, females mate only once in their lives (Hill et al. 1989). The sperm from this mating is stored in seminal receptacles of the female and used as often as the female spawns during a one or two year period (Hill et al. 1989). All young produced by a female must be fertilized by stored sperm (Darnell et al. 2009). Eggs are spawned and held under the female for approximately 14 days. This egg mass carried by the female looks similar to a sponge. Thus, females carrying eggs are sometimes referred to as “sponge crabs”. The egg mass changes color from yellow, to orange, to brown, to black as the eggs develop prior to hatching.

Spawning usually occurs within two months after mating in the spring and summer. However females that mate in the fall usually delay spawning until the following spring (Darnell et al. 2009). Peak spawning periods are from April to June and August to September (NCDMF 2004). A fecundity study conducted in one spawning season in North Carolina found female blue crabs could produce at least 3 and up to 7 clutches in one season (Dickinson et al. 2006). Clutch size was related to body size and clutch size decreased with increasing clutch number in the season (Dickinson et. al. 2006; Darnell et al. 2009). The reproductive potential was similar for most size classes of female blue crabs (Dickinson et al. 2006; Darnell et al. 2009). Larger females produce larger clutch sizes but spawned less frequently than smaller females; thus, small and large crabs had the same overall reproductive potential (Dickinson et al. 2006)

Eggs hatch in approximately 15 days, and the first larval stage (zoeae) is carried offshore by ocean currents where they undergo seven to eight developmental stages (Figure 6.1.2) (Costlow et al. 1959; Costlow and Bookhout 1959; Epifanio 1995). Zoeae larvae are restricted to high salinity areas because of their intolerance of low salinity water (Costlow and Bookhout, 1959). This stage and all following life stages only increase in body size through molting (Hay 1905; Hill et al. 1989). Following the zoeal stages, a megalopal stage occurs which lasts from 6 to 20 days (Costlow and Bookhout 1959).
Settlement of blue crab megalopae along the western North Atlantic (Delaware to South Carolina) is characterized by constant low levels of settlement with episodic peaks that vary in duration and intensity (van Montfrans et al. 1995). The van Montfrans et al. (1995) study shows there are both consistent and variable settlement patterns seen across this geographic range which are likely due to random and consistent oceanic processes. Blue crab megalopae settlement in the Pamlico and Albemarle sounds is possibly a result of wind-driven onshore transport through the inlets and peak settlement is based on the direction and magnitude of wind events associated with tropical storms and other significant wind events occurring in short periods (Epifanio 2007; Eggleston et al. 2010). Megalopae settlement in the southern region of the state (Beaufort Inlet and south) may be more tidally influenced with highest settlement at neap tides during quarter phases of the moon and increasing with hours of dark flood tides. Seasonal wind patterns and storms also play a role in megalopal movement into the estuary (van Montfrans et al. 1995; Forward et al. 2004; Ogburn et al. 2009).

Once within the estuary, megalopal stage blue crabs settle in beds of submerged aquatic vegetation and other complex habitats (i.e.: salt marsh, detritus, and oyster shell) where they undergo further metamorphosis to become juveniles (Hill et al. 1989; Etherington and Eggleston 2000; Heck and Thoman 1984; Orth and van Montfrans 1987; Pardieck et al. 1999; Posey et al. 1999; and Ruiz et al. 2003). Juveniles gradually migrate to less-saline waters in the upper estuaries and rivers, to grow and mature.

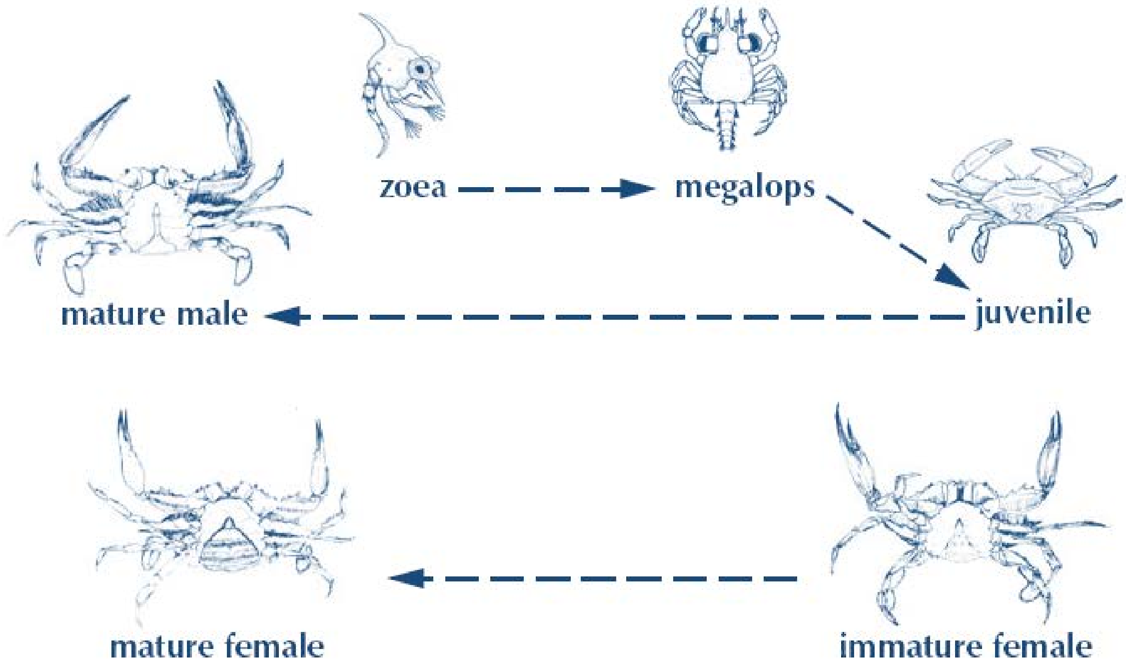

Figure 6.1.2 Lifecycle of the blue crab (*Callinectes sapidus*). [From: S.C. Department of Natural Resources (Whitaker 2006)].

6.1.3 LOCAL DISTRIBUTION AND MOVEMENT OF ADULTS

Adult blue crabs have differential habitat distribution by sex and salinity. Mature female blue crabs are more commonly found in higher salinity waters (>10 ppt) and males prefer lower salinities (3 to 15 ppt). In North Carolina, adult male blue crabs are found predominantly in the rivers and on the western side of the sounds.

Beginning in the fall 2002 and continuing through fall 2005, 23,964 mature female blue crabs were tagged and released at various locations throughout coastal North Carolina (NCDMF 2008). Tag return rates varied considerably by area and tagging period and there was an overall return rate of 11.6 %. Most of the recaptures occurred within a short time frame in close proximity to the release site. However, one notable difference among the three years of tagging was that long distance returns were more prevalent in 2003 from the northern to the southern coastal area.

This tagging study has shown that females use the nearshore ocean waters during some long distance migrations (NCDMF 2008). Releases in the upper and mid-estuaries of the Albemarle-Pamlico systems and Cape Fear River show a general pattern of summer to fall movement towards the lower estuary areas and coastal inlets (NCDMF 2008) (Figures 6.1.3 and 6.1.4). Mature female blue crabs tagged in the southern coastal area (i.e. Bogue, Stump, and Topsail sounds, Cape Fear River, and Atlantic Ocean) have a southward pattern of movement (NCDMF 2008) (Figures 6.1.5 to 6.1.7). A significant portion of mature females in the southern area overwinter in the ocean near the coastal inlets and move back into the estuaries the following spring to forage and potentially spawn multiple times (NCDMF 2008). The same trend of springtime movement was confirmed in another study of female blue crabs tagged and released in the Atlantic Ocean south of the Cape Fear River during February to April 2005 and 2006, and suggested female blue crab movement was cued to the warming of the estuarine waters

(Logothetis et al. 2007). Other studies have also shown that the migratory behavior of mature female blue crabs continues between clutches and spawning females are continually moving seaward through the spawning season (Hench et al. 2004; Forward et al. 2005; and Darnell et al. 2009).

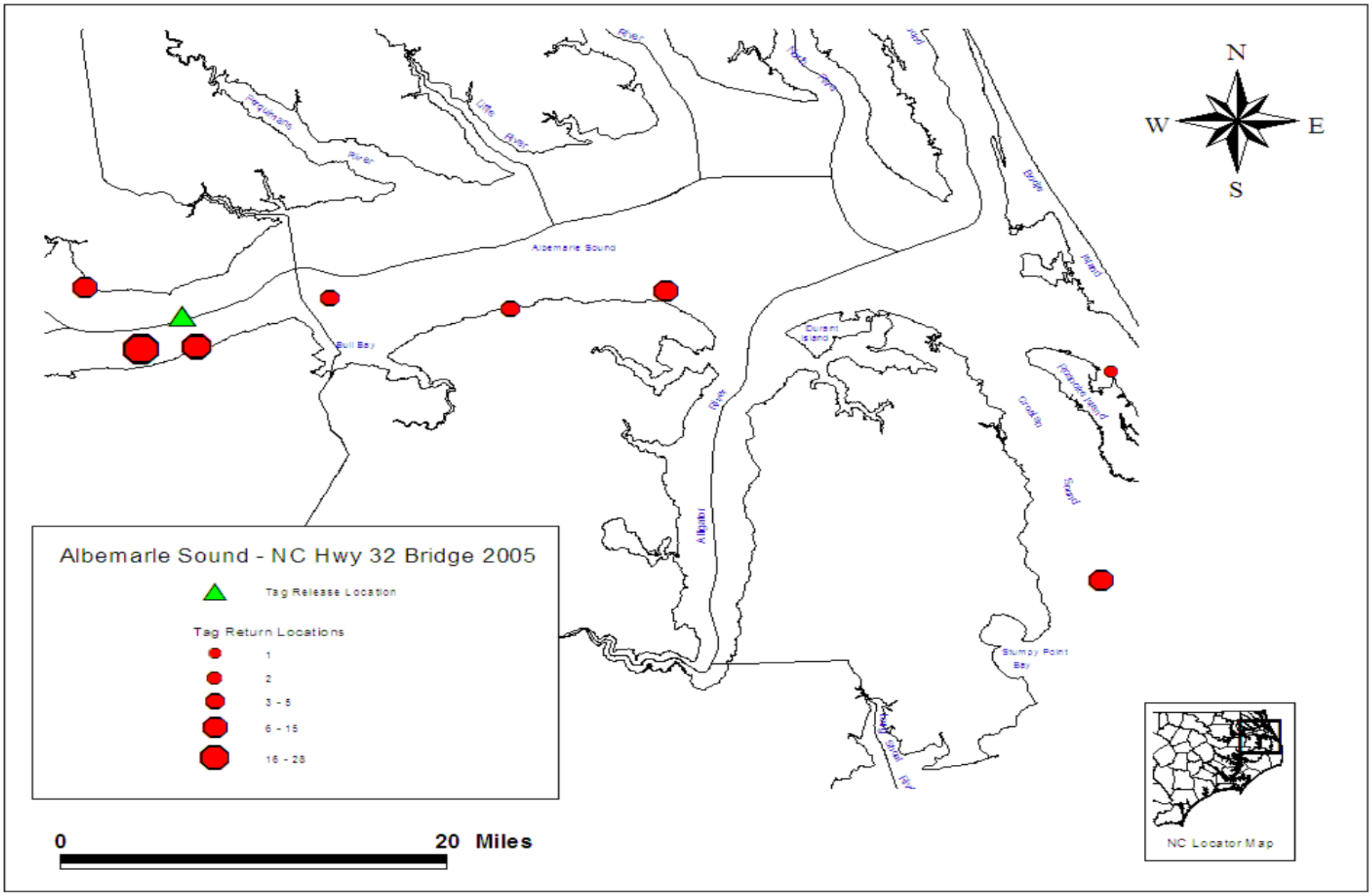

Figure 6.1.3 NCDMF Blue Crab Tagging: Albemarle Sound at the Highway 32 Bridge release (N= 250, July 2005) and recapture locations (N=60) (NCDMF 2008).

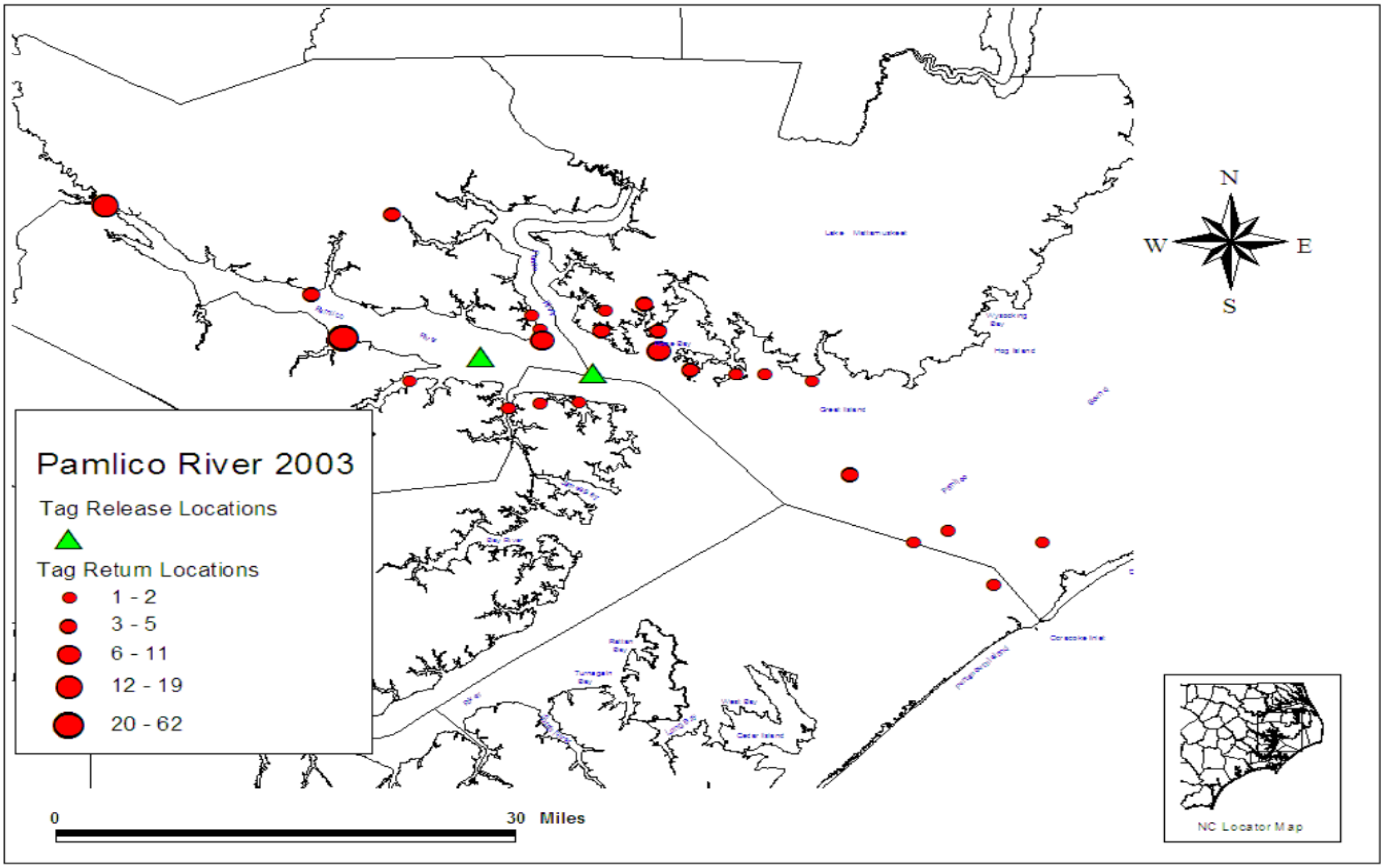

Figure 6.1.4 NCDMF Blue Crab Tagging: Pamlico River release (N= 1000, August–September 2003) and recapture locations (N=148) (NCDMF 2008).

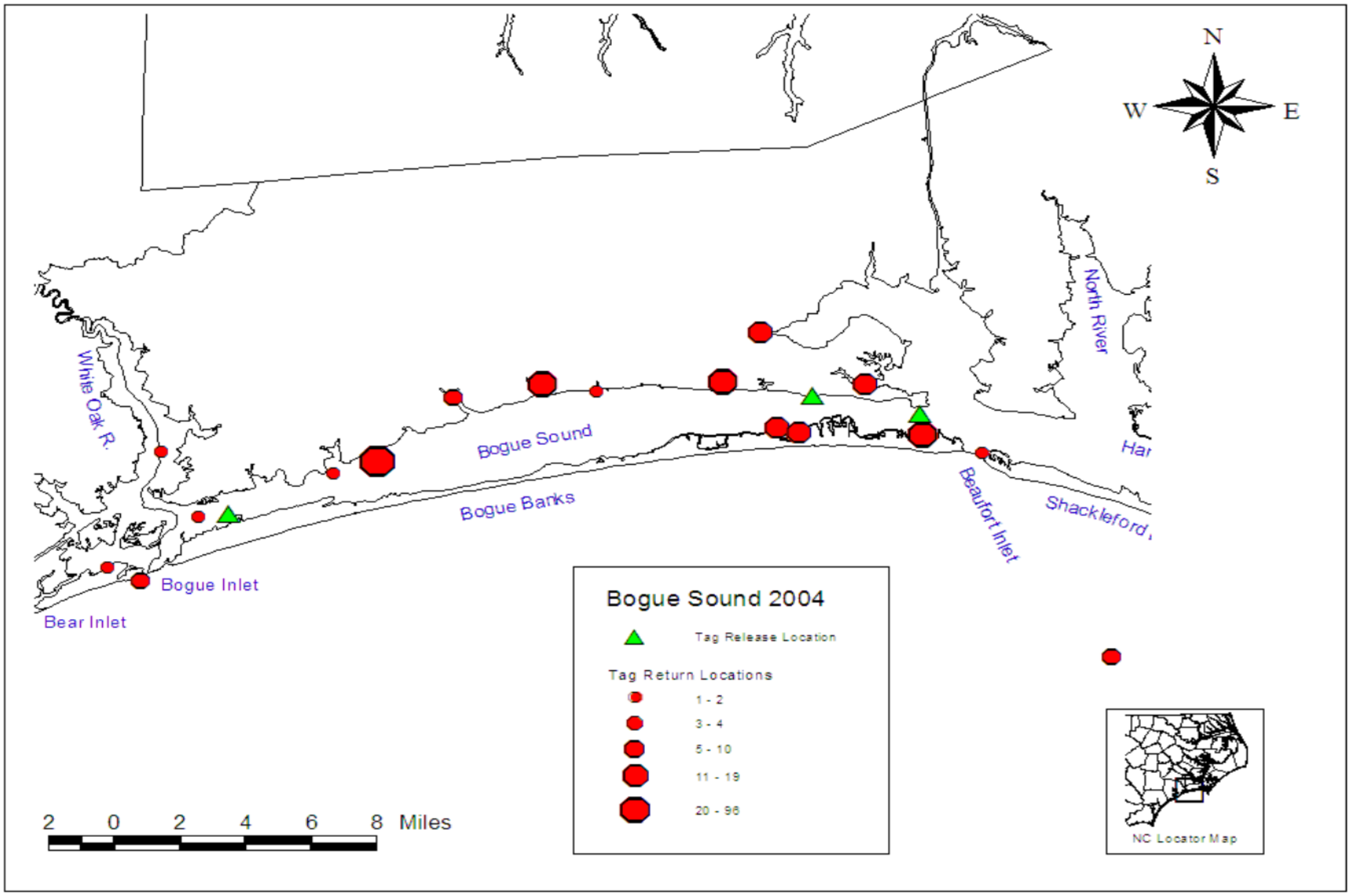

Figure 6.1.5 NCDMF Blue Crab Tagging: Bogue Sound release (N= 1000, May–November 2004) and recapture locations (N=196).

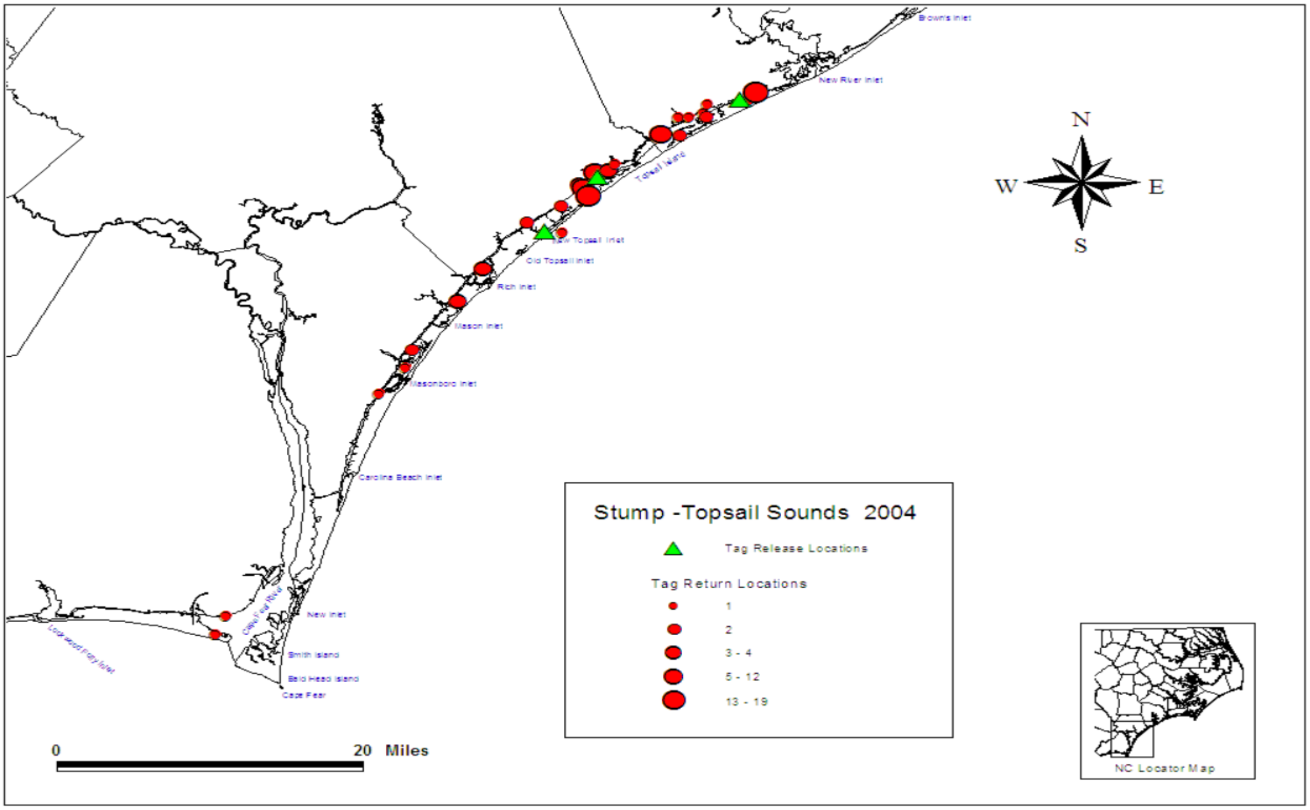

Figure 6.1.6 NCDMF Blue Crab Tagging: Stump and Topsail Sounds release (N= 499, September-October 2004) and recapture locations (N=101) in NC waters (NCDMF 2008).

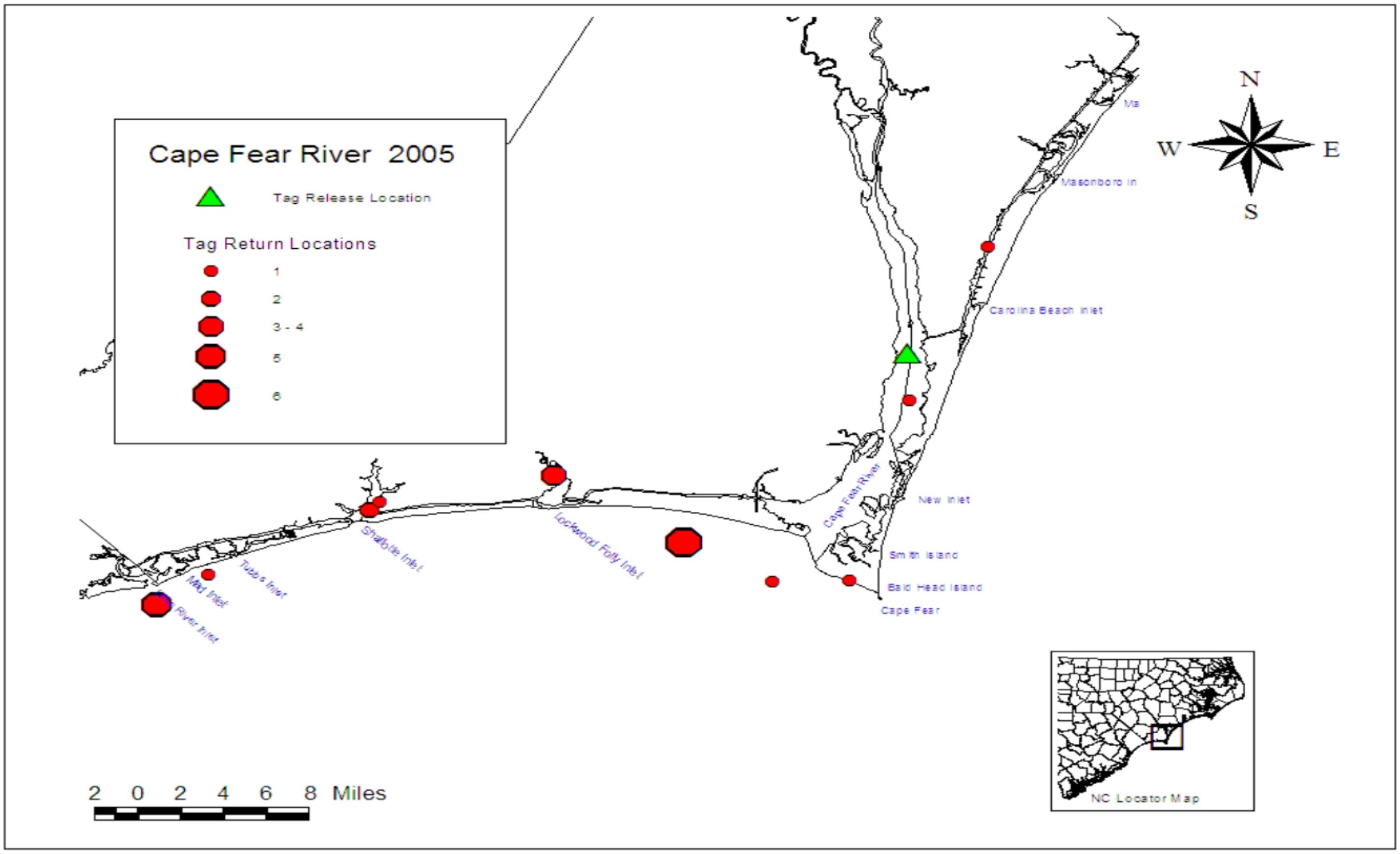

Figure 6.1.7 NCDMF Blue Crab Tagging: Cape Fear River release (N= 294, July – November 2005) and recapture locations (N=23) from NC waters (cooperative trawl tagging with UNCW (NCDMF 2008).

6.1.4 HABITAT TOLERANCES AND PREFERENCE

The preferred habitat of blue crabs is tidal marsh estuaries characterized by soft mud substrate and waters of moderate salinity (NCDMF 2004). The blue crab requires both inshore brackish waters and high salinity ocean waters to complete its life cycle (Whitaker 2006). Blue crab larvae require salinities of at least 26 ppt for proper development (Chesapeake Bay Program 1997). Both juveniles and adults can tolerate a wide range of salinities including fresh water areas.

Juvenile blue crabs require suitable habitat in order to grow and avoid predation (Posey et al. 2005). Seagrass beds are an important nursery habitat that provide refuge from predators, but are not available in all coastal waters of North Carolina to support juvenile blue crab development. Lower salinity regions in the river-dominated estuaries may provide important nursery areas for the blue crab population (Posey et al. 2005).

More detailed habitat and water quality information is provided in Section 10.0: Environmental Factors.

6.1.5 AGE AND GROWTH

Growth in blue crabs is rapid the first summer and is dependent on temperature, molt frequency, food quality and availability, and life stage. Optimum growth of blue crabs occurs at temperatures between 15°C to 30°C, and growth stops when the temperature goes below 10°C (Cadman and Weinstein 1988). In temperate regions, where winter temperatures regularly fall below this threshold, blue crabs bury into the sediment. During this dormant period, no growth occurs, thereby extending the time to reach maturity (Bauer and Miller 2010). Laboratory observations indicate that growth of blue crabs is 12% to 35% per molt (Cadman and Weinstein 1988).

The average life span is about three years with a five to eight year maximum (NCDMF 2004). Age determination of crustaceans is difficult because, unlike finfish, they lack permanent hard structures because of losing the hard parts through molting. Often modal analysis of length frequency data is used instead of accurate age information for estimating year-class strength in a population (NCDMF 2004). Biochemical measures for ageing blue crabs have been attempted (Ju et al. 1999; Ju et al. 2001; Puckett et al. 2008). Cellular oxidation products termed “lipofuscins” (LF) are used, which accumulate as stable fluorescent by-products in specific tissues of the blue crab. The amount of LF held in the tissues increases with age (Puckett et al. 2008). The accuracy of age determination using this technique has always been a concern, and a new validation method was attempted on known-age individuals (Campana 2001; Puckett et al. 2008). Like most species, there is a lot of variation in size at estimated age (Puckett et al. 2008). Moderately large sample sizes will account for the variation in size at estimated age and blue crabs can be accurately assigned to cohorts using biochemical LF measures (Ju et al. 2001; Puckett et al. 2008).

6.1.6 FOOD AND FEEDING

Blue crabs perform many functions within the ecosystem. During various stages of their lifecycle, blue crabs function both as predator and prey. In early stages of their development, blue crabs are phytoplanktivorous, eating dinoflagellates and larvae of many species (Hill et al. 1989). The megalopae stage of blue crab development is known to eat fish larvae, small shellfish, and aquatic plants (Van Engel 1958). Juvenile and adult blue crabs are considered scavengers, bottom carnivores, detritivores, and omnivores (Hay 1905; Hill et al. 1989). Blue crabs will eat what is available to them, including: dead and live fish, crabs, organic debris, shrimp, shellfish, and aquatic plants. Their diet varies considerably with location and prey availability. Blue crabs are found in the diet of many fishes, including striped bass (Manooch 1973; Speir 2001), red drum (Bass and Avault 1975; Speir 2001), Atlantic croaker (Overstreet and Heard 1978), and American eel (Wenner and Musick 1975).

6.2 PRESENT STOCK STATUS

North Carolina’s blue crab stock is currently listed as one of concern due to reduced commercial landings of hard blue crabs during 2000 through 2002 and 2005 through 2007. These reduced landings followed record-high commercial landings observed during 1996 through 1999 (NCDMF 2011). Harvest from Pamlico and Core sounds and their tributaries continue to remain significantly less than historical levels. Albemarle Sound continues to be the dominant contributor, landing 15.1 million pounds of the state’s total blue crab commercial harvest of 29.7 million pounds in 2009.

The North Carolina blue crab stock was last assessed in 2004 as part of the review and amendment of the Blue Crab FMP (Eggleston et al. 2004). The time series data were extremely variable, there was not much correspondence between the pre-recruits and full recruits, and the data showed a poor fit when compared to the predicted model results (J. Hightower, NCSU, pers. comm.). Concerns regarding the uncertainty of estimates of maximum sustainable yield as well as data and modeling limitations led the NCDMF to conclude that the status of the blue crab stock could not be accurately assessed at the time (NCDMF 2004). The results of the 2004 assessment were not used for management. The management tool that was adopted at the time was the implementation of restrictions to protect the blue crab spawning stock when the defined spawning stock biomass trigger is activated. In addition, an overfished stock definition for blue crabs was adopted based on commercial landings trends. The blue crab resource was considered overfished when annual commercial landings declined for five consecutive years. No definition of overfishing could be developed.

During this amendment process, the assessment working group considered applying a surplus production model and catch-survey analysis for the current assessment, but it was concluded that the information needed to conduct a reliable assessment using these methods were limited or unavailable. Uncertainties include unclear boundaries of the unit stock, lack of discard data, limited estimates of recreational harvest, and lack of a reliable statewide index of abundance. Additional factors specifically limiting the use of a catch-survey analysis include highly variable estimates of natural mortality, differing size limits, high coefficients of variation in many indices, and no knowledge of an appropriate scaling factor to relate indices of pre-recruits to indices of full recruits. Therefore, the working group decided it would be more appropriate to conduct an index-based assessment.

The Traffic Light method was used for the current assessment. The Traffic Light method is capable of synthesizing a variety of information to provide a description of the stock condition. See Appendix 14.8, for a detailed description of the Traffic Light method and its application to the data available for the North Caroline blue crab stock. The nature of the Traffic Light method does not allow for a quantitative assessment of sustainable harvest for the N.C. blue crab stock since overfishing cannot be calculated.

The indicator value in each year for each data series was assigned a green, yellow, or red ‘signal’ based on the state of the indicator relative to stock condition. Typically the color green is indicative of a favorable stock condition, yellow of an uncertain or transitioning stock condition, and red of an unfavorable stock condition. Similar indicators were aggregated into three characteristics: adult abundance, recruit abundance, and production. The main assumptions of the Traffic Light method are that the indicators reflect the characteristic to which they are assigned and that the characteristics adequately reflect the feature of the stock they represent.

The Traffic Light analysis showed that adult and recruit abundance levels were higher overall before 2000 in the Pamlico and Southern regions (Figure 6.2.1). There was some suggestion of negative trends in recent years, especially in recruit abundance for the Pamlico and Southern regions. However, without a robust recruit monitoring program in the Albemarle region, it is not possible to determine the relative status of recruit abundance in the Albemarle region. The production characteristic (monitoring spawning stock, median size, and pre-recruits) was variable, but the Traffic Light gave evidence of increasingly positive trends in recent years.

The assessment working group developed an example management strategy for the adult abundance, recruit abundance, and production characteristics based on a three-year quartile approach. If the proportion of red in the Traffic Light for any of the characteristics is less than the first (<0.25) or second (<0.50) quartiles for three consecutive years, no management action may be necessary (i.e., status quo). If the proportion of red exhibited for a specific characteristic is greater than or equal to the second (≥0.50) quartile but less than the third quartile (<0.75), one or more of several moderate management actions could be taken, specific to the characteristic exceeding the threshold. If the proportion of red in the Traffic Light for any of the characteristics is greater than or equal to the third quartile (≥0.75), then more strict management measures could be implemented specific to the characteristic exceeding the threshold.

The blue crab stock is considered overfished when the proportion of red in the production characteristic is greater than or equal to the third quartile (≥0.75) for three consecutive years. **Based on this definition, the results of the current assessment suggest the North Carolina blue crab stock is not overfished.** Staff feels this status is warranted based on evaluation of available supporting data.

Though the overfished definition is based only on the production characteristic, the working group recommended evaluating the adult and recruit characteristics for warning signs that the stock may be approaching an undesirable state. If a series of negative trends is evident in the Traffic Light representation of the adult abundance or production characteristics for three consecutive years, management should consider implementing actions so as not to further reduce the viability of the stock. More information on the selected management strategy using the Traffic Light method analysis is provided in the issue paper 11.1 Adaptive Management Framework for the North Carolina Blue Crab Stock.

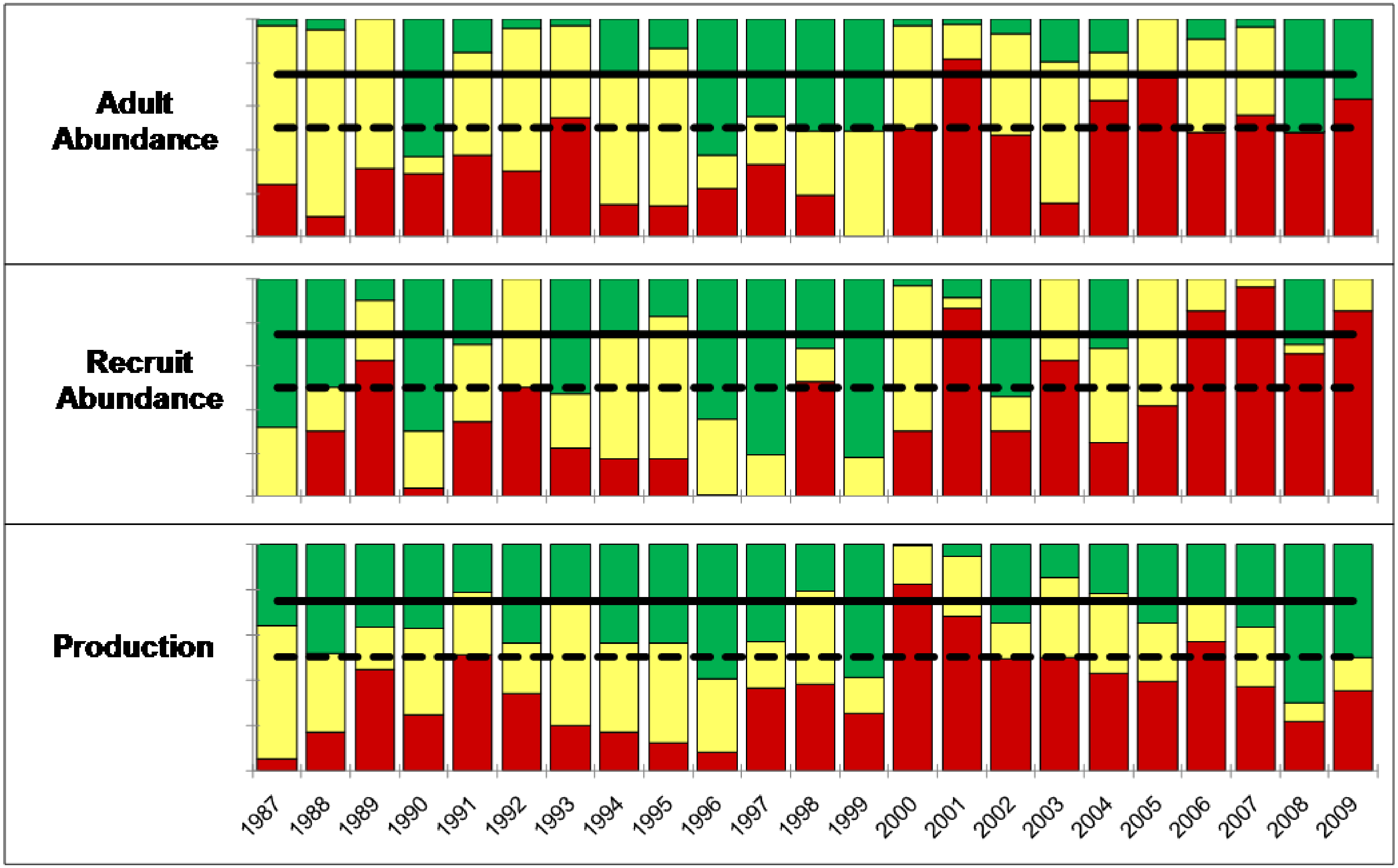

Figure 6.2.1 Traffic Light representations of adult abundance, recruit abundance, and production characteristic. The dashed (– –) and solid (—) lines represent the 50% and 75% quartiles for the proportion of red. ● = Favorable stock condition; ○ = Uncertain or transitioning stock condition; and ● = Unfavorable stock condition.

7.0 STATUS OF THE FISHERIES

7.1 COMMERCIAL FISHERY

The blue crab supports North Carolina's most valuable commercial fishery in almost every measure (Henry and McKenna 1998). During the period 1950–1993, North Carolina ranked 3rd among blue crab producing states, accounting for 13% of the total blue crab harvest (Figure 7.1.1). However, over the last sixteen years (1994–2009), North Carolina has ranked 2nd among blue crab producing states in the country accounting for 22% of the total harvest (Figure 7.1.2; Table 7.1.1).

Table 7.1.1 Reported blue crab landings (hard, soft, and peeler pounds combined) from the Atlantic and Gulf coasts, 1994–2009 (NMFS data).

	Year								
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002
North Carolina	53,513,176	46,443,612	67,080,288	56,090,204	62,076,277	57,546,023	40,639,200	32,180,314	37,736,591
Maryland	46,608,174	44,270,267	38,957,512	45,575,161	30,870,447	35,371,030	22,847,019	25,933,144	26,480,553
Louisiana	36,764,750	36,966,523	40,001,240	43,525,813	43,656,898	46,664,148	52,047,449	41,799,397	50,123,164
Virginia	35,424,970	32,569,003	34,216,731	39,064,541	34,599,284	31,437,077	28,846,173	25,057,395	27,300,529
Georgia	8,914,315	9,376,359	5,894,532	6,958,453	5,169,703	3,992,980	3,296,255	2,771,227	2,075,426
Florida West Coast	8,463,934	8,780,833	12,474,914	9,321,176	12,862,781	11,169,467	6,572,644	4,646,660	5,567,018
South Carolina	7,183,875	7,130,122	5,954,147	6,283,375	7,595,874	6,608,475	5,817,508	5,566,261	4,435,325
Delaware	6,489,894	8,024,600	3,906,727	5,451,593	4,359,822	4,993,165	4,092,195	4,084,568	3,061,924
New Jersey	5,604,056	7,697,013	3,822,884	4,562,591	5,829,331	5,579,188	5,092,764	4,724,352	6,229,082
Florida East Coast	5,394,401	3,456,489	5,584,072	5,696,571	4,532,593	4,415,043	4,748,417	2,672,151	2,233,437
Texas	5,154,397	5,786,967	6,310,672	7,083,790	6,988,544	6,472,115	4,653,306	5,163,132	7,037,012
Alabama	2,687,961	2,520,268	3,218,948	3,486,851	3,478,259	3,767,527	4,783,861	2,457,532	2,574,892
New York	886,840	1,743,111	2,298,351	1,178,622	1,184,713	1,334,075	1,481,728	1,245,544	3,713
Mississippi	171,667	320,844	408,525	684,598	593,182	922,544	840,243	433,656	716,628
Florida, Inland Waters	153,137	82,475	78,028	235,883	89,837	212,464	275,335	268,586	84,448
Connecticut	0	317	0	0	2,144	3,237	1,745	0	951
Rhode Island	0	2	0	0	0	0	0	0	9
Total	223,408,987	215,168,805	230,205,505	234,673,622	223,889,689	220,488,558	186,035,842	159,004,069	175,574,226

Table 7.1.1 (cont) Reported blue crab landings (hard, soft, and peeler pounds combined) from the Atlantic and Gulf coasts, 1994–2009 (NMFS data).

	Year						
Year	2003	2004	2005	2006	2007	2008	2009
North Carolina	42,769,856	34,129,013	25,430,176	25,343,216	21,425,001	32,916,716	29,386,346
Louisiana	27,816,215	33,826,132	34,914,418	29,445,503	30,783,648	34,871,784	40,283,915
Maryland	48,089,280	44,396,715	38,099,763	53,394,262	45,106,808	41,712,977	51,220,185
Virginia	21,464,379	27,641,876	26,063,743	22,718,990	19,045,018	18,401,365	32,580,777
Florida, West Coast	1,899,747	3,119,807	4,427,885	4,098,939	4,466,932	4,256,367	3,653,501
South Carolina	7,225,373	8,083,164	7,370,003	8,610,150	6,109,825	2,657,064	3,327,950
Texas	4,410,545	4,373,506	4,439,741	4,214,689	4,136,845	4,484,131	3,947,053
Georgia	1,791,677	2,275,706	2,923,503	2,856,148	3,799,487	3,507,865	3,413,798
New Jersey	4,011,694	4,350,041	6,332,879	5,981,414	4,821,452	5,816,473	256,972
Delaware	1,987,747	3,535,658	4,045,438	3,129,831	4,062,683	3,341,520	1,605,812
Florida, East Coast	4,811,275	3,960,838	3,119,000	1,965,694	3,453,692	2,635,100	2,844,263
Alabama	2,958,121	3,328,571	1,023,790	2,384,234	2,556,594	1,798,718	1,458,468
New York	963,407	885,335	748,725	870,670	714,627	535,998	868,910
Mississippi	876,521	811,498	428,620	1,126,806	737,442	450,037	545,328
Florida, Inland Waters	0	0	0	0	0	0	0
Connecticut	222	0	0	0	1,111	0	3,912
Rhode Island	0	0	0	0	0	0	0
Total	170,889,509	174,561,212	159,242,143	166,132,808	151,174,808	157,371,871	173,513,055

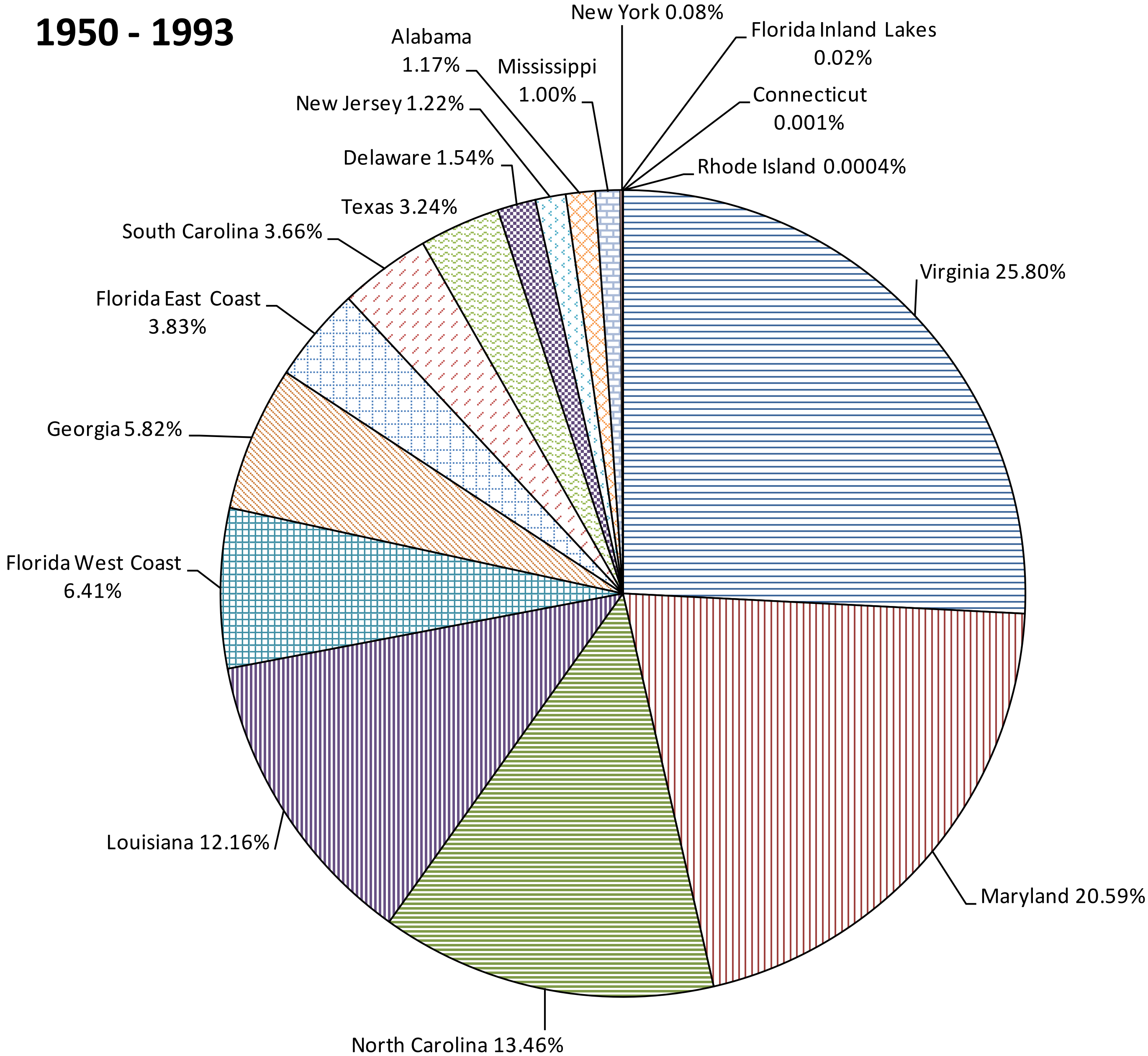

Figure 7.1.1 Contribution of blue crab producing states to total (hard, soft, and peeler) blue crab production, 1950–1993 (NMFS data).

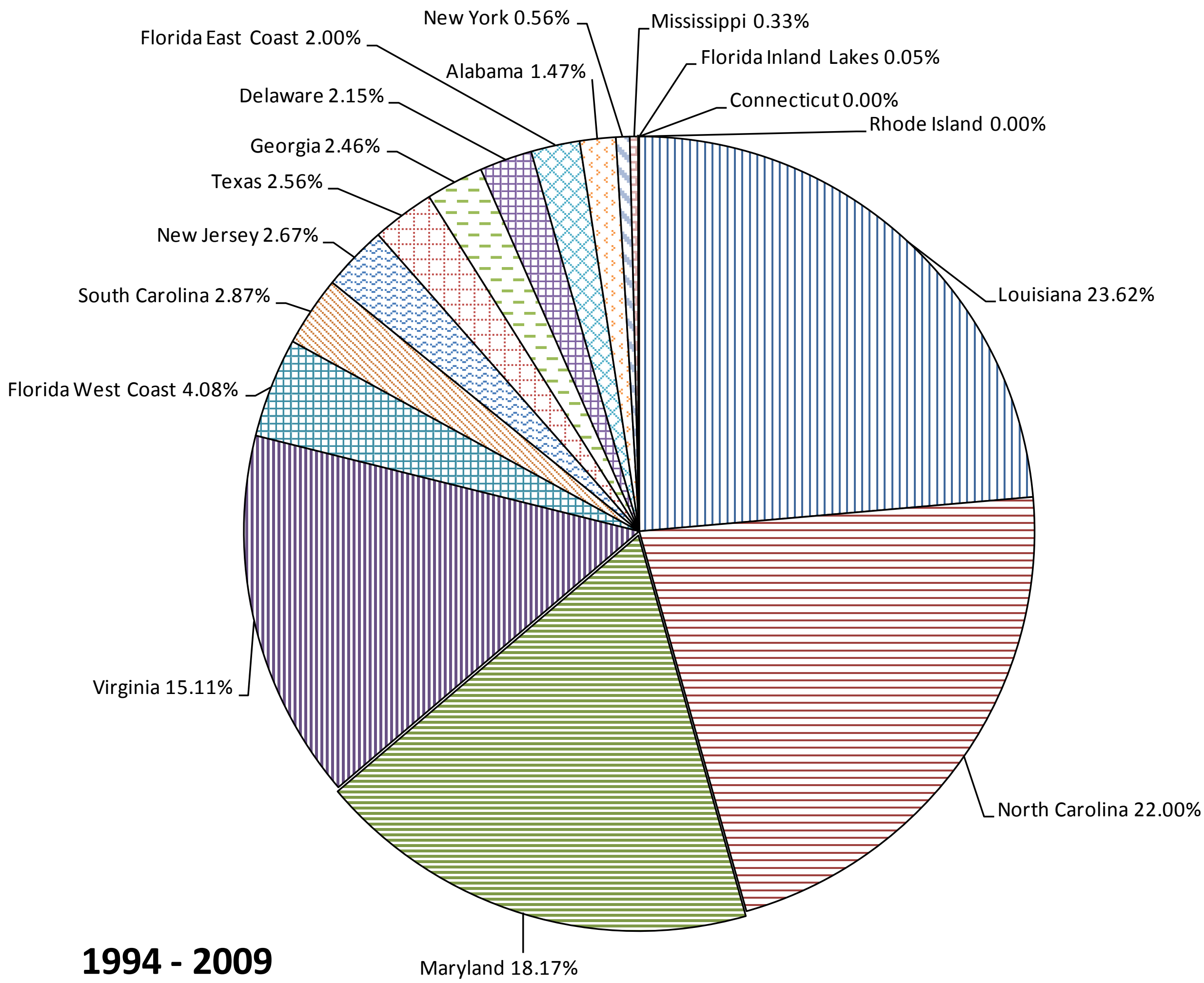

Figure 7.1.2 Contribution of blue crab producing states to total (hard, soft, and peeler) blue crab production, 1994–2009 (NMFS data).

Commercial blue crab landings in North Carolina have averaged 27 million pounds annually over the last 60 years, 1950–2009 (Figure 7.1.3). The major increases in landings during 1978 and 1994 were, in part, a function of improved data collection. The National Marine Fisheries Service (NMFS) and its predecessors collected commercial landings statistics in North Carolina from the 1880s until 1978. In 1978, the North Carolina Division of Marine Fisheries (NCDMF) augmented (6 port agents vs. 1 NMFS agent) landings collection under the NMFS/ North Carolina Cooperative Statistics Program. Both programs were based entirely on voluntary reporting. In 1994, NCDMF implemented a mandatory Trip Ticket Program (TTP), a landings information record keeping system for each commercial harvest trip. During 1994, 131 seafood dealers, who had not previously reported hard blue crab landings under the voluntary collection programs, reported approximately 14 million pounds (26% of the total landings). Care should be used when comparing these landings because of the likely differences in the precision of these methods. Additionally, since the start of the TTP in 1994, caution must be used in the interpretation of landings assigned to a specific gear and waterbody. Tickets with only one gear listed make up the majority (97%) of tickets in the TTP database; however, up to three gears may be reported on an individual trip ticket. On tickets with more than one gear, assignment of landings to a specific gear is a judgment call. Hence, for the majority of gear and trip discussions in this section, only trip tickets with one gear listed are used. For blue crabs, approximately 99.2% of the total landings were reported on trip tickets with a single gear type reported. For overall landings and landings by waterbody, all reported blue crab landings are used regardless of the number of gears reported. While pots may be set in a number of waterbodies (i.e., Pamlico River and Pamlico Sound), the fisherman is supposed to report the waterbody where the majority of the catch occurred. This method might lead to over/under reporting of landings from certain waters, however there is no way to correct for this and data presented in this report shows landings as recorded. Furthermore, commercial landings data should be viewed as only a general indicator of fishing trends since they are influenced by market demand, price, fishing effort, weather, availability of alternate species, regulations, and data collection techniques as well as stock abundance. The full time series of data was split into three sections based on how the data were gathered: 1950–1977, 1978–1993, and 1994–2009. For these time periods, blue crab landings averaged 14, 34, and 42 million pounds respectively; however, it is not practical to compare among these time periods because of variation in reporting methods. All three time periods had at least one period of three or more years with declining catches: 1953–1956, 1964–1967, 1969–1973, 1982–1986, 1998–2001, and 2003–2007 (Figure 7.1.3). The yearly percent change in total crab landings shows relatively no trend and is highly variable (Figure 7.1.4).

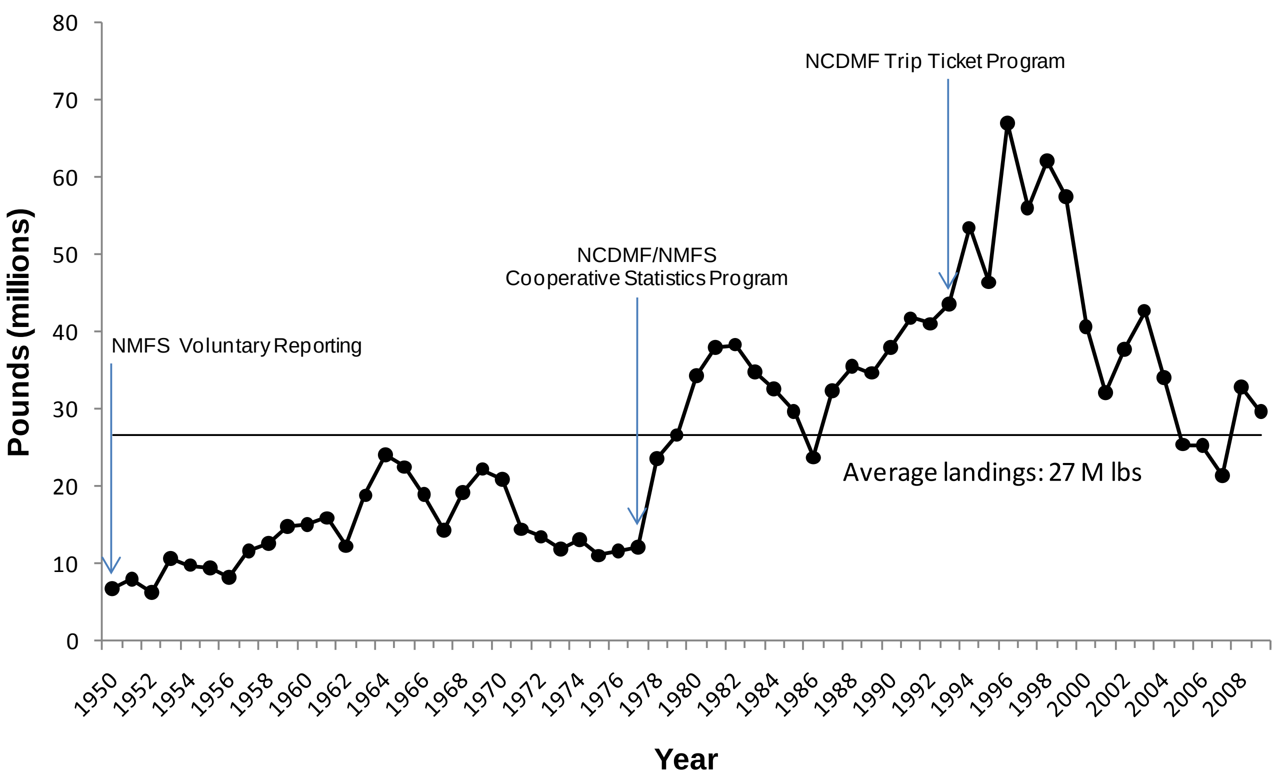

Figure 7.1.3 Total blue crab landings (hard, soft, and peeler pounds combined) for North Carolina, 1950–2009 (NMFS data 1950–1993; NCDMF Trip Ticket Data 1994–2009).

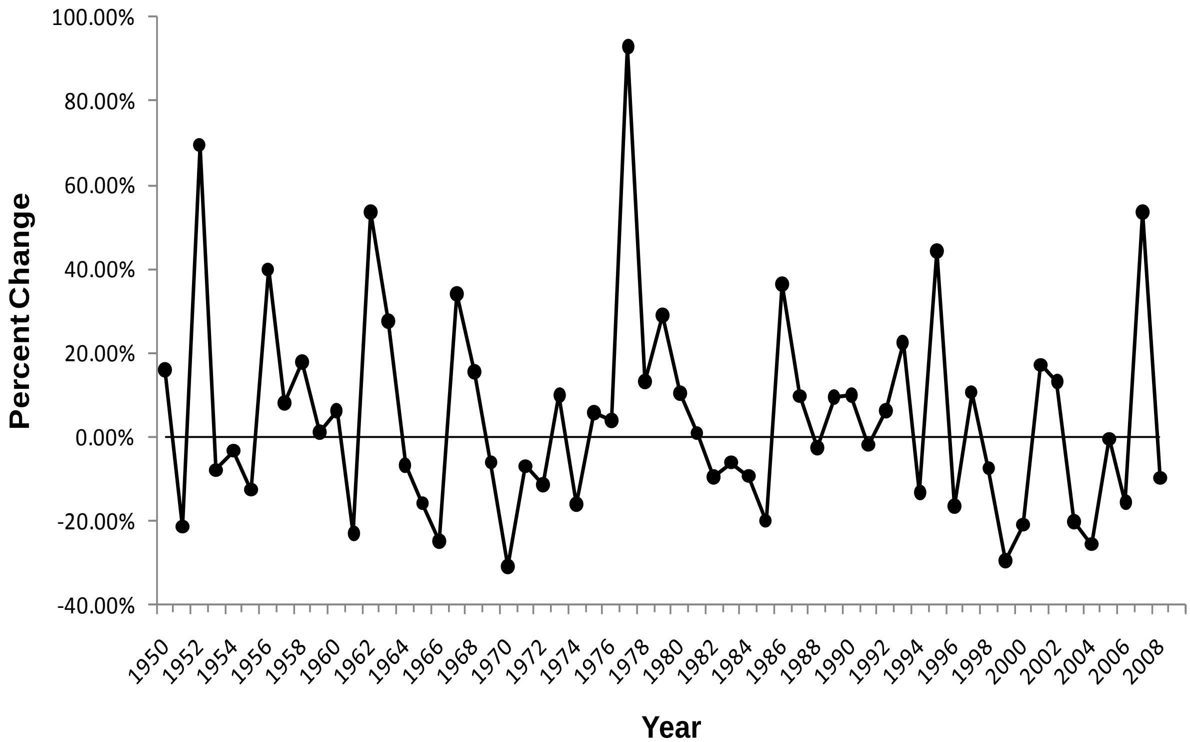

Figure 7.1.4 Percent change (year$_{+1}$ - year) for blue crab landings (hard, soft, and peeler pounds combined) in North Carolina, 1950–2009 (NMFS data 1950–1993; NCDMF Trip Ticket Data 1994–2009).

Blue crabs are targeted and landed in three main market categories; hard, peeler, and soft crabs. Average North Carolina hard crab landings since 1994 are 40 million pounds with an average dockside value of $28 million annually. Peeler crab landings averaged 0.8 million pounds and a dockside value of $1.6 million, while soft crabs had annual average landings of 0.6 million pounds with a dockside value of $2.3 million during the same time frame (Table 7.1.2).

Table 7.1.2 Blue crab landings (pounds) and value by market category for North Carolina, 1994–2009.

		Year								
		1994	1995	1996	1997	1998	1999	2000	2001	2002
Pounds (lb)	Hard crabs	52,260,168	45,033,543	65,682,500	54,353,545	60,402,332	56,094,091	38,889,273	29,939,494	36,461,890
	Peelers	642,238	724,442	878,382	1,022,668	976,097	942,150	998,971	1,319,202	718,897
	Soft shell	610,717	685,555	519,318	713,896	697,741	510,435	750,140	921,693	555,532
	Total	53,513,124	46,443,541	67,080,200	56,090,109	62,076,170	57,546,676	40,638,384	32,180,390	37,736,319
Value ($)	Hard crabs	$26,896,282	$33,053,805	$39,873,553	$33,165,872	$40,466,879	$33,526,081	$32,154,369	$25,079,256	$29,349,251
	Peelers	$771,697	$1,052,607	$1,280,991	$1,768,855	$1,932,821	$2,111,690	$1,946,369	$3,081,350	$1,465,913
	Soft shell	$1,931,975	$2,132,875	$1,887,890	$2,751,311	$2,559,941	$2,174,429	$3,336,990	$4,070,990	$2,333,268
	Total	$29,599,954	$36,239,286	$43,042,433	$37,686,039	$44,959,640	$37,812,199	$37,437,727	$32,231,596	$33,148,432
Price/lb	Hard crabs	$0.51	$0.73	$0.61	$0.61	$0.67	$0.60	$0.83	$0.84	$0.80
	Peelers	$1.20	$1.45	$1.46	$1.73	$1.98	$2.24	$1.95	$2.34	$2.04
	Soft shell	$3.16	$3.11	$3.64	$3.85	$3.67	$4.26	$4.45	$4.42	$4.20
	Total	$0.55	$0.78	$0.64	$0.67	$0.72	$0.66	$0.92	$1.00	$0.88

		Year							
		2003	2004	2005	2006	2007	2008	2009	Average
Pounds (lb)	Hard crabs	41,644,612	32,592,768	23,571,451	24,408,932	20,562,159	32,338,889	29,140,473	40,211,008
	Peelers	693,294	982,874	1,166,270	549,916	498,904	351,986	367,881	802,136
	Soft shell	431,891	554,966	692,398	384,311	363,896	225,816	198,878	551,074
	Total	42,769,797	34,130,608	25,430,119	25,343,159	21,424,960	32,916,691	29,707,232	41,564,217
Value ($)	Hard crabs	$32,904,677	$20,248,333	$15,374,714	$14,146,591	$18,109,497	$25,429,231	$25,039,379	$27,801,111
	Peelers	$1,815,304	$1,678,928	$1,902,624	$1,172,353	$1,186,031	$882,319	$1,106,883	$1,572,296
	Soft shell	$2,388,111	$2,538,582	$2,996,574	$1,768,450	$2,136,426	$1,243,836	$1,282,733	$2,345,899
	Total	$37,108,093	$24,465,843	$20,273,912	$17,087,395	$21,431,955	$27,555,386	$27,428,995	$31,719,305
Price/lb	Hard crabs	$0.79	$0.62	$0.65	$0.58	$0.88	$0.79	$0.86	$0.71
	Peelers	$2.62	$1.71	$1.63	$2.13	$2.38	$2.51	$3.01	$2.02
	Soft shell	$5.53	$4.57	$4.33	$4.60	$5.87	$5.51	$6.45	$4.46
	Total	$0.87	$0.72	$0.80	$0.67	$1.00	$0.84	$0.92	$0.79

Blue crabs are landed in the majority of North Carolina's coastal waterbodies. The Atlantic Ocean is counted as 2 waterbodies (less than 3 miles; more than 3 miles) in this report (Table 7.1.3 and Figure 7.1.5). To prevent the release of confidential data within years and waterbodies, only the top 20 waterbodies based on pounds landed are presented in this report. Albemarle and Pamlico sounds are the two largest producers of blue crabs, accounting for about 55% of the total landings and dockside value (Figure 7.1.6; Tables 7.1.3 and 7.1.4).

Table 7.1.3 Total blue crab landings (hard, soft, and peeler pounds combined) for top 20 reported waterbodies from North Carolina,1994–2009.

	Year									
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Albemarle Sound	10,968,245	14,611,043	20,391,581	7,974,980	12,340,123	12,784,465	13,170,738	10,512,216	16,037,314	13,109,530
Pamlico Sound	17,211,304	9,161,103	13,282,622	19,082,541	21,919,036	18,840,349	9,852,129	7,939,038	5,471,338	11,091,023
Pamlico River	7,571,535	5,565,009	8,227,883	7,875,190	6,667,367	7,627,083	3,732,530	2,097,303	2,977,627	3,442,817
Neuse River	3,736,768	2,688,191	5,305,414	4,561,921	3,942,274	4,291,147	2,053,452	1,574,661	1,366,243	1,765,407
Currituck Sound	2,258,407	3,404,223	2,404,653	1,941,770	2,264,396	1,718,447	1,766,657	1,347,864	2,587,787	2,305,662
Croatan Sound	2,084,106	2,059,613	3,047,266	1,900,957	2,896,949	1,836,237	738,395	956,875	863,806	811,265
Roanoke Sound	1,053,290	1,121,068	1,303,820	1,363,125	1,324,753	1,488,567	1,179,919	2,179,478	1,762,142	2,313,603
Alligator River	1,341,428	1,474,517	2,212,724	662,739	1,369,231	1,315,462	1,584,339	1,018,953	2,217,623	2,522,200
Bay River	2,165,253	1,833,870	3,898,980	3,923,504	3,094,312	1,576,629	1,156,775	515,698	428,623	497,556
Pungo River	N/C	540,376	2,249,253	2,514,498	1,692,466	2,147,732	2,159,741	862,754	1,472,347	1,434,822
Core Sound	1,964,839	1,112,562	2,360,565	2,156,694	1,884,183	1,584,263	909,150	858,557	441,376	1,192,480
Cape Fear River	777,941	682,454	554,583	559,715	627,981	558,121	594,555	571,188	651,868	436,842
Newport River	396,378	334,205	355,400	402,396	457,868	388,803	253,133	229,881	214,952	260,775
New River	264,827	341,269	189,330	259,250	279,685	309,807	432,543	424,934	289,005	309,591
Inland Waterway*	376,945	396,934	345,171	163,513	203,119	218,922	291,202	228,966	194,261	282,366
Bogue Sound	264,936	184,481	279,370	199,994	214,288	153,368	215,361	162,215	90,283	243,691
Masonboro Sound	138,625	166,591	100,401	82,093	162,433	109,003	122,701	134,831	135,865	147,940
Topsail Sound	155,988	149,707	90,197	82,637	142,037	112,937	89,748	108,950	77,268	112,548
Stump Sound	106,524	171,856	129,233	154,984	169,961	162,149	139,446	106,546	95,202	114,749
White Oak River	135,293	111,011	99,068	80,150	153,312	173,757	128,929	172,884	166,830	157,916
Other**	540,491	333,458	252,687	147,457	270,397	149,430	66,940	176,595	194,560	217,014
Total	53,513,124	46,443,541	67,080,200	56,090,109	62,076,171	57,546,676	40,638,384	32,180,390	37,736,319	42,769,797

N/C=No landings data collected.
*Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
**Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown

Table 7.1.3 (cont) Total blue crab landings (hard, soft, and peeler pounds combined) for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year								
Waterbody	2004	2005	2006	2007	2008	2009	Total	Average	Percent of Total
Albemarle Sound	10,066,172	8,336,983	11,891,160	10,924,829	17,863,716	15,092,424	206,075,519	12,879,720	30.99
Pamlico Sound	8,750,943	4,373,885	2,515,031	1,674,242	4,159,293	3,317,535	158,641,412	9,915,088	23.85
Pamlico River	3,877,497	3,533,137	2,689,484	1,844,696	1,498,722	1,083,294	70,311,173	4,394,448	10.57
Neuse River	2,272,753	2,119,825	1,572,796	671,431	694,625	407,133	39,024,041	2,439,003	5.87
Currituck Sound	2,068,061	846,257	1,113,362	1,621,588	2,447,954	3,381,293	33,478,378	2,092,399	5.03
Croatan Sound	1,094,551	773,783	768,927	651,130	1,104,994	1,386,344	22,975,200	1,435,950	3.45
Roanoke Sound	949,434	886,860	721,887	780,571	1,323,804	833,479	20,585,799	1,286,612	3.10
Alligator River	373,904	371,868	399,670	768,983	1,228,833	1,645,630	20,508,106	1,281,757	3.08
Bay River	425,723	349,041	121,799	128,916	131,290	181,740	20,429,710	1,276,857	3.07
Pungo River	1,349,696	1,079,125	1,223,158	550,642	598,383	495,420	20,370,413	1,358,028	3.06
Core Sound	869,424	658,402	468,480	252,941	216,571	190,689	17,121,176	1,070,073	2.57
Cape Fear River	519,132	506,452	593,083	550,637	715,521	642,271	9,542,345	596,397	1.43
Newport River	249,023	274,303	103,280	105,236	74,719	101,887	4,202,239	262,640	0.63
New River	257,525	222,956	158,233	169,704	105,682	129,190	4,143,533	258,971	0.62
Inland Waterway*	190,705	179,950	179,856	90,804	121,459	195,641	3,659,814	228,738	0.55
Bogue Sound	161,271	157,691	176,641	116,109	139,492	101,834	2,861,027	178,814	0.43
Masonboro Sound	115,827	191,128	173,269	107,966	138,586	137,752	2,165,011	135,313	0.33
Topsail Sound	109,224	151,454	164,308	160,518	166,117	202,053	2,075,689	129,731	0.31
Stump Sound	101,171	117,877	95,986	63,233	43,659	72,279	1,844,855	115,303	0.28
White Oak River	110,019	110,069	40,917	52,007	64,612	24,859	1,781,632	111,352	0.27
Other**	218,555	189,074	171,831	138,775	78,659	84,484	3,230,407	201,900	0.49
Total	34,130,608	25,430,119	25,343,158	21,424,960	32,916,691	29,707,232	665,027,478	41,564,217	100.00

*Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
**Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.4 Annual dockside value of blue crab landings (hard, soft, and peeler value combined) for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year									
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Albemarle Sound	$6,295,389	$12,229,142	$13,611,900	$6,017,314	$10,263,565	$9,273,408	$13,089,015	$11,219,062	$15,016,933	$12,301,826
Pamlico Sound	$8,730,654	$6,465,418	$7,899,748	$11,464,371	$13,957,927	$11,081,650	$8,222,850	$7,118,574	$3,694,840	$8,091,469
Pamlico River	$4,310,556	$4,312,778	$5,464,808	$4,964,679	$4,916,722	$4,657,940	$3,105,725	$2,007,809	$2,320,362	$2,721,024
Neuse River	$2,201,989	$2,193,082	$3,522,601	$3,120,390	$2,965,328	$3,007,902	$1,805,261	$1,576,988	$1,209,389	$1,629,094
Currituck Sound	$1,160,909	$2,355,200	$1,612,796	$1,326,245	$1,770,414	$1,095,818	$1,654,469	$1,274,791	$2,870,971	$2,524,334
Croatan Sound	$1,411,307	$1,878,217	$1,949,913	$1,854,519	$2,113,573	$1,375,108	$848,816	$1,225,406	$819,169	$670,927
Roanoke Sound	$1,050,806	$1,108,344	$1,132,882	$1,824,286	$1,699,925	$1,561,151	$1,765,152	$2,792,018	$2,030,047	$2,572,269
Alligator River	$694,491	$1,224,747	$1,331,579	$405,200	$955,361	$867,254	$1,380,144	$906,963	$1,627,883	$2,114,969
Bay River	$1,115,646	$1,268,221	$2,265,609	$2,438,628	$2,139,958	$1,040,655	$963,124	$471,061	$335,606	$398,979
Pungo River	N/C	$409,525	$1,582,688	$1,683,143	$1,309,469	$1,357,309	$1,888,241	$891,025	$1,153,234	$1,275,374
Core Sound	$924,676	$711,674	$1,210,382	$1,195,150	$1,110,180	$938,695	$687,307	$681,110	$287,766	$855,670
Cape Fear River	$452,629	$520,855	$330,147	$390,179	$481,604	$362,375	$581,163	$564,196	$694,186	$439,670
Newport River	$206,928	$210,793	$201,726	$231,503	$241,936	$242,255	$188,382	$198,785	$125,411	$178,265
New River	$142,184	$285,909	$127,298	$192,711	$195,691	$218,453	$410,539	$386,745	$246,206	$327,100
Inland Waterway*	$207,394	$275,302	$189,273	$102,835	$128,570	$121,275	$207,748	$173,671	$128,903	$156,274
Bogue Sound	$144,454	$145,398	$172,153	$137,761	$141,166	$101,510	$171,993	$130,710	$64,629	$185,210
Masonboro Sound	$64,333	$95,568	$50,621	$43,952	$84,916	$64,018	$90,470	$104,058	$106,676	$137,102
Topsail Sound	$69,463	$89,009	$44,014	$47,361	$91,561	$69,813	$63,386	$71,729	$46,854	$67,163
Stump Sound	$51,923	$102,471	$74,397	$90,938	$113,070	$109,167	$111,791	$96,689	$70,857	$88,984
White Oak River	$69,942	$81,774	$69,074	$59,813	$115,252	$144,834	$133,237	$172,118	$143,987	$160,409
Other**	$294,281	$275,860	$198,824	$95,062	$163,453	$121,611	$68,915	$168,089	$154,523	$211,979
Total $	$29,599,954	$36,239,286	$43,042,433	$37,686,038	$44,959,640	$37,812,199	$37,437,727	$32,231,597	$33,148,433	$37,108,092

N/C=No landings data collected.
*Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
**Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.4 (cont) Annual dockside value of blue crab landings (hard, soft, and peeler value combined) for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year								Percent
Waterbody	2004	2005	2006	2007	2008	2009	Total	Average	of total
Albemarle Sound	$7,903,306	$6,719,950	$7,999,651	$11,099,409	$15,302,358	$14,502,080	$172,844,306	$10,802,769	34.06
Pamlico Sound	$5,338,025	$3,207,045	$1,651,866	$1,612,519	$2,996,324	$2,540,881	$104,074,162	$6,504,635	20.51
Pamlico River	$2,297,583	$2,426,053	$1,570,546	$1,467,330	$1,147,266	$900,592	$48,591,775	$3,036,986	9.57
Neuse River	$1,613,258	$1,573,966	$994,275	$725,646	$727,752	$474,763	$29,341,684	$1,833,855	5.78
Currituck Sound	$1,575,829	$737,869	$781,006	$1,755,828	$2,255,704	$3,635,671	$28,387,854	$1,774,241	5.59
Croatan Sound	$1,169,520	$1,078,754	$647,384	$803,709	$1,029,368	$1,255,932	$20,131,622	$1,258,226	3.97
Roanoke Sound	$1,295,327	$1,487,151	$917,737	$1,235,737	$1,208,622	$858,982	$24,540,436	$1,533,777	4.84
Alligator River	$194,748	$209,265	$261,455	$518,615	$880,778	$1,083,524	$14,656,975	$916,061	2.89
Bay River	$261,252	$260,132	$81,601	$132,278	$112,771	$189,406	$13,474,928	$842,183	2.66
Pungo River	$908,609	$782,912	$755,861	$551,425	$470,133	$407,486	$15,426,434	$1,028,429	3.04
Core Sound	$549,901	$366,949	$284,247	$181,604	$162,382	$146,288	$10,293,982	$643,374	2.03
Cape Fear River	$417,157	$427,946	$412,624	$545,908	$531,754	$589,723	$7,742,113	$483,882	1.53
Newport River	$132,800	$134,465	$74,898	$89,747	$76,533	$114,822	$2,649,249	$165,578	0.52
New River	$203,226	$194,159	$116,983	$162,038	$115,775	$154,369	$3,479,389	$217,462	0.69
Inland Waterway*	$64,750	$75,054	$72,873	$70,183	$63,794	$93,369	$2,131,266	$133,204	0.42
Bogue Sound	$97,243	$99,900	$98,765	$86,608	$109,630	$83,579	$1,970,710	$123,169	0.39
Masonboro Sound	$62,989	$106,351	$80,345	$72,106	$88,612	$91,633	$1,343,750	$83,984	0.26
Topsail Sound	$52,491	$67,173	$73,630	$94,151	$94,836	$117,105	$1,159,740	$72,484	0.23
Stump Sound	$65,410	$80,742	$59,225	$53,536	$36,729	$68,281	$1,274,210	$79,638	0.25
White Oak River	$98,179	$112,131	$49,551	$78,055	$82,109	$29,333	$1,599,798	$99,987	0.32
Other**	$164,238	$125,943	$102,871	$95,523	$62,156	$91,177	$2,394,505	$149,657	0.47
Total $	$24,465,843	$20,273,913	$17,087,395	$21,431,955	$27,555,386	$27,428,996	$507,508,888	$31,719,306	100.00

*Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
**Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Figure 7.1.5 Map of coastal North Carolina showing location of various waterbodies.

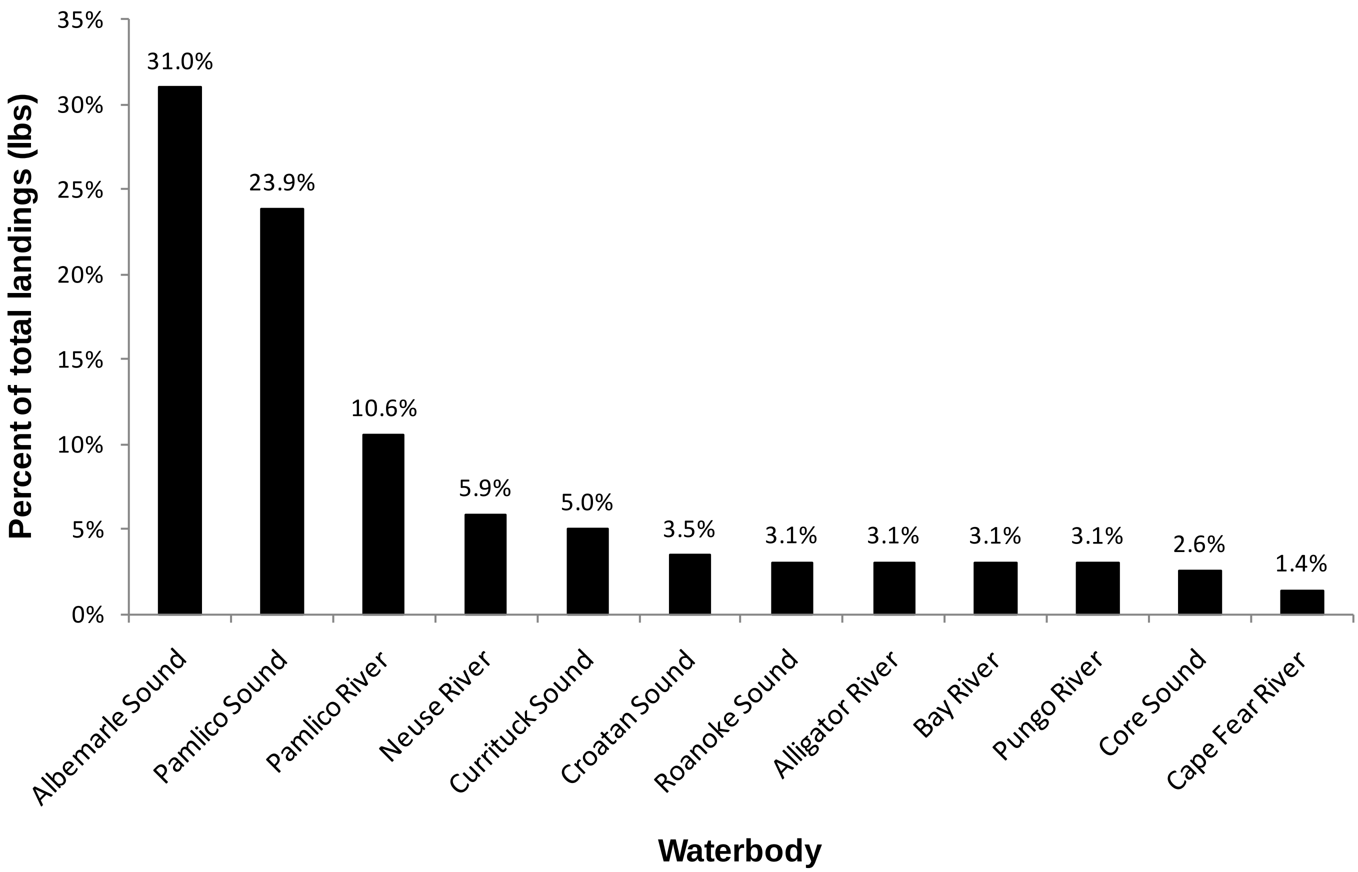

Figure 7.1.6 Top blue crab (hard, soft, and peeler pounds combined) producing waters for North Carolina, 1994–2009.

Blue crabs are harvested in every month of the year; however 88% of all crabs are harvested from May through October (Table 7.1.5). The crab pot, crab trawl, and peeler pot are the major gears used in the directed crab fisheries. Crab pots (both hard and peeler) are described as a wire-mesh box with funnel shaped openings that measures approximately 2 by 2 feet, however, hard crab pots require escape (cull) rings while peeler pots do not. Crab trawls are a type of bottom to mid-water trawl equipped with otter doors and small mesh netting. Exact mesh size depends on the type of crab being targeted, consequently, larger mesh sizes are required when targeting hard crabs compared to small mesh nets used for soft or peeler crabs. Blue crabs are also caught as bycatch with other types of gear; however, to prevent the release of confidential landings within years and gears, only the top 5 gears based on pounds landed are presented in this report (Table 7.1.6). Further breakdown of gears, regions, and seasons will be discussed with respect to the three market categories and their fisheries.

Table 7.1.5 Monthly blue crab total landings (hard, soft, and peeler pounds combined) for North Carolina, 1994–2009.

	Year									
Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
January	29,831	121,555	25,112	282,150	179,085	206,933	237,922	41,164	39,547	79,165
February	399,665	51,214	68,088	595,349	269,650	445,121	274,689	273,416	119,753	46,851
March	1,368,612	788,245	164,622	1,754,787	841,595	568,344	1,412,985	498,907	411,075	637,072
April	3,071,133	1,685,812	1,294,634	1,853,843	1,896,707	1,894,687	1,374,984	1,059,515	1,434,501	1,062,028
May	6,134,268	5,455,489	5,214,486	5,234,491	4,873,082	4,606,816	4,384,123	4,655,482	3,011,168	3,092,444
June	10,368,155	8,160,859	9,932,351	7,152,478	9,565,609	9,162,932	6,123,320	5,490,152	5,004,126	4,740,255
July	12,117,277	9,111,263	15,294,007	12,930,716	13,619,888	12,488,344	7,435,558	6,210,753	6,391,411	7,296,645
August	8,927,376	8,280,208	15,554,437	12,114,452	9,637,072	10,100,250	8,212,501	5,919,216	7,387,276	9,009,769
September	5,008,858	5,843,942	9,797,756	7,356,705	9,484,570	6,373,560	6,033,854	3,759,070	6,351,775	5,610,707
October	3,194,893	5,005,848	6,455,972	4,586,662	7,110,705	7,430,515	3,630,126	2,522,975	4,687,670	7,248,796
November	2,213,762	1,701,126	2,516,734	1,636,441	3,232,590	3,015,162	1,211,773	1,208,081	2,541,872	2,929,185
December	679,293	237,981	762,002	592,035	1,365,619	1,254,012	306,551	541,658	356,144	1,016,880
Total	53,513,124	46,443,541	67,080,200	56,090,109	62,076,170	57,546,676	40,638,384	32,180,390	37,736,319	42,769,797

	Year								Percent
Month	2004	2005	2006	2007	2008	2009	Total	Average	of total
January	180,099	82,143	155,353	126,699	60,839	159,491	2,007,086	125,443	0.30
February	61,536	22,626	125,072	31,623	165,932	85,017	3,035,601	189,725	0.46
March	1,256,549	187,571	438,590	569,669	374,956	1,084,528	12,358,108	772,382	1.86
April	1,754,161	458,064	785,008	503,271	513,156	1,451,109	22,092,612	1,380,788	3.32
May	6,145,509	2,620,566	3,520,737	2,258,566	2,247,329	3,369,317	66,823,872	4,176,492	10.05
June	6,958,601	6,049,307	4,637,779	4,133,364	4,223,806	4,438,211	106,141,304	6,633,831	15.96
July	6,152,847	5,581,353	3,869,752	4,187,320	5,792,894	3,194,740	131,674,767	8,229,673	19.80
August	4,255,200	3,725,090	4,242,200	3,157,342	5,851,562	4,652,329	121,026,280	7,564,142	18.20
September	3,649,774	2,763,929	3,691,292	2,818,986	4,786,930	4,933,754	88,265,463	5,516,591	13.27
October	2,706,067	2,539,743	2,504,722	2,591,230	4,473,607	4,101,384	70,790,913	4,424,432	10.64
November	759,971	1,075,467	1,007,006	826,447	2,721,483	1,672,162	30,269,262	1,891,829	4.55
December	250,295	324,261	365,647	220,445	1,704,199	565,188	10,542,210	658,888	1.59
Total	34,130,608	25,430,119	25,343,159	21,424,960	32,916,691	29,707,232	665,027,478	41,564,217	100.00

Table 7.1.6 Annual blue crab total landings (hard, soft, and peeler pounds combined) for top 5 reported gears from single gear trip tickets, 1994–2009

	Year									
Gear	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Crab pot*	50,602,626	44,645,600	63,217,222	51,859,125	57,380,295	54,440,834	38,465,604	29,456,212	35,432,351	40,352,775
Crab trawl	1,886,561	1,065,171	3,083,436	3,288,440	3,083,832	1,812,344	941,437	997,091	1,119,050	1,259,407
Peeler pot	N/C	N/C	59,422	145,504	581,386	515,570	558,000	937,744	535,745	423,090
Shrimp trawl	462,464	224,829	303,839	312,745	554,043	280,599	208,153	186,006	160,651	304,592
Gill net set (sink)	6,601	4,741	19,839	19,123	29,504	32,589	18,557	22,786	30,022	31,841
Other**	176,753	63,932	54,902	46,057	14,420	16,028	67,758	116,404	125,370	27,187
Total	53,135,004	46,004,273	66,738,661	55,670,994	61,643,480	57,097,964	40,259,509	31,716,243	37,403,189	42,398,892

	Year								Percent
Gear	2004	2005	2006	2007	2008	2009	Total	Average	of total
Crab pot*	31,971,412	23,687,068	24,457,268	20,716,015	30,848,182	28,255,174	625,787,763	39,111,735	94.85
Crab trawl	896,554	388,996	138,708	28,604	1,557,934	913,928	22,461,492	1,403,843	3.40
Peeler pot	794,136	1,077,651	469,784	412,189	290,185	261,089	7,061,495	504,392	1.07
Shrimp trawl	163,625	61,457	37,027	31,772	4,223	17,298	3,313,323	207,083	0.50
Gill Net set (sink)	15,196	9,606	17,309	21,059	44,902	39,319	362,993	22,687	0.06
Other**	24,636	11,344	9,401	7,681	3,122	9,751	774,746	48,422	0.12
Total	33,865,559	25,236,122	25,129,498	21,217,320	32,748,547	29,496,559	659,761,811	41,235,113	100.00

N/C=No landings data collected.
*Hard and peeler pot landings were combined in 1994 and 1995.
**Other category includes: Channel Net, Trotline, Crab Dredge, Pound Net, Rakes, Hand, Gill Net Set (float), Skimmer Trawl, Fyke Net, Oyster Dredge, Tongs, Hand, Rakes, Bull, Clam Trawl Kicking, Haul Seine, Clam Dredge (hydraulic), By Hand, Flounder Trawl, Conch Pot, Eel Pot, Gill Net (runaround), Fish Pot, Cast Net, Dip Net, Flynet, Gill Net (drift), Beach Seine, Shrimp Pound, Swipe Net, Clam Dredge, Butterfly Net, Scallop Trawl, Rod-n-Reel, and Gigs.

7.1.1 HARD CRAB FISHERY

Hard crabs account for 97% of the total blue crab harvest. Since 1994, the annual reported landings of hard crabs have averaged 40.2 million pounds (Table 7.1.2). While hard crab landings were the highest on record during the beginning of this sixteen year period, the overall landings have declined (Figure 7.1.7). Annual landings ranged from 65.7 million pounds in 1996 to 20.6 million pounds in 2007 (Table 7.1.2).

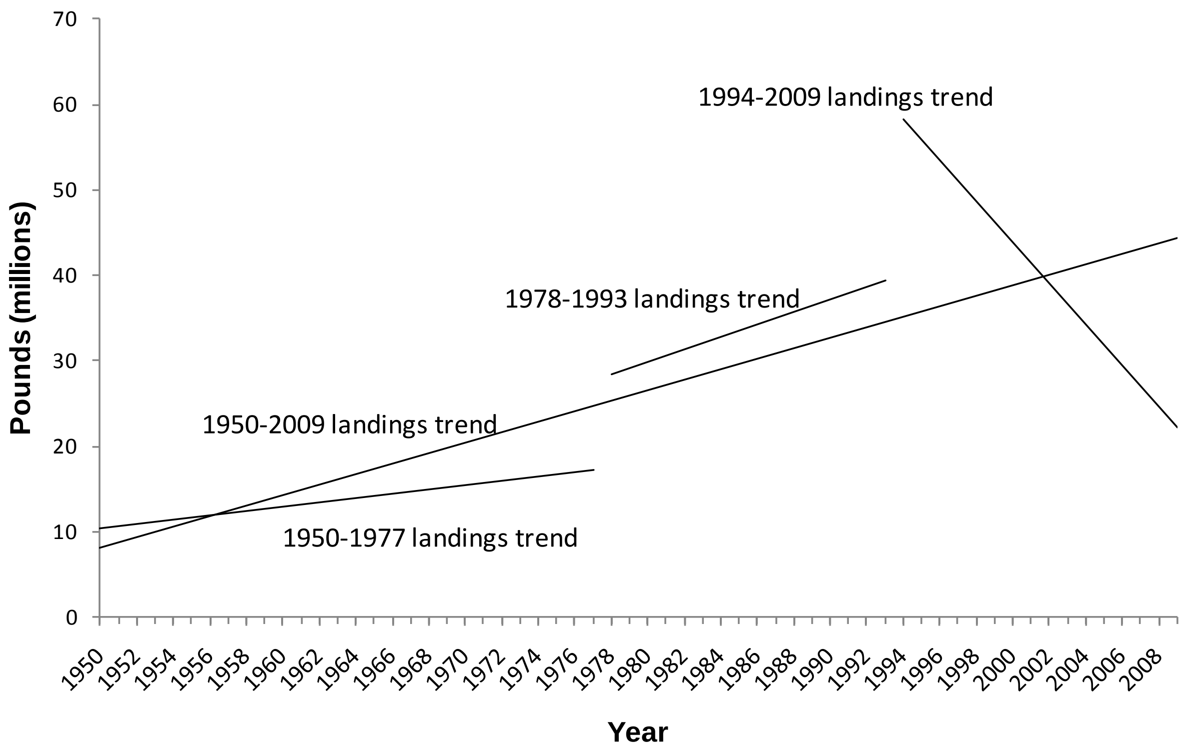

Figure 7.1.7 Trends in hard crab landings for various time periods in North Carolina, 1950–2009.

Like the total catch, 88% of all hard crabs landed are caught from May through October (Table 7.1.7; Figure 7.1.8). Hard crabs are landed in a majority of the waterbodies in North Carolina but Albemarle and Pamlico sounds are the two largest producers of hard crabs, accounting for 55% of the total harvest (Table 7.1.8). These two waterbodies land on average 12.5 and 9.7 million pounds of hard crabs each year, respectively. As is the case with statewide landings, there has been much variation of landings in individual waters (Table 7.1.8). To examine these trends, waterbodies were grouped into four regional areas (Albemarle, Pamlico, Southern, and Ocean) based on geographic proximity (Table 7.1.9). For the time period, the waterbodies making up the Pamlico region contributed 55% to the total hard crab harvest, followed by those of the Albemarle (39%), Southern (5%), and Ocean (<1%) regions (Table 7.1.10). Hard crab landings in the Pamlico and Southern regions show a significant correlation to each other and to total landings (Table 7.1.11; Figure 7.1.9).

Table 7.1.7 Monthly hard crab landings (pounds) for North Carolina, 1994–2009.

	Year									
Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
January	29,463	121,541	24,982	282,092	178,877	206,208	237,911	41,113	39,547	79,165
February	399,662	51,205	67,935	595,329	269,609	444,833	274,689	273,357	119,638	46,851
March	1,356,294	774,541	159,254	1,744,401	836,395	563,504	1,396,275	496,530	405,387	635,320
April	2,886,954	1,534,895	1,226,273	1,795,265	1,723,851	1,772,560	1,254,935	949,386	1,017,854	1,015,911
May	5,434,216	4,637,374	4,454,805	4,200,194	4,035,128	3,897,529	3,714,055	3,398,647	2,674,646	2,538,076
June	10,173,267	7,945,866	9,565,651	6,831,335	9,263,203	8,825,643	5,959,796	5,091,577	4,774,581	4,585,771
July	12,063,468	9,063,483	15,227,046	12,797,402	13,513,528	12,366,085	7,326,298	6,091,683	6,309,722	7,208,131
August	8,882,365	8,180,257	15,449,179	12,002,493	9,498,759	9,980,136	7,732,974	5,685,630	7,235,387	8,809,122
September	4,952,086	5,788,638	9,774,457	7,299,267	9,388,825	6,346,029	5,888,724	3,657,163	6,309,097	5,540,296
October	3,189,942	4,997,246	6,454,281	4,577,503	7,096,578	7,423,045	3,586,765	2,505,204	4,682,479	7,241,070
November	2,213,176	1,700,521	2,516,641	1,636,230	3,232,045	3,014,787	1,211,331	1,207,575	2,537,409	2,928,076
December	679,276	237,977	761,998	592,033	1,365,537	1,253,733	305,521	541,629	356,143	1,016,824
Total	52,260,168	45,033,543	65,682,500	54,353,545	60,402,332	56,094,091	38,889,273	29,939,494	36,461,890	41,644,612

	Year								Percent
Month	2004	2005	2006	2007	2008	2009	Total	Average	of total
January	180,099	82,143	155,352	126,699	60,839	159,491	2,005,520	125,345	0.31
February	61,536	22,626	124,002	31,623	165,932	85,010	3,033,835	189,615	0.47
March	1,253,750	185,887	429,163	565,729	370,688	1,082,906	12,256,024	766,002	1.90
April	1,666,776	429,827	677,906	462,811	458,612	1,411,540	20,285,354	1,267,835	3.15
May	4,957,438	1,261,491	2,853,768	1,647,068	1,953,217	3,038,848	54,696,498	3,418,531	8.50
June	6,867,382	5,698,235	4,577,157	4,036,746	4,100,621	4,373,984	102,670,814	6,416,926	15.96
July	6,111,465	5,538,607	3,841,714	4,151,272	5,750,546	3,164,878	130,525,329	8,157,833	20.29
August	4,196,499	3,680,194	4,204,362	3,123,917	5,817,969	4,597,568	119,076,812	7,442,301	18.51
September	3,593,995	2,738,714	3,671,648	2,788,678	4,769,335	4,893,672	87,400,623	5,462,539	13.58
October	2,695,119	2,534,127	2,503,095	2,580,797	4,469,897	4,096,224	70,633,371	4,414,586	10.98
November	758,641	1,075,340	1,005,311	826,374	2,717,061	1,671,164	30,251,682	1,890,730	4.70
December	250,068	324,261	365,454	220,445	1,704,174	565,188	10,540,259	658,766	1.64
Total	32,592,768	23,571,451	24,408,932	20,562,159	32,338,889	29,140,473	643,376,121	40,211,008	100.00

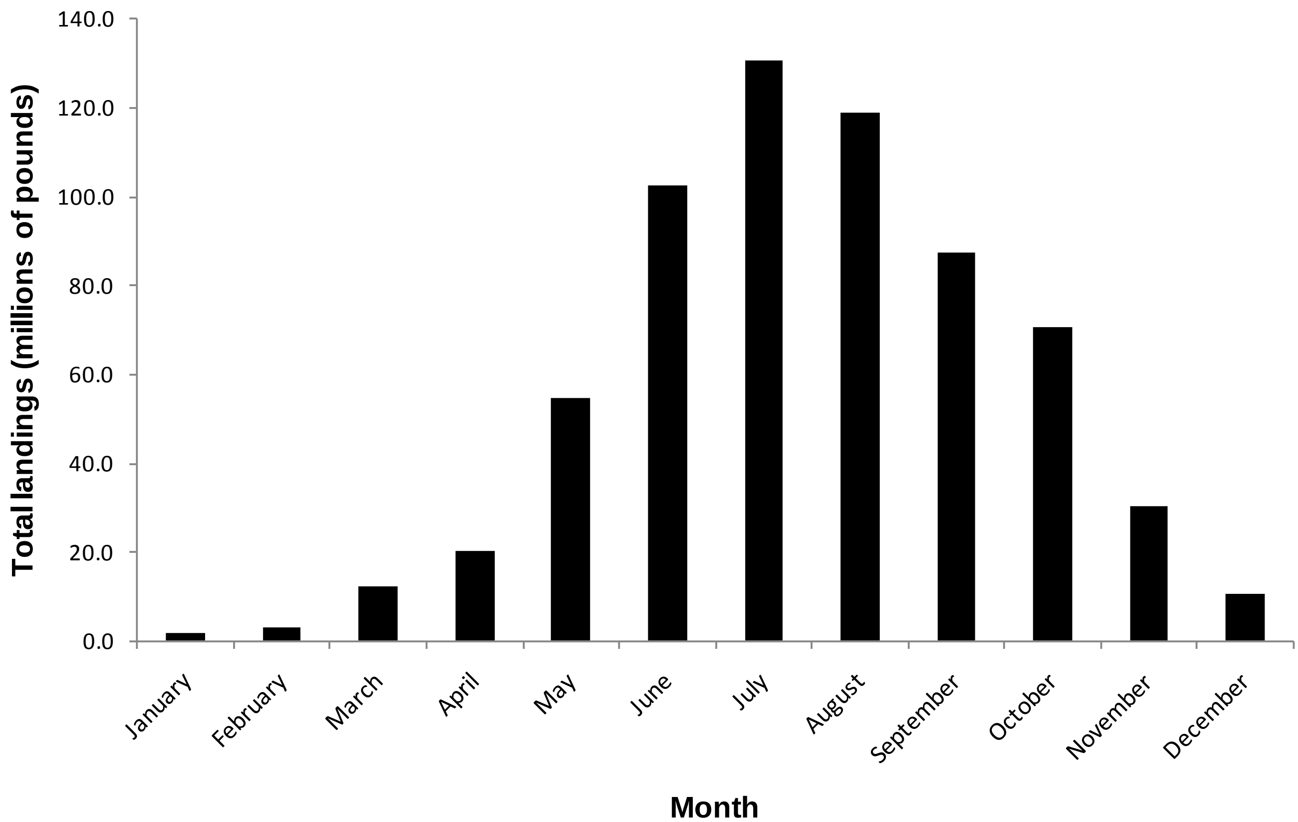

Figure 7.1.8 Monthly hard crab landings (pounds) for North Carolina, 1994–2009.

Table 7.1.8 Annual hard crab landings (pounds) for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year									
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Albemarle Sound	10,767,252	14,273,299	19,999,382	7,630,225	11,983,253	12,390,190	12,565,314	9,747,116	15,605,382	12,783,193
Pamlico Sound	16,878,425	8,887,306	13,037,832	18,687,618	21,498,456	18,516,650	9,443,501	7,438,597	5,324,600	10,917,974
Pamlico River	7,499,888	5,527,871	8,188,298	7,813,444	6,598,595	7,565,541	3,688,300	2,070,166	2,946,023	3,408,471
Neuse River	3,693,585	2,651,343	5,229,019	4,495,550	3,878,696	4,236,004	2,021,216	1,542,024	1,348,704	1,743,801
Currituck Sound	2,218,236	3,348,814	2,335,954	1,872,575	2,145,134	1,668,788	1,717,661	1,236,333	2,498,507	2,177,062
Croatan Sound	1,882,087	1,766,313	2,854,368	1,604,460	2,712,422	1,690,190	619,484	743,605	748,566	768,840
Pungo River	N/C	537,639	2,245,047	2,504,660	1,684,587	2,140,409	2,151,742	858,835	1,463,293	1,428,006
Bay River	2,147,708	1,822,560	3,886,472	3,905,733	3,074,082	1,556,229	1,140,150	501,631	418,196	484,341
Alligator River	1,329,788	1,458,331	2,173,821	645,564	1,346,944	1,285,184	1,542,430	984,321	2,176,081	2,474,712
Roanoke Sound	817,654	889,087	1,114,552	1,004,655	1,007,238	1,249,087	886,379	1,802,418	1,487,061	2,074,428
Core Sound	1,922,675	1,071,988	2,303,252	2,129,434	1,855,509	1,547,119	871,643	820,518	419,014	1,173,043
Cape Fear River	764,281	668,286	539,057	542,423	607,124	540,562	573,289	541,097	629,164	422,513
New River	259,983	331,690	186,289	251,376	276,393	304,759	425,570	411,811	281,726	298,954
Newport River	376,303	314,232	330,894	382,214	443,067	364,911	231,567	201,491	195,980	247,149
Inland Waterway*	375,365	396,709	342,295	160,473	201,169	217,099	288,443	225,525	192,988	279,984
Bogue Sound	261,909	178,314	272,190	195,123	211,821	151,166	212,494	159,684	89,103	241,760
Masonboro Sound	138,048	166,423	99,655	80,903	161,602	106,452	122,044	132,361	134,379	146,496
Topsail Sound	155,801	149,291	89,677	82,462	142,012	112,882	88,746	108,640	76,708	112,107
Stump Sound	103,823	170,486	124,092	151,814	167,741	158,118	135,536	102,067	92,380	111,539
White Oak River	130,848	99,431	92,276	69,721	141,195	157,186	112,649	153,323	149,058	143,504
Other**	536,510	324,132	238,080	143,120	265,293	135,566	51,118	157,933	184,981	206,737
Total	52,260,168	45,033,543	65,682,500	54,353,545	60,402,332	56,094,091	38,889,275	29,939,494	36,461,890	41,644,612

N/C=No landings data collected.
*Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
**Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.8 (cont) Annual hard crab landings (pounds) for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year								Percent
Waterbody	2004	2005	2006	2007	2008	2009	Total	Average	of total
Albemarle Sound	9,567,626	7,736,515	11,553,527	10,609,952	17,682,813	14,882,186	199,777,225	12,486,077	31.05
Pamlico Sound	8,473,910	4,040,450	2,409,507	1,562,070	4,100,667	3,289,219	154,506,783	9,656,674	24.02
Pamlico River	3,849,922	3,495,335	2,637,918	1,807,866	1,470,198	1,059,885	69,627,719	4,351,732	10.82
Neuse River	2,245,031	2,082,635	1,546,790	646,879	673,069	389,297	38,423,641	2,401,478	5.97
Currituck Sound	1,970,820	695,372	1,067,110	1,573,220	2,390,063	3,274,001	32,189,651	2,011,853	5.00
Croatan Sound	853,171	485,364	686,397	549,436	1,033,747	1,345,758	20,344,205	1,271,513	3.16
Pungo River	1,343,181	1,073,772	1,219,434	543,484	595,069	491,072	20,280,229	1,352,015	3.15
Bay River	415,389	338,781	117,210	122,980	124,751	174,130	20,230,340	1,264,396	3.14
Alligator River	356,474	348,643	378,520	756,228	1,219,525	1,632,504	20,109,071	1,256,817	3.13
Roanoke Sound	724,601	608,747	566,325	636,224	1,234,717	772,921	16,876,093	1,054,756	2.62
Core Sound	833,165	636,963	429,681	244,041	209,832	184,359	16,652,234	1,040,765	2.59
Cape Fear River	499,891	488,545	580,083	538,072	703,944	625,345	9,263,674	578,980	1.44
New River	249,932	213,681	152,975	164,752	101,176	123,161	4,034,224	252,139	0.63
Newport River	234,184	259,524	86,738	96,362	61,403	91,659	3,917,677	244,855	0.61
Inland Waterway*	189,098	178,502	178,783	90,126	120,957	194,602	3,632,117	227,007	0.56
Bogue Sound	159,558	156,740	174,026	115,326	139,211	100,583	2,819,007	176,188	0.44
Masonboro Sound	114,737	188,508	171,480	105,940	137,474	136,744	2,143,245	133,953	0.33
Topsail Sound	108,140	151,431	164,243	160,518	166,054	202,016	2,070,725	129,420	0.32
Stump Sound	98,033	114,455	94,081	61,816	42,528	70,325	1,798,833	112,427	0.28
White Oak River	96,070	95,667	29,088	40,989	55,642	20,372	1,587,018	99,189	0.25
Other**	209,838	181,823	165,016	135,879	76,051	80,336	3,092,412	193,276	0.48
Total	32,592,768	23,571,451	24,408,932	20,562,159	32,338,889	29,140,473	643,376,123	40,211,008	100.00

*Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
**Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.9 Regional breakdown and their corresponding trip ticket waterbodies for North Carolina.

Albemarle	Pamlico	Southern	Ocean
Albemarle Sound	Croatan Sound	Masonboro Sound	Ocean less than 3 miles
Currituck Sound	Roanoke Sound	Stump Sound	Ocean more than 3 miles
Alligator River	Pamlico Sound	Topsail Sound	Ocean <3 mi, N of Cape Hatteras*
Pasquotank River	Pamlico River	Cape Fear River	Ocean >3 mi, N of Cape Hatteras*
Perquimans River	Pungo River	Inland Waterway	Ocean <3 mi, S of Cape Hatteras*
Chowan River	Bay River	Inland Waterway (Brunswick)	Ocean >3 mi, S of Cape Hatteras*
Roanoke River	Neuse River	Inland Waterway (Onslow)	
Back Bay (VA)	Core Sound	Lockwood Folly River	
		New River	
		Shallotte River	
		Bogue Sound	
		Newport River	
		North River	
		White Oak River	

*Ocean waterbodies showing Cape Hatteras split were combined with general ocean codes for less than or greater than 3 miles in tables broken down by waterbody.

Table 7.1.10 Hard crab landings (pounds) by region for North Carolina, 1994–2009.

	Year									
Region	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pamlico	34,842,021	23,154,106	38,858,839	42,145,554	42,309,585	38,501,229	20,822,415	15,777,793	14,155,455	21,998,903
Albemarle	14,675,139	19,303,607	24,640,494	10,181,650	15,500,110	15,414,221	15,832,373	12,017,367	20,383,037	17,446,823
Southern	2,723,113	2,557,032	2,168,031	2,003,955	2,582,457	2,173,074	2,233,959	2,142,192	1,921,674	2,186,872
Ocean	19,895	18,502	8,548	3,120	5,527	5,567	526	2,142	1,724	12,014
Unknown	N/R	296	6,588	19,266	4,654	N/R	N/R	N/R	N/R	N/R
Total	52,260,168	45,033,543	65,682,500	54,353,545	60,402,332	56,094,091	38,889,273	29,939,494	36,461,890	41,644,612

	Year								Percent
Region	2004	2005	2006	2007	2008	2009	Total	Average	of total
Pamlico	18,738,368	12,762,045	9,613,261	6,112,980	9,442,049	7,706,641	356,941,244	22,308,828	55.48
Albemarle	11,903,274	8,793,460	13,023,940	12,959,262	21,305,052	19,808,063	253,187,872	15,824,242	39.35
Southern	1,944,219	2,006,568	1,751,158	1,468,082	1,584,645	1,606,704	33,053,733	2,065,858	5.14
Ocean	6,907	9,378	20,573	21,835	7,144	19,066	162,468	10,154	0.03
Unknown	N/R	N/R	N/R	N/R	N/R	N/R	30,804	7,701	0.00
Total	32,592,768	23,571,451	24,408,932	20,562,159	32,338,889	29,140,473	643,376,121	40,211,008	100.00

N/R=No landings reported.

Table 7.1.11 Correlation coefficients (bolded numbers significant at the 0.05 level or less) for regional hard crab landings in North Carolina, 1994–2009.

	Pamlico	Albemarle	Southern	Ocean	Unknown	Total
Pamlico	1.00					
Albemarle	0.04	1.00				
Southern	**0.70**	0.01	1.00			
Ocean	-0.32	0.03	-0.13	1.00		
Unknown*	**0.60**	-0.16	0.07	-0.29	1.00	
Total	**0.95**	0.35	**0.68**	-0.29	**0.51**	1.00

*Unknown was included in this table for consistency purposes only and makes up a very small portion (0.005%) of the total hard crab landings.

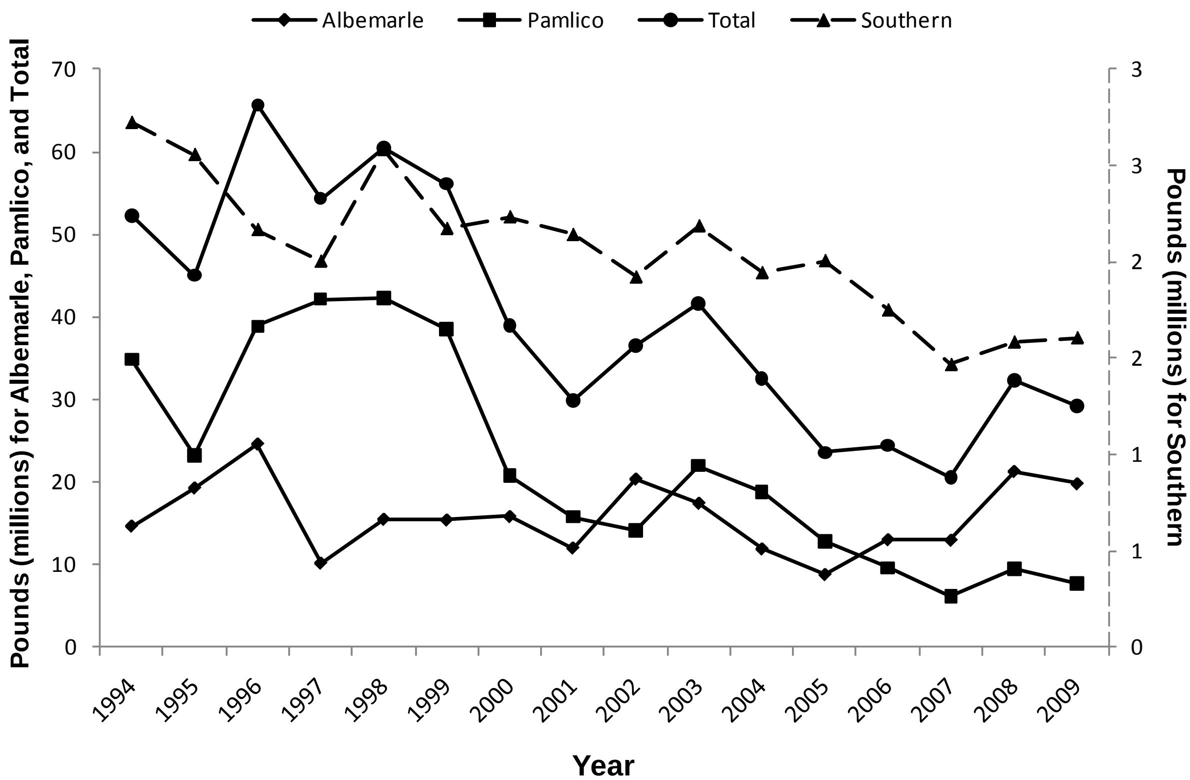

Figure 7.1.9 Annual landings of hard crabs for the Albemarle, Pamlico, Core and Southern regions of North Carolina, 1994–2009. Dashed line is for the Southern region and on the y2 axis.

7.1.1.1 POTS

Over time, crab pots have become the most preferred gear used to catch hard crabs. The first reported landings from crab pots in North Carolina were in 1953. Since then, crab pots have increased from only accounting for 30% of the total hard blue crab landings to over 95% in recent years (Table 7.1.12). For the remainder of this section, hard crab landings reported since 1994 are for only single gear trips. The peak months for pot (hard crab and peeler) landings are May through October, which account for 90% of the total hard crab landings from pots (Table 7.1.13). The Pamlico region accounts for 54% of the total hard crab landings from pots and 50% of the value (Tables 7.1.9, 7.1.14–7.1.17).

Table 7.1.12 Annual hard crab landings (pounds) by top 5 reported gear from single gear trip tickets for North Carolina, 1994–2009.

	Year									
Gear	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Crab pot*	49,392,007	43,268,680	61,907,802	50,311,377	56,292,584	53,521,426	37,327,532	28,175,576	34,693,762	39,643,539
Crab trawl	1,861,955	1,045,592	3,068,339	3,265,929	3,063,173	1,794,072	921,867	983,490	1,113,306	1,252,052
Shrimp trawl	458,181	221,413	297,215	300,312	550,851	275,498	196,850	184,468	156,870	299,872
Peeler pot	N/C	N/C	1,525	14,329	47,575	55,329	48,675	71,082	50,603	55,929
Gill net set (sink)	6,138	3,762	17,265	12,240	24,864	26,073	9,740	15,771	24,662	23,893
Other**	176,033	59,287	53,374	43,779	10,876	15,534	66,895	113,171	124,153	24,296
Total	51,894,313	44,598,733	65,345,521	53,947,964	59,989,923	55,687,933	38,571,559	29,543,556	36,163,356	41,299,581

	Year								Percent
Gear	2004	2005	2006	2007	2008	2009	Total	Average	of total
Crab pot*	31,238,094	22,932,767	24,005,235	20,284,744	30,530,242	27,940,658	611,466,025	38,216,627	95.75
Crab trawl	886,719	381,490	129,312	25,839	1,555,327	911,907	22,260,368	1,391,273	3.49
Shrimp trawl	162,143	60,470	36,627	31,649	3,955	16,784	3,253,158	203,322	0.51
Peeler pot	33,049	30,087	34,007	32,939	54,877	34,500	564,505	40,322	0.09
Gill net set (sink)	13,203	7,158	14,548	16,511	38,204	35,657	289,690	18,106	0.05
Other**	20,844	9,541	6,617	6,338	1,294	9,610	741,640	46,352	0.12
Total	32,354,051	23,421,514	24,226,346	20,398,020	32,183,899	28,949,116	638,575,385	39,910,962	100.00

N/C=No landings data collected.
*Hard and peeler pot landings were combined in 1994 and 1995.
**Other category includes: Channel Net, Trotline, Crab Dredge, Pound Net, Hand Rakes, Gill Net Set (float), Skimmer Trawl, Fyke Net, Oyster Dredge, Hand Tongs, Bull Rakes, Clam Trawl Kicking, Haul Seine, Clam Dredge (hydraulic), By Hand, Flounder Trawl, Conch Pot, Eel Pot, Gill Net (runaround), Fish Pot, Cast Net, Dip Net, Flynet, Gill Net (drift), Beach Seine, Shrimp Pound, Swipe Net, Clam Dredge, Butterfly Net, Scallop Trawl, Rod-n-Reel, and Gigs.

Table 7.1.13 Monthly hard crab landings (pounds) from single gear crab pot trip tickets for North Carolina, 1994–2009.

	Year									
Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
January	18,990	67,708	11,958	150,001	84,038	143,609	226,528	15,141	25,193	35,611
February	187,650	25,314	51,162	179,850	130,326	322,267	188,902	193,223	37,804	26,962
March	950,635	530,421	114,979	1,081,991	525,193	376,868	1,173,482	338,483	221,282	428,499
April	2,521,247	1,380,912	815,190	1,564,411	1,322,659	1,505,498	1,175,239	799,320	926,201	778,931
May	5,164,246	4,502,141	4,196,501	3,888,955	3,711,167	3,566,446	3,475,945	3,187,106	2,566,748	2,396,274
June	9,750,696	7,824,168	8,994,930	6,530,978	8,864,014	8,243,998	5,765,810	4,921,548	4,654,647	4,420,403
July	11,766,720	8,947,636	14,827,177	12,305,828	13,018,495	12,051,027	7,229,392	5,950,391	6,231,862	7,015,750
August	8,664,464	8,059,383	15,158,622	11,686,584	9,088,529	9,852,076	7,615,695	5,554,853	7,131,448	8,554,052
September	4,739,871	5,602,181	9,316,537	6,977,520	8,924,137	6,194,806	5,782,939	3,540,020	6,237,904	5,428,176
October	3,063,951	4,863,334	5,889,516	4,319,888	6,877,955	7,279,761	3,473,364	2,420,758	4,612,150	7,152,374
November	1,995,066	1,298,221	2,001,078	1,344,033	2,670,330	2,938,788	1,097,856	929,258	1,936,587	2,747,077
December	568,472	167,261	531,678	295,665	1,123,316	1,101,612	171,057	396,555	162,540	715,359
Total	49,392,007	43,268,680	61,909,327	50,325,705	56,340,159	53,576,755	37,376,207	28,246,657	34,744,365	39,699,468

	Year								Percent
Month	2004	2005	2006	2007	2008	2009	Total	Average	of total
January	149,523	62,198	120,989	123,991	60,073	99,721	1,395,270	87,204	0.23
February	30,056	16,579	117,840	27,156	164,391	75,862	1,775,342	110,959	0.29
March	825,294	126,955	413,797	542,299	366,620	630,177	8,646,975	540,436	1.41
April	1,411,466	382,267	662,422	453,415	447,774	1,063,589	17,210,541	1,075,659	2.81
May	4,740,581	1,149,212	2,802,821	1,594,149	1,918,237	3,004,126	51,864,655	3,241,541	8.47
June	6,756,061	5,462,291	4,490,714	3,984,567	4,070,012	4,334,647	99,069,484	6,191,843	16.19
July	6,018,425	5,489,671	3,809,868	4,134,029	5,731,056	3,136,276	127,663,603	7,978,975	20.86
August	4,158,429	3,655,347	4,188,561	3,101,108	5,778,118	4,560,866	116,808,133	7,300,508	19.09
September	3,555,457	2,722,033	3,635,068	2,759,582	4,756,288	4,861,813	85,034,331	5,314,646	13.89
October	2,663,988	2,516,979	2,480,359	2,559,494	4,442,830	4,068,938	68,685,639	4,292,852	11.22
November	736,326	1,062,646	993,099	820,104	2,142,781	1,649,795	26,363,045	1,647,690	4.31
December	225,538	316,677	323,705	217,791	706,940	489,346	7,513,511	469,594	1.23
Total	31,271,143	22,962,854	24,039,242	20,317,683	30,585,119	27,975,158	612,030,530	38,251,908	100.00

Table 7.1.14 Hard crab landings (pounds) for crab pots* from single gear trip tickets by region for North Carolina, 1994–2009.

	Year									
Region**	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pamlico	32,233,148	21,713,806	35,334,786	38,412,638	38,492,566	36,193,283	19,533,186	14,388,477	12,704,986	20,320,791
Albemarle	14,568,035	19,054,940	24,442,148	9,956,355	15,306,720	15,272,063	15,727,273	11,862,230	20,247,234	17,281,826
Southern	2,583,463	2,485,154	2,119,919	1,937,467	2,536,219	2,111,409	2,115,748	1,995,950	1,792,145	2,088,124
Ocean	7,362	14,605	6,403	***	***	***	***	***	***	8,726
Unknown	N/R	174	6,071	19,245	4,654	N/R	N/R	N/R	N/R	N/R
Total	49,392,007	43,268,680	61,909,327	50,325,705	56,340,159	53,576,755	37,376,207	28,246,657	34,744,365	39,699,468

	Year								Percent
Region**	2004	2005	2006	2007	2008	2009	Total	Average	of total
Pamlico	17,643,539	12,297,723	9,389,842	5,989,317	7,822,530	6,710,659	329,181,276	20,573,830	53.79
Albemarle	11,795,451	8,718,142	12,931,277	12,898,147	21,204,305	19,687,718	250,953,866	15,684,617	41.00
Southern	1,825,501	1,941,272	1,697,859	1,408,850	1,558,284	1,564,278	31,761,642	1,985,103	5.19
Ocean	6,653	5,717	20,264	21,369	***	12,503	103,602	11,511	0.02
Unknown	N/R	N/R	N/R	N/R	N/R	N/R	30,144	7,536	0.00
Total	31,271,143	22,962,854	24,039,242	20,317,683	30,585,119	27,975,158	612,030,530	38,251,908	100.00

*Crab pots include both hard and peeler pots.
**= See table 9 for region description; N/R=No landings reported.
Ocean landings are confidential in years with ***; since most of the ocean landings occurred south of Hatteras, confidential landings have been lumped into the Southern region

Table 7.1.15 Dockside value of hard crab landings from single gear crab pot* trip tickets by region for North Carolina, 1994–2009.

	Year									
Region**	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pamlico	$16,381,243	$15,307,494	$21,230,103	$23,017,052	$24,842,582	$21,019,378	$15,507,078	$11,963,753	$9,164,820	$15,003,376
Albemarle	$7,674,856	$14,846,445	$15,362,509	$6,532,925	$11,493,099	$9,716,236	$13,729,645	$10,178,604	$17,642,040	$14,913,457
Southern	$1,300,574	$1,690,961	$1,165,231	$1,172,898	$1,569,768	$1,258,834	$1,745,214	$1,624,634	$1,426,151	$1,648,445
Ocean	$3,789	$8,732	$4,076	***	***	***	***	***	***	$4,890
Unknown	N/R	$99	$5,355	$14,528	$3,494	N/R	N/R	N/R	N/R	N/R
Total	$25,360,463	$31,853,731	$37,767,274	$30,737,403	$37,908,943	$31,994,448	$30,981,937	$23,766,992	$28,233,010	$31,570,167

	Year								Percent
Region**	2004	2005	2006	2007	2008	2009	Total	Average	of total
Pamlico	$10,533,442	$8,069,678	$5,324,239	$4,933,805	$5,889,285	$5,373,126	$213,560,455	$13,347,528	50.24
Albemarle	$7,790,206	$5,579,693	$7,668,097	$11,823,503	$17,404,784	$17,669,731	$190,025,831	$11,876,614	44.71
Southern	$1,141,447	$1,231,959	$943,433	$1,144,695	$1,111,577	$1,220,539	$21,396,359	$1,337,272	5.03
Ocean	$3,010	$2,509	$8,281	$12,131	***	$6,774	$54,192	$6,021	0.01
Unknown	N/R	N/R	N/R	N/R	N/R	N/R	$23,476	$5,869	0.01
Total	$19,468,105	$14,883,839	$13,944,051	$17,914,134	$24,405,647	$24,270,171	$425,060,314	$26,566,270	100.00

*Crab pots include both hard and peeler pots.
**= See table 9 for region description; N/R=No landings reported.
Ocean landings are confidential in years with ***; since most of the ocean landings occurred south of Hatteras, confidential landings have been lumped into the Southern region.

Table 7.1.16 Annual hard crab landings (pounds) from single gear crab pot* trip tickets for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year									
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Albemarle Sound	10,697,064	14,072,096	19,851,417	7,486,143	11,827,906	12,268,192	12,475,874	9,619,517	15,487,109	12,635,799
Pamlico Sound	15,671,291	8,031,868	11,603,798	17,040,337	20,137,322	17,695,629	8,903,273	6,633,677	4,308,689	9,985,702
Pamlico River	6,827,121	5,268,057	7,650,630	7,353,775	5,990,860	7,055,435	3,559,119	1,996,496	2,892,498	3,232,817
Neuse River	3,401,441	2,555,407	4,965,394	4,030,502	3,537,016	3,969,404	1,959,098	1,494,787	1,333,475	1,695,700
Currituck Sound	2,184,846	3,305,799	2,290,944	1,797,022	2,114,539	1,651,459	1,705,192	1,224,411	2,487,896	2,162,663
Alligator River	1,329,739	1,456,959	2,173,709	643,676	1,345,102	1,284,598	1,539,612	974,668	2,173,262	2,471,645
Bay River	2,005,908	1,805,575	3,621,406	3,631,783	2,846,190	1,452,317	1,097,672	483,767	414,469	463,584
Croatan Sound	1,769,557	1,676,783	2,424,465	1,494,869	2,494,485	1,589,988	565,253	645,538	609,441	729,132
Pungo River	N/C	519,851	1,950,603	2,186,564	1,275,752	1,916,668	1,905,266	753,736	1,389,849	1,274,647
Roanoke Sound	809,548	880,330	1,025,716	976,578	995,954	1,230,200	839,112	1,724,102	1,424,296	2,021,027
Core Sound	1,748,284	975,937	2,092,774	1,698,229	1,214,987	1,283,643	704,393	656,375	332,271	918,183
Cape Fear River	759,534	666,006	534,358	541,130	602,785	531,685	549,781	531,796	597,661	390,902
Newport River	365,814	312,909	325,589	375,005	438,742	363,299	231,448	199,597	195,928	246,616
Inland Waterway**	367,120	389,733	336,777	157,084	197,513	213,999	285,259	223,575	189,934	270,438
New River	196,013	285,021	164,994	209,828	266,351	275,215	350,566	287,204	195,522	253,331
Bogue Sound	261,728	175,938	270,449	194,644	209,563	150,835	211,608	159,043	88,902	241,190
Masonboro Sound	136,999	165,030	96,650	80,504	161,166	105,025	121,118	130,651	133,550	145,259
Topsail Sound	155,178	146,232	88,803	77,308	135,525	108,215	84,867	106,663	73,769	108,896
Stump Sound	103,583	170,317	123,304	146,678	161,264	146,604	125,873	97,315	89,443	109,970
White Oak River	125,019	94,048	89,358	67,252	137,137	155,559	112,268	152,451	147,619	140,681
Other***	476,224	314,788	228,190	136,795	250,001	128,788	49,556	151,290	178,785	201,287
Total	49,392,007	43,268,680	61,909,327	50,325,705	56,340,159	53,576,755	37,376,207	28,246,657	34,744,365	39,699,468

Table 7.1.16 (cont) Annual hard crab landings (pounds) from single gear crab pot* trip tickets for top 20 reported waterbodies from North Carolina, 1994–2009

	Year								Percent
Waterbody	2004	2005	2006	2007	2008	2009	Total	Average	of total
Albemarle Sound	9,469,177	7,674,331	11,474,086	10,555,774	17,595,266	14,782,791	197,972,542	12,373,284	32.35
Pamlico Sound	7,915,014	3,950,680	2,299,650	1,529,506	2,531,307	2,370,896	140,608,638	8,788,040	22.97
Pamlico River	3,764,680	3,326,627	2,605,186	1,801,513	1,453,228	1,038,961	65,817,000	4,113,563	10.75
Neuse River	2,196,010	2,057,344	1,536,809	644,326	670,860	370,017	36,417,588	2,276,099	5.95
Currituck Sound	1,962,382	682,524	1,054,948	1,567,818	2,379,286	3,257,169	31,828,899	1,989,306	5.20
Alligator River	356,084	348,559	377,969	756,210	1,219,440	1,630,270	20,081,503	1,255,094	3.28
Bay River	405,784	326,183	114,291	122,786	124,709	174,123	19,090,545	1,193,159	3.12
Croatan Sound	841,024	482,673	681,743	546,398	1,026,851	1,326,163	18,904,360	1,181,523	3.09
Pungo River	1,244,774	993,632	1,196,225	532,535	593,121	482,947	18,216,169	1,214,411	2.98
Roanoke Sound	690,682	591,116	559,468	606,598	1,217,792	764,200	16,356,718	1,022,295	2.67
Core Sound	585,572	569,470	396,471	205,655	204,663	183,352	13,770,257	860,641	2.25
Cape Fear River	483,831	481,000	558,466	526,163	698,656	621,921	9,075,673	567,230	1.48
Newport River	234,037	259,524	86,738	96,345	61,403	91,659	3,884,653	242,791	0.63
Inland Waterway**	186,327	177,259	177,008	88,582	120,488	194,084	3,575,178	223,449	0.58
New River	190,047	177,138	143,466	151,824	94,981	120,912	3,362,410	210,151	0.55
Bogue Sound	155,413	154,511	171,278	115,133	139,075	100,583	2,799,892	174,993	0.46
Masonboro Sound	113,265	187,307	168,434	98,522	137,314	136,094	2,116,887	132,305	0.35
Topsail Sound	93,536	145,009	157,926	142,644	150,055	172,273	1,946,896	121,681	0.32
Stump Sound	94,895	111,695	90,691	59,850	42,451	65,948	1,739,879	108,742	0.28
White Oak River	96,002	94,342	25,229	38,330	51,631	19,055	1,545,979	96,624	0.25
Other***	192,610	171,933	163,161	131,171	72,544	71,741	2,918,864	182,429	0.48
Total	31,271,143	22,962,854	24,039,242	20,317,683	30,585,119	27,975,158	612,030,530	38,251,908	100.00

*Crab pots include both hard and peeler pots.
**Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
***Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.17 Annual dockside value of hard crab landings (pounds) from single gear crab pot* trip tickets for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year									
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Albemarle Sound	$5,732,880	$11,281,531	$12,550,978	$5,006,200	$9,115,974	$7,925,421	$10,922,295	$8,380,664	$13,389,395	$10,786,254
Pamlico Sound	$7,591,675	$5,448,204	$6,625,562	$9,753,348	$12,153,523	$9,796,221	$6,878,592	$5,201,186	$2,793,726	$6,993,638
Pamlico River	$3,791,333	$4,011,865	$5,079,829	$4,539,708	$4,373,237	$4,206,873	$2,913,953	$1,863,600	$2,206,791	$2,511,004
Neuse River	$1,933,550	$2,039,097	$3,204,724	$2,682,262	$2,569,307	$2,695,415	$1,675,795	$1,439,311	$1,153,669	$1,507,060
Currituck Sound	$1,065,262	$2,176,643	$1,443,112	$1,134,897	$1,460,038	$950,684	$1,507,132	$936,411	$2,632,874	$2,132,284
Alligator River	$680,181	$1,196,049	$1,271,611	$373,219	$903,892	$788,063	$1,293,338	$816,663	$1,539,298	$1,985,983
Bay River	$1,007,425	$1,240,394	$2,104,758	$2,218,134	$1,940,207	$927,615	$895,599	$420,154	$310,992	$349,378
Croatan Sound	$863,828	$1,037,163	$1,281,396	$904,766	$1,517,411	$834,438	$420,789	$503,373	$421,037	$471,818
Pungo River	N/C	$390,146	$1,362,685	$1,425,796	$972,638	$1,172,255	$1,630,262	$756,441	$1,061,783	$1,117,167
Roanoke Sound	$407,122	$556,458	$533,975	$573,511	$603,562	$661,487	$588,350	$1,294,754	$1,025,314	$1,401,873
Core Sound	$786,311	$584,169	$1,037,174	$919,528	$712,696	$725,075	$503,737	$484,933	$191,508	$651,437
Cape Fear River	$421,478	$489,127	$302,148	$358,333	$436,035	$317,438	$513,665	$484,784	$610,000	$365,923
Newport River	$151,865	$180,786	$161,884	$192,677	$210,174	$187,632	$146,284	$131,245	$86,681	$142,104
Inland Waterway	$200,047	$270,395	$181,293	$94,998	$121,806	$115,458	$200,102	$164,055	$124,105	$143,717
New River	$93,000	$231,015	$105,850	$143,166	$178,626	$186,961	$345,198	$275,456	$179,000	$259,100
Bogue Sound	$139,806	$133,422	$156,493	$129,024	$134,706	$96,389	$165,549	$122,993	$62,116	$179,789
Masonboro Sound	$63,132	$94,522	$47,594	$41,626	$82,992	$57,497	$88,082	$96,333	$101,981	$129,330
Topsail Sound	$68,949	$86,885	$42,746	$43,159	$85,235	$66,920	$58,596	$69,406	$43,715	$64,005
Stump Sound	$48,249	$100,083	$67,997	$80,194	$104,328	$91,647	$96,538	$81,268	$62,212	$76,684
White Oak River	$61,552	$59,947	$52,900	$40,079	$88,698	$105,413	$101,247	$125,834	$106,395	$121,046
Other	$252,818	$245,832	$152,565	$82,779	$143,856	$85,548	$36,835	$118,127	$130,419	$180,574
Total $	$25,360,463	$31,853,731	$37,767,274	$30,737,403	$37,908,942	$31,994,448	$30,981,937	$23,766,992	$28,233,010	$31,570,167

Table 7.1.17 (cont) Annual dockside value of hard crab landings (pounds) from single gear crab pot* trip tickets for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year								Percent
Waterbody	2004	2005	2006	2007	2008	2009	Total	Average	of total
Albemarle Sound	$6,257,161	$4,962,579	$6,773,584	$9,705,334	$14,449,673	$13,336,999	$150,576,921	$9,411,058	35.42
Pamlico Sound	$4,525,632	$2,567,374	$1,327,562	$1,239,296	$1,930,126	$1,890,027	$86,715,692	$5,419,731	20.40
Pamlico River	$2,191,607	$2,183,095	$1,436,194	$1,373,972	$1,063,647	$814,015	$44,560,722	$2,785,045	10.48
Neuse River	$1,521,592	$1,454,338	$904,975	$648,485	$656,536	$390,854	$26,476,971	$1,654,811	6.23
Currituck Sound	$1,363,615	$442,835	$660,161	$1,602,992	$2,086,387	$3,275,255	$24,870,580	$1,554,411	5.85
Alligator River	$164,039	$161,371	$213,959	$487,635	$857,188	$1,040,487	$13,772,974	$860,811	3.24
Bay River	$237,347	$232,846	$70,037	$117,819	$96,355	$166,422	$12,335,482	$770,968	2.90
Croatan Sound	$501,126	$302,130	$400,573	$454,533	$772,990	$1,082,510	$11,769,880	$735,618	2.77
Pungo River	$808,535	$703,610	$731,884	$521,566	$459,426	$387,893	$13,502,086	$900,139	3.18
Roanoke Sound	$373,530	$327,043	$265,450	$438,688	$768,045	$515,338	$10,334,500	$645,906	2.43
Core Sound	$374,073	$299,243	$187,563	$139,446	$142,160	$126,067	$7,865,122	$491,570	1.85
Cape Fear River	$365,563	$388,372	$372,670	$503,316	$499,002	$533,763	$6,961,618	$435,101	1.64
Newport River	$107,020	$110,421	$39,241	$68,587	$43,158	$83,868	$2,043,624	$127,727	0.48
Inland Waterway	$61,209	$72,305	$71,014	$67,227	$62,032	$89,786	$2,039,547	$127,472	0.48
New River	$148,832	$145,769	$93,771	$132,557	$95,900	$123,741	$2,737,941	$171,121	0.64
Bogue Sound	$92,148	$96,403	$90,235	$84,550	$108,735	$79,788	$1,872,145	$117,009	0.44
Masonboro Sound	$60,082	$101,020	$74,877	$62,672	$85,721	$88,034	$1,275,495	$79,718	0.30
Topsail Sound	$43,624	$63,974	$70,904	$83,988	$85,942	$100,680	$1,078,729	$67,421	0.25
Stump Sound	$56,924	$72,955	$52,721	$48,444	$33,736	$58,270	$1,132,250	$70,766	0.27
White Oak River	$74,260	$87,792	$22,132	$49,981	$56,483	$15,204	$1,168,963	$73,060	0.28
Other	$140,189	$108,365	$84,544	$83,046	$52,405	$71,169	$1,969,071	$123,067	0.46
Total $	$19,468,106	$14,883,839	$13,944,050	$17,914,134	$24,405,646	$24,270,171	$425,060,314	$26,566,270	100.00

*Crab pots include both hard and peeler pots.
**Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
***Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

The longest running record of effort in the crab pot fishery comes from annual gear surveys (NMFS annual boat and shore or NCDMF fiscal year licensee reported gear used), which document the reported number of pots. Pot numbers provided by the NMFS were available from 1953 to 1984; however, information on how these data were collected is not well known. For this reason, these data cannot be considered a reliable measure of effort. NCDMF pot data collected prior to 2000 that were presented in the 2004 Blue Crab FMP cannot be verified and should not be used for management purposes. Pot data reported from 2000 to 2009 represent the number of pots that each license holder uses on a regular basis and were recorded during the purchase of the license. This number does not reflect the actual number of pots fished per trip and therefore should not be used to estimate fishing pressure on the stock. Estimated reported pot use has increased from 1,200 in 1953 to a peak of over 1 million pots in 2001 before declining to around 680,000 pots in 2009 (Figure 7.1.10). The spikes in reported pot numbers that occurred in 1994, 1995, 1996, and 1997 may have resulted from proposed effort control measures. Various pot limits and limited entry options based on historic reported pot use were examined, and this may have led to an increase in pot numbers reported to the NCDMF. As a result, pot numbers reported for 1994–1997 are considered inaccurate.

Data on reported pot numbers were used to calculate annual estimates of catch-per-unit-effort (CPUE). For this analysis, CPUE is defined as total hard crab landings from crab pots divided by the total number of crab pots reported and does not reflect the quantity of crabs caught in the number of fished pots for each trip. During 1953 through 1975, CPUE fluctuated without trend; however, once pot numbers started to increase dramatically in the late 1970s, CPUE stabilized for a few years. Since 1982, there has been an inverse relationship between reported pots and CPUE (i.e., increasing pot numbers and decreasing CPUE; Figure 7.1.11).

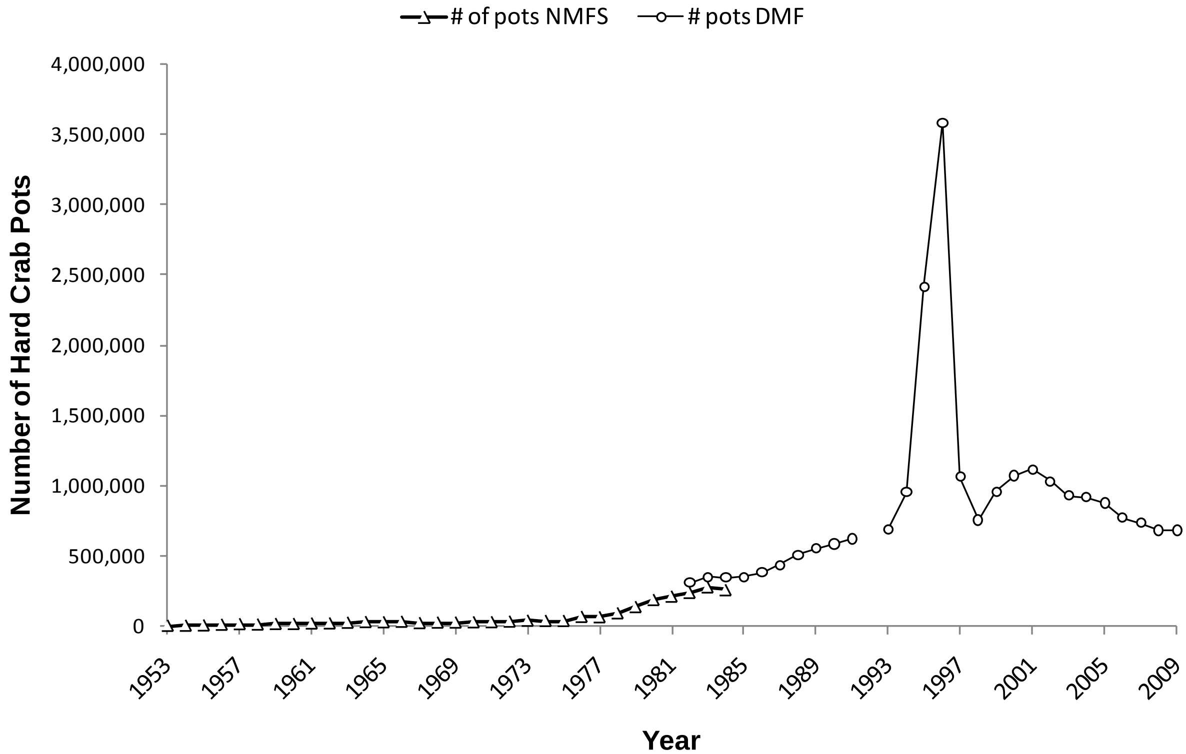

Figure 7.1.10 Number of operating units for the North Carolina blue crab pot fishery, 1953–2009 (NCDMF pot numbers are by license year (July–June), NMFS numbers are by calendar year; 1992 data were not available). **These numbers do not reflect the actual number of pots fished per trip and should not be used to estimate fishing pressure on the blue crab stock.

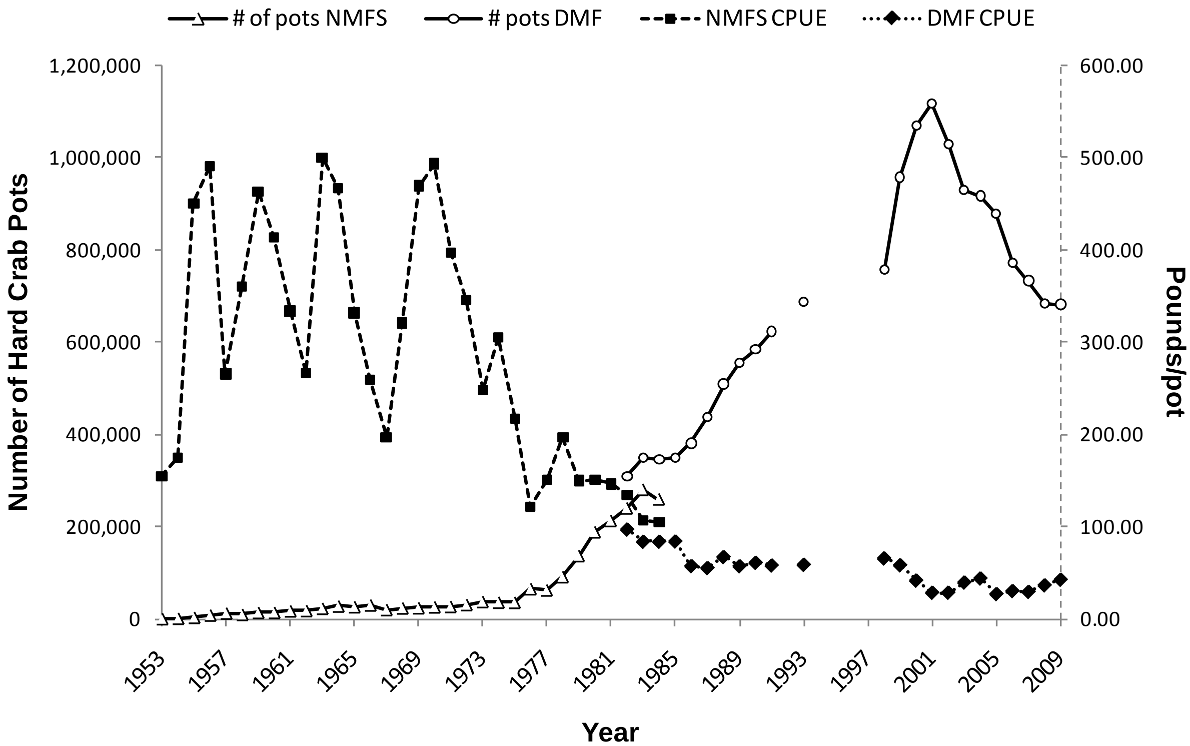

Figure 7.1.11 Catch per unit effort (pounds/pots) for North Carolina, 1953–2009 (Pot numbers from 1994–1997 were considered not valid). **CPUE is defined as total hard crab landings from crab pots divided by the total number of crab pots reported and does not reflect the quantity of crabs caught in the number of fished pots for each trip.

From the TTP, on average, there are 77,467 single gear trips reporting hard crab landings from pots each year (1994–2009) (Table 7.1.18). CPUE can also be defined as the total hard crab landings from crab pots divided by the total number of trips reporting hard crab landings in pots. The Pamlico region accounts for 60% of the pot trips landings hard crabs, but ranks 2nd in CPUE (443 pounds/trip) behind the Albemarle region with 666 pounds/trip (Tables 7.1.18–7.1.21; Figure 7.1.13). CPUE estimates by waterbody from 1994 through 2009 varied annually but showed a slight upward trend (Figure 7.1.12 and Table 7.1.21). The average number of pot trips peaks in July (Table 7.1.22 and Figure 7.1.14), followed by a peak in CPUE estimates in October (Table 7.1.23 and Figure 7.1.14).

Table 7.1.18 Annual trips landing hard crabs by region from single gear crab pot* trip tickets for North Carolina, 1994–2009.

	Year									
Region**	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pamlico	66,450	61,491	61,151	73,169	76,215	65,441	54,050	52,517	38,148	42,828
Albemarle	25,366	31,252	29,894	19,585	23,021	23,671	25,022	25,900	29,463	26,446
Southern	8,725	9,546	7,452	7,095	8,312	6,927	7,539	9,007	7,697	7,588
Ocean	30	33	24	***	***	***	***	***	***	77
Unknown	N/R	1	60	66	28	N/R	N/R	N/R	N/R	N/R
Total	100,571	102,323	98,581	99,915	107,576	96,039	86,611	87,424	75,308	76,939

	Year								Percent
Region**	2004	2005	2006	2007	2008	2009	Total	Average	of total
Pamlico	41,681	31,364	22,567	19,460	17,788	18,593	742,913	46,432	59.94
Albemarle	20,580	14,810	15,756	19,355	20,362	26,495	376,978	23,561	30.41
Southern	7,224	6,961	6,239	6,037	5,920	6,436	118,507	7,419	9.56
Ocean	87	67	150	161	***	77	904	78	0.07
Unknown	N/R	N/R	N/R	N/R	N/R	N/R	155	39	0.01
Total	69,572	53,202	44,712	45,013	44,070	51,601	1,239,457	77,466	100.00

*Crab pots include both hard and peeler pots.
**= See table 9 for region description; N/R=No landings reported.
Ocean landings are confidential in years with ***; since most of the ocean landings occurred south of Hatteras, confidential landings have been lumped into the Southern region.

Table 7.1.19 Annual hard crab CPUE (pounds/trip) estimates by region from single gear crab pot* trip tickets for North Carolina, 1994–2009.

	Year								
Region**	1994	1995	1996	1997	1998	1999	2000	2001	2002
Albemarle	574.31	609.72	817.63	508.37	664.90	645.18	628.54	458.00	687.21
Pamlico	485.07	353.12	577.83	524.99	505.05	553.07	361.39	273.98	333.04
Southern	296.10	260.33	284.48	273.08	305.13	304.81	280.64	221.60	232.84
Unknown	N/R	174.00	101.18	291.59	166.21	N/R	N/R	N/R	N/R
Ocean	245.40	442.58	266.79	***	***	***	***	***	***
Total	491.12	422.86	628.00	503.69	523.72	557.86	431.54	323.10	461.36

	Year							
Region**	2003	2004	2005	2006	2007	2008	2009	Total
Albemarle	653.48	573.15	588.67	820.72	666.40	1,041.37	743.07	665.70
Pamlico	474.47	423.30	392.10	416.09	307.78	439.76	360.92	443.10
Southern	275.19	252.70	278.88	272.14	233.37	263.22	243.05	268.01
Unknown	N/R	N/R	N/R	N/R	N/R	N/R	N/R	194.48
Ocean	113.32	76.47	85.33	135.09	132.73	***	162.38	114.60
Total	515.99	449.48	431.62	537.65	451.37	694.01	542.14	493.79

*Crab pots include both hard and peeler pots.
**= See table 9 for region description; N/R=No landings reported.
Ocean landings are confidential in years with ***; since most of the ocean landings occurred south of Hatteras, confidential landings have been lumped into the Southern region.

Table 7.1.20 Annual number of trips with hard crab landings from single gear crab pot* trip tickets for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year									
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Albemarle Sound	18,400	23,616	22,990	14,832	16,872	18,204	18,929	20,349	22,103	18,716
Pamlico Sound	25,895	20,958	18,163	26,770	30,570	28,191	22,191	19,787	12,037	16,118
Pamlico River	19,512	16,628	14,231	15,142	15,671	13,005	10,589	10,083	8,698	9,265
Neuse River	7,122	6,741	8,167	8,931	8,868	7,835	6,140	6,262	5,009	4,520
Pungo River	N/C	2,037	4,993	5,962	4,629	4,880	5,718	4,799	4,808	4,417
Currituck Sound	3,978	4,483	3,468	3,523	3,782	3,378	3,647	3,177	4,366	4,294
Roanoke Sound	2,965	2,893	2,848	3,328	2,764	3,348	2,725	5,330	3,753	4,190
Croatan Sound	3,428	3,718	4,217	3,671	5,226	2,801	1,603	2,101	1,457	1,096
Bay River	4,012	5,091	5,088	6,005	5,837	2,728	2,908	2,049	1,375	1,452
Core Sound	3,516	3,425	3,444	3,360	2,650	2,653	2,176	2,106	1,011	1,770
Alligator River	2,286	2,668	3,071	1,157	2,329	1,916	2,422	2,208	2,720	3,413
Cape Fear River	2,230	2,003	1,722	1,851	1,626	1,484	1,485	1,709	1,674	1,260
Inland Waterway**	1,341	2,165	1,684	1,067	1,476	1,103	1,637	1,549	1,278	1,529
New River	689	1,024	555	821	753	749	1,056	1,436	1,160	1,072
Masonboro Sound	1,080	1,265	666	485	805	563	571	875	745	695
Bogue Sound	900	627	648	663	619	369	548	626	392	577
Newport River	784	685	582	647	768	643	585	569	482	365
Topsail Sound	443	495	350	259	461	493	411	475	352	460
White Oak River	511	456	462	473	615	722	545	756	694	462
Stump Sound	313	423	381	467	389	388	350	323	338	372
Other***	1,166	922	851	501	866	586	375	855	856	896
Total	100,571	102,323	98,581	99,915	107,576	96,039	86,611	87,424	75,308	76,939

Table 7.1.20 (cont) Annual number of trips with hard crab landings from single gear crab pot* trip tickets for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year								Percent
Waterbody	2004	2005	2006	2007	2008	2009	Total	Average	of total
Albemarle Sound	16,265	12,590	13,274	15,635	16,418	20,003	289,196	18,075	23.33
Pamlico Sound	15,877	9,830	5,675	4,950	4,438	4,818	266,268	16,642	21.48
Pamlico River	9,265	7,706	6,054	4,928	3,894	3,538	168,209	10,513	13.57
Neuse River	5,310	4,556	3,414	2,504	2,197	1,731	89,307	5,582	7.21
Pungo River	4,339	3,641	3,262	2,386	1,947	2,101	59,919	3,995	4.83
Currituck Sound	3,603	1,663	1,872	2,749	2,928	4,671	55,582	3,474	4.48
Roanoke Sound	2,156	1,902	1,688	2,050	2,495	2,361	46,796	2,925	3.78
Croatan Sound	2,023	1,529	1,455	1,604	1,972	2,965	40,866	2,554	3.30
Bay River	1,109	992	330	578	392	708	40,654	2,541	3.28
Core Sound	1,605	1,208	690	461	454	371	30,900	1,931	2.49
Alligator River	697	518	546	898	967	1,732	29,548	1,847	2.38
Cape Fear River	1,236	1,221	1,412	1,361	1,547	1,651	25,472	1,592	2.06
Inland Waterway**	1,216	1,207	1,012	650	862	1,362	21,138	1,321	1.71
New River	1,049	960	716	703	444	507	13,694	856	1.10
Masonboro Sound	664	700	778	691	697	803	12,083	755	0.97
Bogue Sound	667	469	515	392	431	486	8,929	558	0.72
Newport River	443	460	228	355	254	340	8,190	512	0.66
Topsail Sound	399	576	557	568	660	574	7,533	471	0.61
White Oak River	419	344	173	254	275	90	7,251	453	0.59
Stump Sound	323	352	294	309	223	272	5,517	345	0.45
Other***	910	778	768	988	577	517	12,412	776	1.00
Total	69,575	53,202	44,713	45,014	44,072	51,601	1,239,464	77,467	100.00

N/C=No landings data collected.
*Crab pots include both hard and peeler pots.
**Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
***Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.21 Annual hard crab CPUE (pounds/trip) estimates from single gear crab pot* trip tickets for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year								
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002
Albemarle Sound	581.36	595.87	863.48	504.73	701.04	673.93	659.09	472.73	700.68
Alligator River	581.69	546.09	707.82	556.33	577.54	670.46	635.68	441.43	798.99
Currituck Sound	549.23	737.41	660.60	510.08	559.11	488.89	467.56	385.40	569.83
Pamlico Sound	605.19	383.24	638.87	636.55	658.73	627.70	401.21	335.25	357.95
Newport River	466.60	456.80	559.43	579.61	571.28	565.01	395.64	350.79	406.49
Bay River	499.98	354.66	711.75	604.79	487.61	532.37	377.47	236.10	301.43
Croatan Sound	516.21	450.99	574.93	407.21	477.32	567.65	352.62	307.25	418.28
Core Sound	497.24	284.95	607.66	505.43	458.49	483.85	323.71	311.67	328.66
Neuse River	477.60	379.08	607.98	451.29	398.85	506.62	319.07	238.71	266.22
Pamlico River	349.89	316.82	537.60	485.65	382.29	542.52	336.11	198.01	332.55
Cape Fear River	340.60	332.50	310.31	292.34	370.72	358.28	370.22	311.17	357.03
Roanoke Sound	273.03	304.30	360.15	293.44	360.33	367.44	307.93	323.47	379.51
Stump Sound	330.94	402.64	323.63	314.08	414.56	377.85	359.64	301.28	264.62
Bogue Sound	290.81	280.60	417.36	293.58	338.55	408.77	386.15	254.06	226.79
Pungo River	N/C	255.20	390.67	366.75	275.60	392.76	333.20	157.06	289.07
Topsail Sound	350.29	295.42	253.72	298.49	293.98	219.50	206.49	224.55	209.57
New River	284.49	278.34	297.29	255.58	353.72	367.44	331.98	200.00	168.55
White Oak River	244.66	206.25	193.42	142.18	222.99	215.46	206.00	201.65	212.71
Masonboro Sound	126.85	130.46	145.12	165.99	200.21	186.54	212.12	149.31	179.26
Inland Waterway**	273.77	180.02	199.99	147.22	133.82	194.02	174.26	144.33	148.62
Other***	408.43	341.42	268.14	273.04	288.69	219.77	132.15	176.95	208.86
Total	491.12	422.86	628.00	503.69	523.72	557.86	431.54	323.10	461.36

Table 7.1.21 (cont) Annual hard crab CPUE (pounds/trip) estimates from single gear crab pot* trip tickets for top 20 reported waterbodies from North Carolina, 1994–2009.

	Year							
Waterbody	2003	2004	2005	2006	2007	2008	2009	Total
Albemarle Sound	675.13	582.18	609.56	864.40	675.14	1071.71	739.03	684.56
Alligator River	724.19	510.88	672.89	692.25	842.10	1261.05	941.26	679.62
Currituck Sound	503.65	544.65	410.42	563.54	570.32	812.60	697.32	572.65
Pamlico Sound	619.54	498.52	401.90	405.22	308.99	570.37	492.09	528.07
Newport River	675.66	528.30	564.18	380.43	271.39	241.74	269.59	474.32
Bay River	319.27	365.90	328.81	346.33	212.43	318.14	245.94	469.59
Croatan Sound	665.27	415.73	315.68	468.55	340.65	520.72	447.27	462.59
Core Sound	518.75	364.84	471.42	574.60	446.11	450.80	494.21	445.64
Neuse River	375.15	413.56	451.57	450.15	257.32	305.35	213.76	407.78
Pamlico River	348.93	406.33	431.69	430.32	365.57	373.20	293.66	391.28
Cape Fear River	310.24	391.45	393.94	395.51	386.60	451.62	376.69	356.30
Roanoke Sound	482.35	320.35	310.79	331.44	295.90	488.09	323.68	349.53
Stump Sound	295.62	293.79	317.32	308.47	193.69	190.36	242.46	315.37
Bogue Sound	418.01	233.00	329.45	332.58	293.71	322.68	206.96	313.57
Pungo River	288.58	286.88	272.90	366.72	223.19	304.63	229.87	304.01
Topsail Sound	236.73	234.42	251.75	283.53	251.13	227.36	300.13	258.45
New River	236.32	181.17	184.52	200.37	215.97	213.92	238.49	245.54
White Oak River	304.50	229.12	274.25	145.83	150.91	187.75	211.72	213.21
Masonboro Sound	209.01	170.58	267.58	216.50	142.58	197.01	169.48	175.20
Inland Waterway**	176.87	153.23	146.86	174.91	136.28	139.78	142.50	169.14
Other***	224.65	211.66	220.99	212.45	132.76	125.73	138.76	235.16
Total	515.99	449.46	431.62	537.63	451.36	693.98	542.14	493.79

*Crab pots include both hard and peeler pots.

**Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).

***Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.22 Monthly trips with hard crab landings by year from single gear crab pot* trip tickets for North Carolina, 1994–2009.

	Year									
Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
January	75	339	65	315	350	594	653	86	232	147
February	478	130	224	500	595	1,032	520	627	235	102
March	3,146	3,000	813	3,628	2,714	1,828	3,333	1,615	1,401	1,492
April	7,611	6,592	4,092	5,676	5,549	5,304	4,080	4,287	4,476	3,724
May	13,096	14,871	14,204	12,764	12,330	11,972	10,533	13,121	10,459	9,390
June	17,921	17,531	19,183	16,535	18,900	18,416	15,545	16,062	13,346	12,956
July	17,306	19,138	18,059	18,636	20,164	18,506	15,566	15,867	13,975	14,956
August	15,831	16,234	17,373	17,274	15,732	14,843	15,102	15,398	12,789	14,944
September	11,249	11,516	11,655	11,811	14,148	8,686	10,636	9,806	8,797	8,260
October	7,168	8,852	8,053	8,372	9,909	8,271	6,905	6,241	6,170	6,638
November	4,616	3,391	3,590	3,401	4,768	4,467	3,037	2,954	2,861	3,145
December	2,074	729	1,270	1,003	2,417	2,120	701	1,360	567	1,185
Total	100,571	102,323	98,581	99,915	107,576	96,039	86,611	87,424	75,308	76,939

	Year							Percent
Month	2004	2005	2006	2007	2008	2009	Average	of total
January	285	234	312	354	213	350	288	0.37
February	112	111	402	130	498	310	375	0.48
March	2,025	601	1,274	1,579	1,365	1,776	1,974	2.55
April	4,601	2,320	2,420	2,037	1,986	3,649	4,275	5.52
May	11,404	5,320	6,574	5,123	5,888	6,787	10,240	13.22
June	13,127	12,030	8,372	8,272	7,661	8,759	14,039	18.12
July	12,936	11,439	8,261	8,308	8,018	8,275	14,338	18.51
August	10,005	9,051	7,130	7,372	6,531	7,667	12,705	16.40
September	7,402	5,386	4,785	5,358	4,936	6,331	8,798	11.36
October	4,903	4,076	2,877	4,230	3,740	4,251	6,291	8.12
November	2,022	1,906	1,512	1,590	2,101	2,257	2,976	3.84
December	753	728	794	661	1,135	1,189	1,168	1.51
Total	69,575	53,202	44,713	45,014	44,072	51,601	77,467	100.00

*Crab pots include both hard and peeler pots.

Table 7.1.23 Monthly hard crab CPUE (pounds/trip) by year from single gear crab pot* trip tickets for North Carolina,1994–2009.

	Year								
Month	1994	1995	1996	1997	1998	1999	2000	2001	2002
January	253.19	199.73	183.97	476.19	240.11	241.77	346.90	176.06	108.59
February	392.57	194.72	228.40	359.70	219.04	312.27	363.27	308.17	160.87
March	302.17	176.81	141.42	298.23	193.51	206.16	352.08	209.59	157.95
April	331.26	209.48	199.22	275.62	238.36	283.84	288.05	186.45	206.93
May	394.34	302.75	295.45	304.68	300.99	297.90	330.01	242.90	245.41
June	544.09	446.30	468.90	394.98	469.00	447.65	370.91	306.41	348.77
July	679.92	467.53	821.04	660.33	645.63	651.20	464.43	375.02	445.93
August	547.31	496.45	872.54	676.54	577.71	663.75	504.28	360.75	557.62
September	421.36	486.47	799.36	590.76	630.77	713.19	543.71	361.01	709.09
October	427.45	549.41	731.34	515.99	694.11	880.15	503.02	387.88	747.51
November	432.21	382.84	557.40	395.19	560.05	657.89	361.49	314.58	676.89
December	274.09	229.44	418.64	294.78	464.76	519.63	244.02	291.58	286.67
Total	491.12	422.86	628.00	503.69	523.72	557.86	431.54	323.10	461.36

	Year							
Month	2003	2004	2005	2006	2007	2008	2009	Total
January	242.25	524.64	265.80	387.79	350.26	282.03	284.92	303.06
February	264.33	268.36	149.36	293.13	208.89	330.10	244.71	295.59
March	287.20	407.55	211.24	324.80	343.44	268.59	354.83	273.73
April	209.17	306.77	164.77	273.73	222.59	225.47	291.47	251.60
May	255.19	415.69	216.02	426.35	311.17	325.79	442.63	316.56
June	341.19	514.67	454.06	536.40	481.69	531.26	494.88	441.06
July	469.09	465.25	479.91	461.19	497.60	714.77	379.01	556.49
August	572.41	415.64	403.86	587.46	420.66	884.72	594.87	574.63
September	657.16	480.34	505.39	759.68	515.04	963.59	767.94	604.10
October	1,077.49	543.34	617.51	862.13	605.08	1,187.92	957.17	682.38
November	873.47	364.16	557.53	656.81	515.79	1,019.89	730.97	553.64
December	603.68	299.52	435.00	407.69	329.49	622.85	411.56	402.09
Total	515.99	449.46	431.62	537.63	451.36	693.98	542.14	493.79

*Crab pots include both hard and peeler pots.

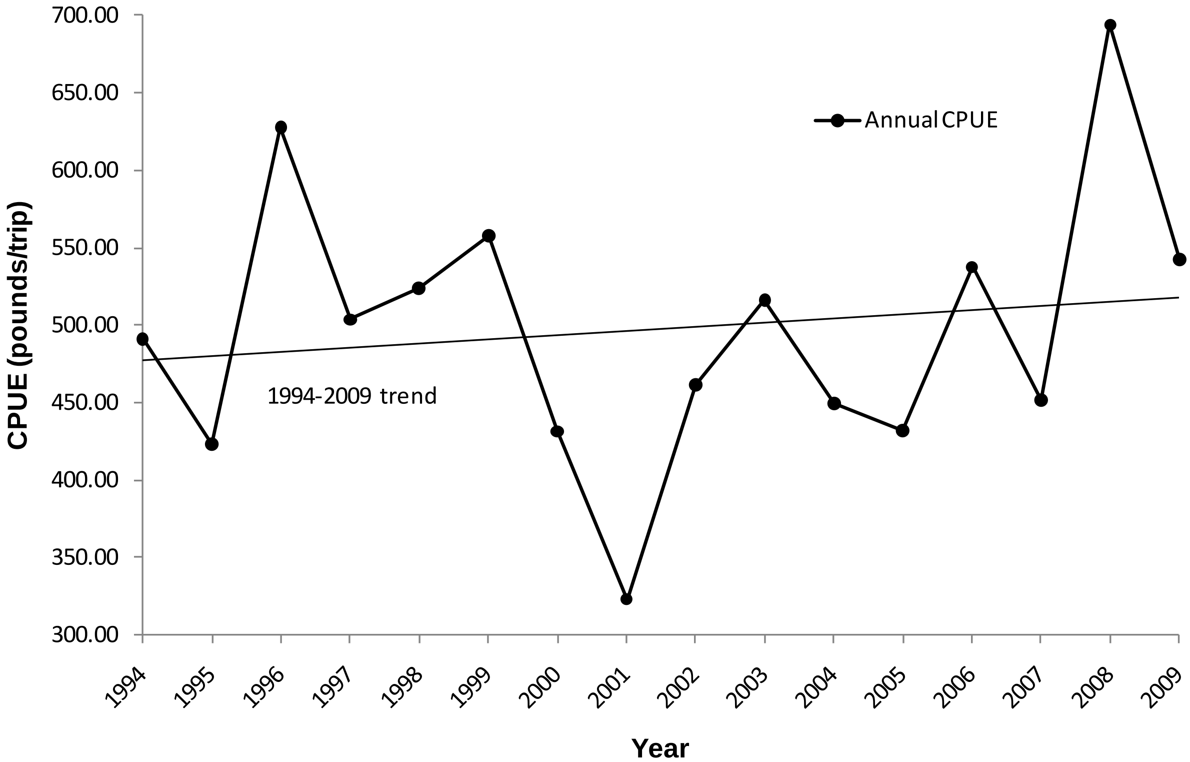

Figure 7.1.12 Trends in annual hard blue crab landings from single gear crab pot trips (pounds/trip) in North Carolina, 1994–2009.

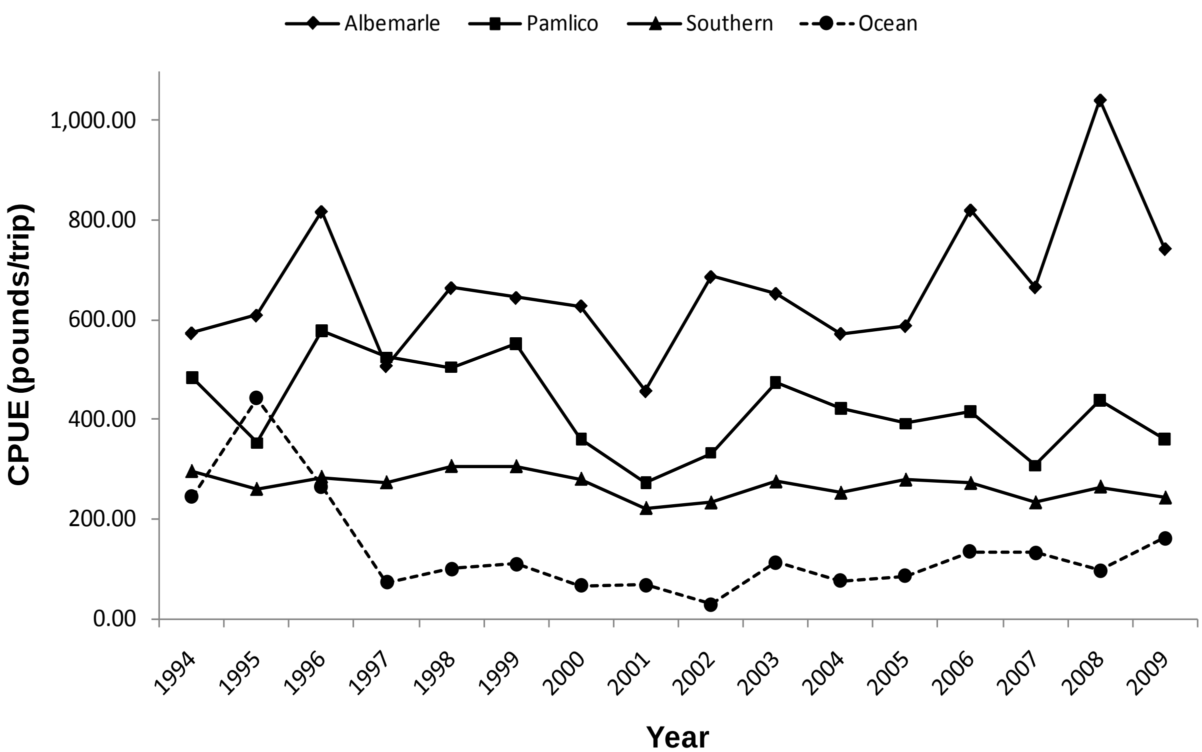

Figure 7.1.13 Annual hard crab CPUE (pounds/trip) from single gear crab pot trips for blue crab management regions in North Carolina, 1994–2009.

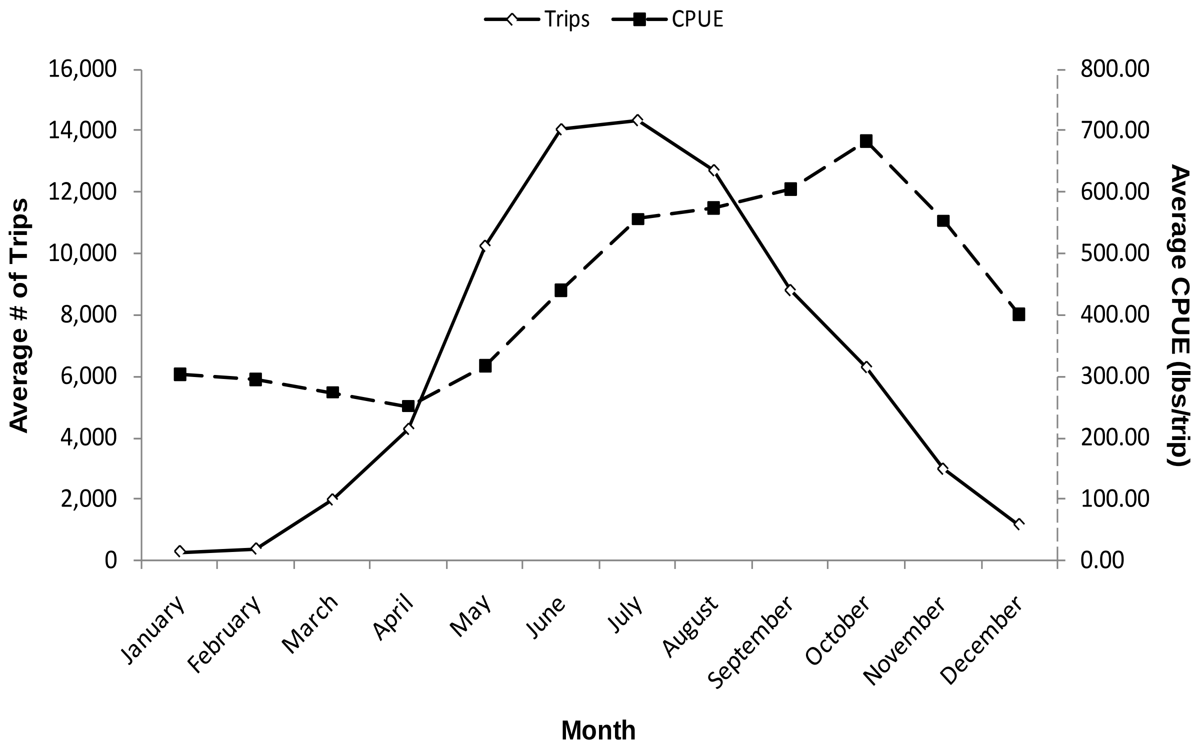

Figure 7.1.14 Monthly CPUE (pounds/trip), and trips from single gear crab pot trip tickets for North Carolina, 1994–2009.

In 1996, the TTP started to collect data on the number of pots fished during each trip. Data collected in 1996 were deemed unusable due to the large amount of null and erroneous entries. In 1997, 42% of the crab pot trips did not report any pot numbers, while in 2009 the number of non-reports was only 11%. Additionally, in 1997, only 67% of crab fishermen showed more than one value for pots fished on their trip tickets during the entire year, while in 2009, 89% of these fishermen showed more than one value suggesting more accurate estimates of pot numbers reported. Filtering out erroneous points is accomplished by using annual and monthly values collected in a fishery dependent sampling program (Program 436) that started in 1995. In this program, NCDMF employees intercept fishermen at the point of landing and collect data on the number of pots fished, soak time, landings by market grade, waterbody fished, size, and sex of crabs. Data collected in this fishery dependent program shows a significant correlation to trip ticket data, in terms of pounds per trip ($R=0.67$, $p=0.012$), and pounds per pot fished [$R=0.58$, $p=0.039$ (Figure 7.1.15)]. Based on data from the fishery dependent program, an upper (≥1,200 pots fished per trip) and lower limit (>10 pots fished per trip) were set for pots fished. This resulted in 2,285 trip ticket data points being omitted from the analysis. An upper limit of 15 pounds per pot was determined to be acceptable and resulted in an additional 4,443 samples being dropped from the data set. Table 7.1.24 shows the number of trip tickets with effort data (pots fished) and the number of filtered trips for each waterbody.

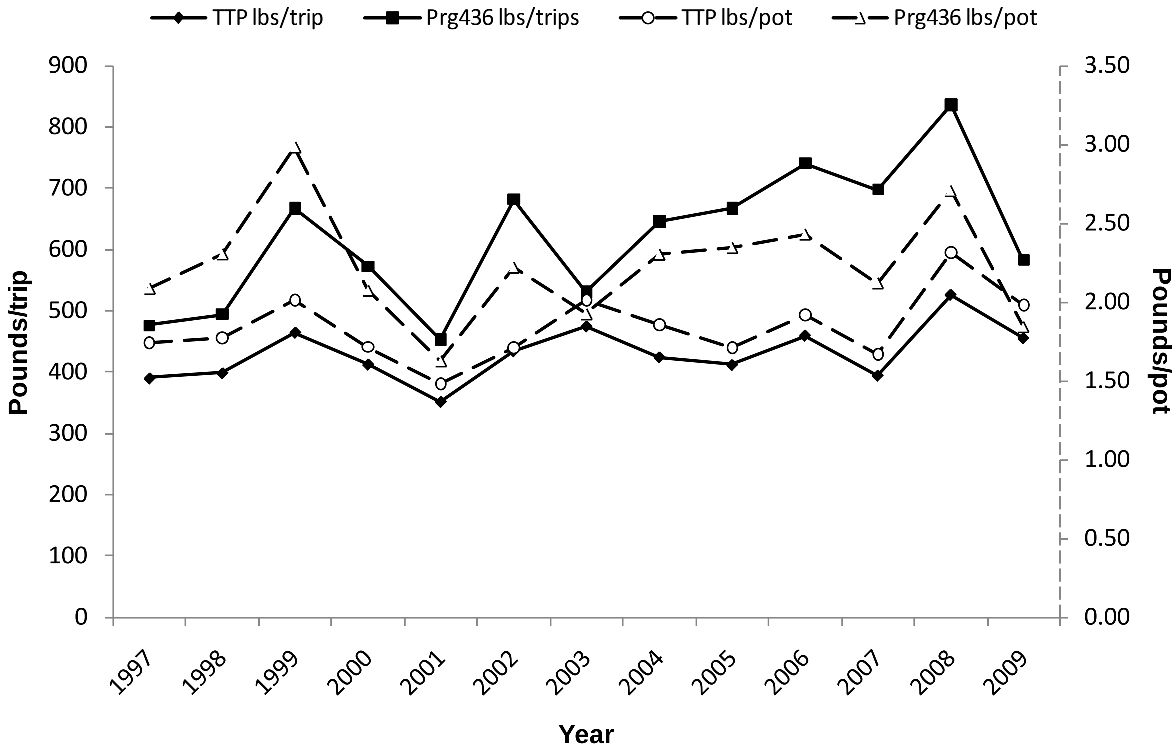

Figure 7.1.15 Comparisons of CPUE estimates for the North Carolina Blue Crab Pot Fishery: 1997–2009 (Prg436=Fishery Dependent Samples; TTP=Filtered Trip Ticket Data).

Table 7.1.24 Total trips with effort data and filtered trips by type for the crab pot fishery in North Carolina, 1997–2009.

Waterbody	Total crab pot trips with effort data	Filtered data: ≥1,200 pots fished	<10 pots fished	lbs/pot ≥15*	Total unusable	Percent of total trips	Total usable trips
Albemarle Sound	237,895	38	175	30	243	0.10%	237,652
Pamlico Sound	178,548	75	352	11	438	0.25%	178,110
Pamlico River	119,881	90	89	12	191	0.16%	119,690
Neuse River	63,238	39	40	7	86	0.14%	63,152
Pungo River	53,994	0	29	5	34	0.06%	53,960
Roanoke Sound	46,630	8	492	16	516	1.11%	46,114
Currituck Sound	45,149	0	45	17	62	0.14%	45,087
Croatan Sound	33,840	9	23	23	55	0.16%	33,785
Alligator River	21,802	3	23	11	37	0.17%	21,765
Bay River	20,704	8	37	2	47	0.23%	20,657
Cape Fear River	18,547	0	31	3	34	0.18%	18,513
Core Sound	18,314	8	14	20	42	0.23%	18,272
New River	11,540	0	109	4	113	0.98%	11,427
Inland Waterway	15,190	0	145	9	154	1.01%	15,036
Masonboro Sound	8,554	1	31	2	34	0.40%	8,520
Newport River	8,417	0	10	1	11	0.13%	8,406
Bogue Sound	6,036	0	26	0	26	0.43%	6,010
Topsail Sound	5,983	0	28	7	35	0.58%	5,948
White Oak River	5,194	2	109	2	113	2.18%	5,081
Stump Sound	4,260	0	1	9	10	0.23%	4,250
Shallotte River	3,267	0	8	1	9	0.28%	3,258
North River/Back Sound	2,329	0	20	1	21	0.90%	2,308
Lockwood Folly	1,604	0	44	6	50	3.12%	1,554
Pasquotank River	969	0	9	0	9	0.93%	960
Chowan River	368	0	3	0	3	0.82%	365
Ocean less than 3 miles	746	0	6	0	6	0.80%	740
Perquimans River	238	0	0	0	0	0.00%	238
Back Bay (VA)	23	0	0	0	0	0.00%	23
Ocean more than 3 miles	2	0	0	0	0	0.00%	2
Roanoke River	1	0	0	0	0	0.00%	1
Unknown	76	0	0	0	0	0.00%	76
Total	933,339	281	1,899	199	2,379	0.25%	930,960

Eight of the top 10 most productive waterbodies in terms of pounds/pots fished are located south of Core Sound in the Southern region (Table 7.1.25). Many of these same waterbodies have the lowest number of pots fished per trip (Table 7.1.26). When regional effort trends were examined, a similar pattern was exhibited; regions with high numbers of pots fished had a relatively lower CPUE (Tables 7.1.27 and 7.1.28). The highest monthly CPUEs (pounds/pot fished) occur from October through December (Table 7.1.29; Figure 7.1.16). On average, the monthly number of pots fished per trip increases steadily from January through July and declines from August through December (Table 7.1.30; Figure 7.1.16).

Table 7.1.25 Annual CPUE (pounds/pots fished) for filtered crab pot* data in top 20 reported waterbodies from North Carolina, 1997–2009.

	Year													
Waterbody	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Newport River	4.35	2.82	2.72	1.78	2.34	3.77	4.75	3.79	3.42	2.64	1.55	1.59	2.40	2.84
Masonboro Sound	3.11	2.91	2.33	2.56	1.95	1.97	2.27	2.32	2.76	2.63	2.33	2.62	2.48	2.43
Inland Waterway**	1.53	2.03	3.52	2.70	1.94	1.50	2.48	2.21	2.63	2.90	2.62	2.69	2.74	2.33
Stump Sound	2.53	2.90	2.65	2.32	2.13	2.12	2.32	2.25	2.46	1.88	1.76	1.56	2.70	2.30
Cape Fear River	3.21	3.32	2.53	2.31	1.75	2.22	1.81	2.09	2.28	2.24	2.18	2.56	2.08	2.26
Topsail Sound	2.89	3.11	2.19	1.74	1.92	1.87	1.69	1.60	1.75	2.95	3.32	3.02	2.95	2.25
Currituck Sound	2.13	2.04	1.64	1.53	1.31	1.93	1.82	1.87	1.51	1.98	2.01	2.50	2.28	1.90
Croatan Sound	1.86	1.96	2.39	1.48	1.45	1.57	2.45	1.91	1.77	1.72	1.41	1.75	1.61	1.81
Albemarle Sound	1.56	1.94	1.75	1.55	1.11	1.60	1.68	1.60	1.60	2.19	1.95	3.03	2.05	1.76
Pamlico Sound	2.29	2.39	2.03	1.43	1.11	1.25	1.93	1.68	1.35	1.66	1.32	2.07	1.91	1.76
Alligator River	1.61	1.59	1.87	1.41	1.17	1.86	1.60	1.58	1.64	1.34	1.87	2.86	2.37	1.72
Roanoke Sound	1.34	1.72	1.55	1.43	1.56	1.54	1.93	1.52	1.51	1.53	1.53	2.24	1.63	1.63
Core Sound	1.49	2.00	2.16	1.51	1.16	1.05	1.48	0.96	1.37	1.58	1.27	1.42	1.53	1.47
New River	1.06	1.65	1.71	1.76	1.49	1.15	1.45	1.06	1.02	1.11	1.30	1.13	1.39	1.34
Bogue Sound	1.16	1.26	1.59	1.43	1.29	1.25	1.54	1.14	1.36	1.30	1.24	1.15	1.12	1.29
Pamlico River	1.41	1.05	1.57	1.10	0.72	1.18	1.20	1.35	1.39	1.30	1.12	1.18	0.98	1.22
Pungo River	1.43	1.06	1.42	1.26	0.57	1.08	1.16	1.13	1.07	1.47	0.89	1.24	1.11	1.15
White Oak River	1.04	1.04	1.12	0.91	0.79	1.22	1.33	1.29	1.54	1.50	1.01	1.16	2.41	1.09
Neuse River	1.26	1.02	1.33	0.89	0.71	0.73	1.04	1.10	1.21	1.15	0.71	0.86	0.59	1.02
Bay River	1.79	1.15	0.98	0.88	0.54	0.99	0.92	0.85	0.72	0.77	0.69	1.10	0.77	1.02
Other***	1.79	2.18	1.09	1.28	1.47	1.33	1.82	1.58	1.92	1.93	1.88	1.30	1.05	1.58
Total	1.68	1.72	1.73	1.38	1.06	1.43	1.62	1.50	1.45	1.76	1.60	2.31	1.86	1.58

*Crab pots include both hard and peeler pots.
**Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
***Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.26 Number of pots fished per trip by year and top 20 reported waterbody from filtered crab pot* data in North Carolina, 1997–2009.

	Year													
Waterbody	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
Alligator River	355	322	320	394	365	416	453	330	365	348	395	427	400	376
Bay River	352	404	457	443	383	304	339	410	423	379	313	298	325	372
Neuse River	348	362	354	353	336	360	366	376	370	387	362	350	358	360
Albemarle Sound	314	328	334	364	375	383	369	348	373	362	326	334	345	350
Pamlico River	296	299	299	290	263	280	286	295	308	321	325	309	286	297
Core Sound	295	235	215	204	254	276	331	372	314	333	307	286	289	286
Currituck Sound	263	267	283	293	294	287	280	289	271	268	276	315	302	284
Pamlico Sound	264	263	299	260	280	284	310	290	274	229	215	249	247	266
Pungo River	244	238	265	253	261	264	245	250	251	246	239	235	203	246
Bogue Sound	321	282	259	282	202	181	269	194	247	255	242	271	183	245
Croatan Sound	219	222	224	203	221	242	247	215	200	207	207	231	221	220
Roanoke Sound	178	184	204	180	197	199	215	193	189	182	180	189	183	190
White Oak River	32	176	176	217	245	204	251	209	196	134	144	220	84	176
New River	228	228	213	193	131	144	165	158	174	174	159	163	134	174
Cape Fear River	109	121	138	164	184	171	184	190	172	168	170	176	185	164
Stump Sound	118	133	135	143	134	124	126	134	127	159	154	131	85	131
Newport River	150	143	141	135	105	81	124	129	128	121	112	114	111	123
Topsail Sound	112	99	104	116	114	110	140	144	142	94	76	71	87	108
Masonboro Sound	62	78	86	82	76	95	93	74	96	83	59	75	70	79
Inland Waterway**	95	66	56	65	76	101	72	70	55	59	52	52	51	67
Other***	158	138	163	96	116	154	124	138	110	107	70	99	132	123
Total	279	278	293	288	287	302	303	290	288	280	267	278	278	286

*Crab pots include both hard and peeler pots.
**Inland Waterway includes: Inland Waterway, Inland Waterway (Brunswick), and Inland Waterway (Onslow).
***Other category includes: Back Bay (VA), Chowan River, Lockwood Folly, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, and Unknown.

Table 7.1.27 Annual CPUE (pounds/pots fished) estimates from filtered crab pot* data by region in North Carolina, 1997–2009.

	Year													
Region**	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Ocean	N/R	***	***	***	***	***	2.23	1.88	1.48	2.69	2.85	***	2.98	2.40
Southern	2.12	2.19	2.15	1.91	1.61	1.78	1.93	1.78	1.99	1.99	1.92	2.03	2.05	1.94
Albemarle	1.64	1.92	1.74	1.53	1.14	1.65	1.69	1.64	1.60	2.14	1.95	2.93	2.11	1.77
Pamlico	1.67	1.62	1.70	1.23	0.95	1.15	1.54	1.39	1.30	1.41	1.13	1.54	1.35	1.41
Grand Total	1.68	1.72	1.73	1.38	1.06	1.43	1.62	1.50	1.45	1.76	1.60	2.31	1.86	1.58

Table 7.1.28 Number of pots fished per trip from filtered crab pot* data by region and year for North Carolina, 1997–2009.

	Year													
Region**	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Albemarle	307	317	325	357	364	371	364	337	359	348	322	335	340	344
Pamlico	280	281	298	274	272	278	292	293	288	276	260	261	248	280
Southern	146	137	134	139	135	134	145	143	137	134	118	129	116	135
Ocean	N/R	***	***	***	***	***	51	43	55	50	44	***	59	48
Total	279	278	293	288	287	302	303	290	288	280	267	278	278	287

*Crab pots include both hard and peeler pots.
**= See table 9 for region description; N/R=No landings reported

Table 7.1.29 Monthly CPUE (pounds/pots fished) estimates from filtered crab pot* data for North Carolina, 1997–2009.

	Year													
Month	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
January	1.89	1.29	1.54	1.81	1.20	0.80	1.28	2.26	1.66	2.58	2.52	2.01	1.80	1.82
February	1.77	1.32	1.52	1.75	1.52	1.05	2.18	1.65	1.43	1.81	2.21	2.06	1.77	1.63
March	1.10	0.90	0.91	1.47	0.94	0.69	1.25	1.54	1.08	1.54	1.56	1.21	1.59	1.25
April	0.95	0.88	0.99	1.07	0.77	0.78	0.75	1.02	0.65	1.02	0.89	0.88	1.11	0.91
May	1.07	1.05	0.92	1.10	0.88	0.81	0.86	1.46	1.11	1.34	1.13	1.14	1.52	1.08
June	1.30	1.48	1.23	1.16	0.99	1.04	1.02	1.65	1.46	1.58	1.68	1.72	1.70	1.33
July	1.94	1.96	1.82	1.36	1.12	1.33	1.42	1.49	1.47	1.49	1.67	2.23	1.30	1.58
August	1.99	1.79	2.05	1.47	1.10	1.70	1.75	1.37	1.28	1.88	1.43	2.84	1.89	1.69
September	1.92	1.95	2.35	1.64	1.15	2.15	2.19	1.54	1.65	2.45	1.72	3.10	2.40	1.94
October	1.93	2.43	3.07	1.75	1.31	2.43	3.44	1.79	2.01	3.05	2.14	4.07	3.12	2.44
November	1.76	2.29	2.60	1.58	1.30	2.52	3.07	1.54	2.18	2.98	2.30	3.97	2.68	2.35
December	1.29	2.13	2.19	1.34	1.29	1.52	2.50	1.65	2.20	2.31	2.06	3.00	1.96	2.06
Total	1.68	1.72	1.73	1.38	1.06	1.43	1.62	1.50	1.45	1.76	1.60	2.31	1.86	1.58

*Crab pots include both hard and peeler pots.

Table 7.1.30 Monthly number of pots fished per trip from filtered crab pot* data for North Carolina,1997–2009.

	Year													
Month	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
January	172	170	158	189	153	124	196	236	159	145	135	150	156	167
February	176	161	201	202	197	147	139	167	106	156	91	159	139	173
March	212	229	229	231	217	227	235	262	193	201	215	221	220	226
April	236	233	256	238	230	258	259	289	237	236	209	232	243	245
May	273	258	277	265	280	282	290	286	261	279	245	254	270	273
June	285	284	309	294	286	316	318	293	295	300	266	284	283	295
July	294	300	325	321	311	327	324	297	311	300	296	308	285	310
August	293	289	310	310	308	318	316	298	305	300	290	306	299	304
September	279	298	290	300	300	317	293	301	295	291	289	290	303	297
October	272	284	279	282	285	301	304	299	298	268	279	283	295	287
November	221	243	247	226	240	264	273	236	250	214	225	250	262	244
December	179	217	225	178	222	189	233	180	190	173	160	203	207	206
Total	279	278	293	288	287	302	303	290	288	280	267	278	278	287

*Crab pots include both hard and peeler pots.

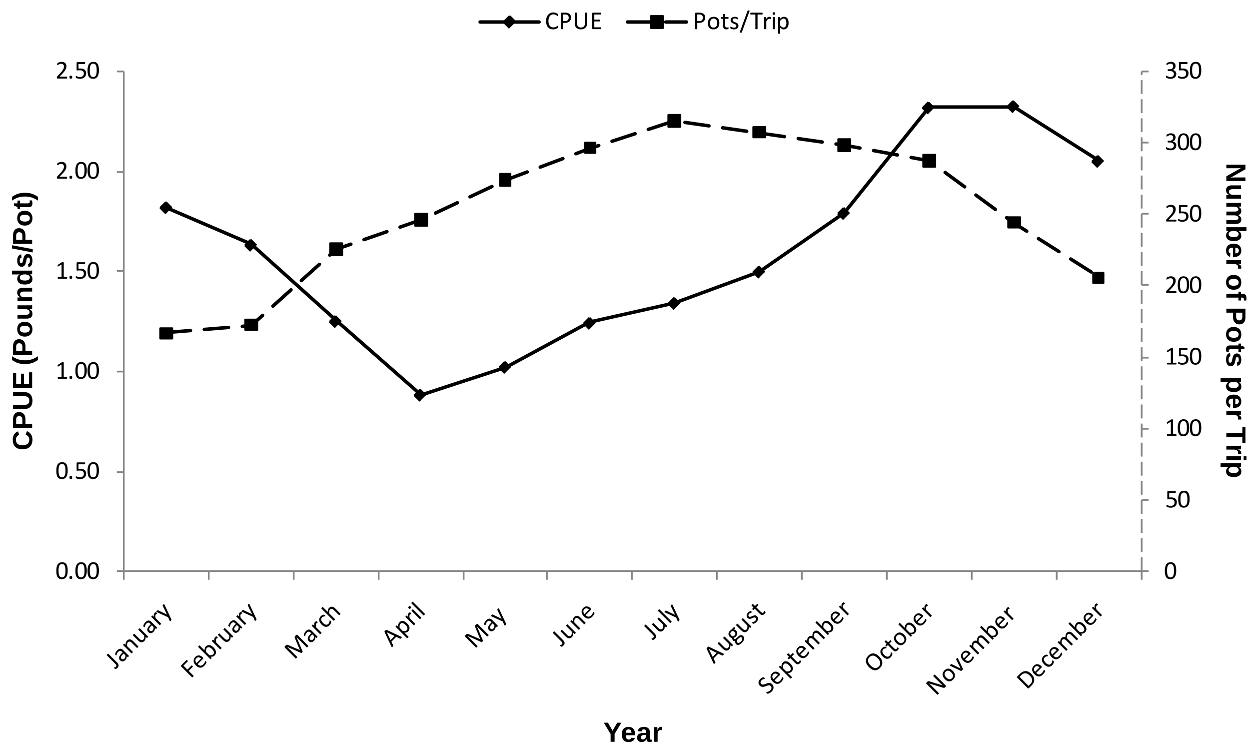

Figure 7.1.16 Monthly number of pots fished, and CPUE (pounds/pots fished) from filtered crab pot data for North Carolina, 1997–2009.

7.1.1.2 TRAWLS

Prior to 1964, blue crab landings in trawls were not separated by trawl type, so crabs caught as bycatch in other trawl fisheries were included in the total. From 1950 to 1963, the average landings of trawl-caught hard crabs were approximately 2.1 million pounds (Figure 7.1.17). In 1966, crab trawl landings of hard crabs reached their peak at around 7.6 million pounds while the total hard crab landings in all trawls didn't peak until 1968, however, crab trawls made up 85% of the total trawl landings that reported crabs that year (Figure 7.1.17). Crab trawl landings showed a smaller peak in 1981 but have been on an overall decline through 2009. Since 1994, the average contribution of this gear to the total hard crab landings in all gears has been 3% (Table 7.1.12).

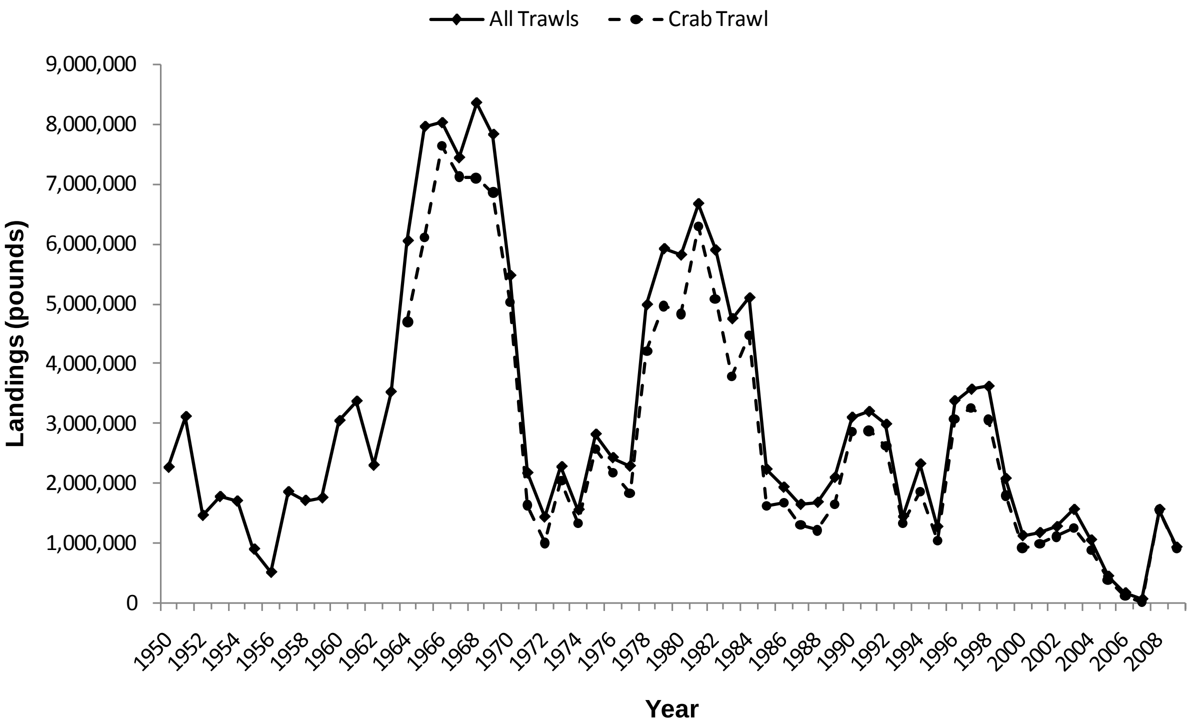

Figure 7.1.17 Hard crab landings from trawls for North Carolina, 1950–2009.

Hard crab landings from crab trawls have been reported in 15 waterbodies with average annual landings of 1.4 million pounds from 1994–2009 (Table 7.1.31). No trawling of any kind is allowed in Albemarle Sound, accordingly, hard crab landings from crab trawls are highest for the waterbodies in the Pamlico region with 97% of the total crab trawl landings from 1994–2009 (Table 7.1.31). Hard crab landings are reported from every month with 15% peaks in both March and November (Table 7.1.32). November and December have the highest CPUE (pounds/trip) for hard crabs; 1,935 and 2,149 pounds per trip respectively (Table 7.1.32).

Table 7.1.31 Hard crab landings (pounds), trips, and CPUE (pounds/trip) from single gear crab trawl trip tickets across years for North Carolina waters, 1994–2009.

Waterbody	Pounds	Average lbs	% of Total lbs	Trips	Average trips	% of Total Trips	Pounds/Trip
Pamlico Sound	11,947,956	746,747	53.67	8,330	521	25.08	1,434.33
Pamlico River	3,205,344	200,334	14.40	7,062	441	21.26	453.89
Pungo River	1,786,141	119,076	8.02	5,813	388	17.50	307.27
Neuse River	1,612,882	100,805	7.25	4,182	261	12.59	385.67
Croatan Sound	1,189,779	79,319	5.34	1,981	132	5.96	600.60
Bay River	1,118,755	86,058	5.03	1,804	139	5.43	620.15
Core Sound	961,237	64,082	4.32	2,448	163	7.37	392.66
New River	249,358	19,181	1.12	1,069	82	3.22	233.26
Roanoke Sound	145,575	10,398	0.65	340	24	1.02	428.16
North River/Back Sound	21,708	3,101	0.10	89	13	0.27	243.91
Newport River	11,043	1,578	0.05	48	7	0.14	230.06
Ocean less than 3 miles	4,260	1,065	0.02	21	5	0.06	202.86
Ocean more than 3 miles	2,490	1,245	0.01	6	3	0.02	415.00
Inland Waterway	1,952	488	0.01	12	3	0.04	162.67
Bogue Sound	1,888	378	0.01	12	2	0.04	157.33
Total	22,260,368	1,391,273	100.00	33,217	2,185	100.00	670.15

Table 7.1.32 Monthly hard crab landings (pounds), trips, and CPUE (pounds/trip) from single gear crab trawl trip tickets across years in North Carolina, 1994–2009.

Month	Pounds	Average lbs	% of Total lbs	Trips	Average trips	% of Total trips	Pounds/trip
January	532,338	35,489	2.39	627	42	1.89	849.02
February	1,149,084	71,818	5.16	1,567	98	4.72	733.30
March	3,404,902	212,806	15.30	4,810	301	14.48	707.88
April	2,460,889	153,806	11.06	5,274	330	15.88	466.61
May	1,448,830	90,552	6.51	5,337	334	16.07	271.47
June	2,062,416	137,494	9.26	4,616	308	13.90	446.80
July	1,512,307	108,022	6.79	2,260	161	6.80	669.16
August	1,138,061	94,838	5.11	1,985	165	5.98	573.33
September	1,313,168	93,798	5.90	2,051	147	6.17	640.26
October	1,049,913	74,994	4.72	1,638	117	4.93	640.97
November	3,349,115	209,320	15.05	1,731	108	5.21	1,934.79
December	2,839,346	189,290	12.76	1,321	88	3.98	2,149.39
Total	22,260,368	1,391,273	100.00	33,217	2,076	100.00	670.15

7.1.1.3 OTHER GEARS

Other gears with reported commercial hard crab landings are gill nets (float, sink, drift, and runaround), pound nets, trotlines, shrimp trawls, skimmer trawls, clam trawls, pots (eel, fish, conch), rakes, channel nets, fyke nets, seines, hand tongs, swipe net, dredges, flynets, dip nets, butterfly nets, rod-n-reel, and by hand (Table 7.1.12). Combined, these gears contribute less than 1% to the total hard crab harvest.

7.1.2 PEELER AND SOFT CRAB ("SHEDDER") FISHERY

Recent developments in the peeler/soft crab fishery, notably on-shore shedding systems and the peeler pot, have promoted steady growth in landings and value since the mid 1980's (Table 7.1.33). Peeler crabs account for 2% of the total crab landings (pounds) and 5% of the total value of all blue crab landings (Table 7.1.2). Peeler and soft crab landings are usually reported in numbers instead of pounds. The TTP conversion of numbers to pounds for peeler and soft crabs is 0.33 (i.e., three peeler/soft crabs equal one pound). Since 1994, annual landings of peeler crabs have averaged 802,136 pounds with an average dockside value of $1.6 million (Table 7.1.2). Soft crabs account for 1% of the landings and 7% of the value of all crabs landed. Annual landings of soft crabs have averaged 551,074 pounds and had a dockside value of $2.3 million since 1994 (Table 7.1.2). Landings can either be reported at the peeler or soft crab stage, which makes trends difficult to consider separately, so the two grades were combined into a single category (shedders) for the remainder of this section.

The Pamlico region accounts for 58% of the shedder landings and 56% of the value although Albemarle Sound contains the highest landings and dockside value for shedders among individual waterbodies with average annual landings around 394,000 pounds and a value of $1.3 million (Tables 7.1.9 and 7.1.34-7.1.37).

Traditionally, shedder landings peak in May with 56% of the catch occurring during this month (Table 7.1.38). From 1950 to 1993, shedder landings were significantly correlated ($R=0.56$, $P<0.02$) to hard crab landings. Since 1994, this relationship is not significant ($R=0.25$; $P<0.33$). The change in correlation from significant (pre 1993) to non-significant (post 1993) likely reflects changes in the fishery from a hard crab pot bycatch to a directed peeler pot fishery or possible changes in how landings were collected.

Table 7.1.33 Yearly shedder (peeler and soft blue crabs) landings* (pounds) and value for North Carolina,1950–2009.

Year	Landings	Value	Year	Landings	Value
1950	208,800	$24,753	1980	87,482	$132,448
1951	167,000	$24,906	1981	77,748	$100,860
1952	124,200	$18,630	1982	148,364	$296,838
1953	167,800	$33,560	1983	87,570	$188,223
1954	95,100	$14,265	1984	199,771	$276,302
1955	25,800	$5,170	1985	326,978	$350,373
1956	71,000	$14,200	1986	595,468	$684,822
1957	63,600	$15,900	1987	663,191	$2,263,437
1958	75,600	$21,415	1988	468,191	$921,403
1959	124,400	$37,320	1989	788,681	$1,567,298
1960	90,900	$31,815	1990	1,085,122	$2,136,942
1961	100,800	$35,280	1991	755,613	$1,389,140
1962	97,700	$34,200	1992	560,959	$996,904
1963	83,400	$37,530	1993	805,623	$1,515,569
1964	69,700	$32,924	1994	1,252,956	$2,703,672
1965	237,000	$85,133	1995	1,409,997	$3,185,481
1966	125,600	$56,342	1996	1,397,700	$3,168,881
1967	86,100	$36,972	1997	1,736,564	$4,520,166
1968	83,500	$31,354	1998	1,673,838	$4,492,762
1969	93,400	$42,224	1999	1,452,585	$4,286,119
1970	59,800	$23,246	2000	1,749,111	$5,283,359
1971	48,900	$25,414	2001	2,240,896	$7,152,340
1972	49,809	$29,186	2002	1,274,429	$3,799,182
1973	45,280	$27,762	2003	1,125,185	$4,203,416
1974	33,439	$23,130	2004	1,537,840	$4,217,510
1975	20,234	$16,996	2005	1,858,668	$4,899,198
1976	20,065	$26,549	2006	934,227	$2,940,804
1977	15,974	$17,000	2007	862,801	$3,322,458
1978	46,826	$89,718	2008	577,802	$2,126,155
1979	80,367	$129,908	2009	566,758	$2,389,616

*Peeler/soft crab landings are usually reported in numbers. The Trip Ticket Program conversion from #s to lbs for peeler/soft crabs is 0.33 (i.e., 3 peeler/soft crabs= 1 pound).

Table 7.1.34 Shedder (peeler and soft blue crabs combined) landings (pounds) by region* for North Carolina, 1994–2009.

	Year									
Region*	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pamlico	945,073	927,685	816,964	1,232,876	1,111,756	890,778	959,677	1,206,572	628,047	550,069
Albemarle	253,447	410,026	504,519	431,676	498,907	483,819	702,590	924,161	569,076	506,537
Southern	54,305	72,125	76,133	71,782	63,175	77,838	86,845	110,162	77,306	68,579
Ocean*	130	161	83	194	***	150	***	***	***	***
Unknown	N/R	N/R	N/R	36	N/R	N/R	N/R	N/R	N/R	N/R
Total	1,252,956	1,409,997	1,397,700	1,736,564	1,673,838	1,452,585	1,749,111	2,240,896	1,274,429	1,125,185

	Year								Percent
Region*	2004	2005	2006	2007	2008	2009	Total	Average	of total
Pamlico	851,651	1,012,012	468,302	441,589	285,633	188,994	12,517,679	782,355	57.81
Albemarle	615,642	776,240	405,209	376,434	248,336	331,079	8,037,699	502,356	37.12
Southern	70,547	70,415	60,716	44,778	43,834	46,685	1,095,226	68,452	5.06
Ocean	***	N/R	***	N/R	N/R	N/R	718	144	0.00
Unknown	N/R	N/R	N/R	N/R	N/R	N/R	36	36	0.00
Total	1,537,840	1,858,668	934,227	862,801	577,802	566,758	21,651,356	1,353,210	100.00

*= See table 9 for region description; N/R=No landings reported.
Ocean landings are confidential in years with ***; since most of the ocean landings occurred south of Hatteras, confidential landings have been lumped into the Southern Region.

Table 7.1.35 Shedder (peeler and soft blue crabs combined) landings value by region for North Carolina, 1994–2009.

Region*	Year									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pamlico	$1,964,487	$2,060,999	$1,841,679	$3,290,012	$2,995,651	$2,614,432	$2,786,382	$3,735,454	$1,799,609	$2,103,948
Albemarle	$622,515	$987,149	$1,180,599	$1,094,388	$1,365,937	$1,489,342	$2,323,157	$3,153,533	$1,833,657	$1,902,078
Southern	$116,371	$136,826	$146,529	$135,347	$131,172	$181,947	$173,820	$263,353	$165,915	$197,390
Ocean	$299	$507	$73	$351	***	$398	***	***	***	***
Unknown	N/R	N/R	N/R	$68	N/R	N/R	N/R	N/R	N/R	N/R
Total	$2,703,672	$3,185,481	$3,168,881	$4,520,166	$4,492,761	$4,286,119	$5,283,359	$7,152,340	$3,799,182	$4,203,416

Region*	Year						Total	Average	Percent of total
	2004	2005	2006	2007	2008	2009			
Pamlico	$2,274,910	$2,723,308	$1,462,302	$1,680,835	$1,060,740	$781,799	$35,176,549	$2,198,534	56.11
Albemarle	$1,809,396	$2,050,872	$1,338,629	$1,524,358	$950,047	$1,453,237	$25,078,894	$1,567,431	40.00
Southern	$133,204	$125,018	$139,873	$117,265	$115,367	$154,579	$2,433,978	$152,124	3.88
Ocean	***	N/R	***	N/R	N/R	N/R	$1,628	$326	0.00
Unknown	N/R	N/R	N/R	N/R	N/R	N/R	$68	$68	0.00
Total	$4,217,510	$4,899,198	$2,940,804	$3,322,457	$2,126,155	$2,389,616	$62,691,116	$3,918,195	100.00

*= See table 9 for region description; N/R=No landings reported.
Ocean landings are confidential in years with ***; since most of the ocean landings occurred south of Hatteras, confidential landings have been lumped into the Southern Region.

Table 7.1.36 Yearly shedder (peeler and soft blue crabs combined) landings (pounds) for top 15 reported waterbodies from North Carolina,1994–2009.

	Year									
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Albemarle Sound	200,993	337,744	392,199	344,755	356,870	394,275	605,423	765,101	431,933	326,337
Pamlico Sound	332,878	273,797	244,790	394,923	420,580	323,698	408,628	500,441	146,738	173,049
Roanoke Sound	235,636	231,981	189,268	358,469	317,515	239,480	293,540	377,060	275,082	239,175
Croatan Sound	202,019	293,300	192,898	296,498	184,527	146,048	118,911	213,271	115,240	42,425
Currituck Sound	40,170	55,409	68,699	69,194	119,261	49,659	48,996	111,532	89,280	128,600
Pamlico River	71,647	37,137	39,585	61,746	68,772	61,542	44,230	27,138	31,604	34,346
Neuse River	43,183	36,847	76,395	66,372	63,578	55,143	32,237	32,637	17,539	21,605
Core Sound	42,164	40,574	57,313	27,260	28,674	37,144	37,507	38,039	22,362	19,437
Alligator River	11,640	16,186	38,903	17,175	22,287	30,278	41,909	34,632	41,542	47,488
Newport River	20,075	19,973	24,506	20,182	14,801	23,892	21,566	28,390	18,972	13,626
Cape Fear River	13,660	14,169	15,526	17,293	20,857	17,559	21,266	30,091	22,704	14,330
Bay River	17,546	11,311	12,508	17,771	20,230	20,401	16,625	14,067	10,427	13,215
White Oak River	4,445	11,579	6,791	10,429	12,117	16,571	16,280	19,561	17,772	14,413
New River	4,845	9,579	3,041	7,875	3,292	5,048	6,973	13,124	7,280	10,637
Pungo River	N/C	2,737	4,206	9,838	7,880	7,323	7,998	3,919	9,055	6,817
Other*	12,054	17,673	31,070	16,785	12,597	24,525	27,020	31,893	16,901	19,685
Total	1,252,956	1,409,998	1,397,699	1,736,564	1,673,839	1,452,586	1,749,111	2,240,896	1,274,429	1,125,185

Table 7.1.36 (cont) Yearly shedder (peeler and soft blue crabs combined) landings (pounds) for top 15 reported waterbodies from North Carolina, 1994–2009.

	Year								Percent
Waterbody	2004	2005	2006	2007	2008	2009	Total	Average	of total
Albemarle Sound	498,546	600,467	337,632	314,877	180,903	210,238	6,298,294	393,643	29.09
Pamlico Sound	277,032	333,434	105,525	112,172	58,626	28,316	4,134,629	258,414	19.10
Roanoke Sound	224,833	278,113	155,562	144,347	89,087	60,558	3,709,706	231,857	17.13
Croatan Sound	241,380	288,420	82,530	101,694	71,247	40,586	2,630,995	164,437	12.15
Currituck Sound	97,241	150,884	46,252	48,368	57,891	107,292	1,288,727	80,545	5.95
Pamlico River	27,575	37,802	51,566	36,830	28,524	23,410	683,454	42,716	3.16
Neuse River	27,722	37,190	26,006	24,552	21,557	17,836	600,400	37,525	2.77
Core Sound	36,259	21,439	38,799	8,900	6,739	6,330	468,941	29,309	2.17
Alligator River	17,430	23,225	21,150	12,755	9,308	13,126	399,035	24,940	1.84
Newport River	14,839	14,779	16,542	8,874	13,316	10,228	284,563	17,785	1.31
Cape Fear River	19,241	17,907	13,000	12,565	11,578	16,926	278,671	17,417	1.29
Bay River	10,335	10,260	4,590	5,936	6,539	7,610	199,370	12,461	0.92
White Oak River	13,949	14,402	11,829	11,018	8,970	4,488	194,613	12,163	0.90
New River	7,593	9,275	5,258	4,952	4,507	6,029	109,308	6,832	0.50
Pungo River	6,515	5,354	3,724	7,158	3,314	4,348	90,184	6,012	0.42
Other*	17,350	15,716	14,262	7,802	5,697	9,437	280,467	17,529	1.30
Total	1,537,840	1,858,668	934,227	862,801	577,802	566,758	21,651,357	1,353,210	100.00

N/C=No landings data collected.
*Other category includes: Back Bay (VA), Bogue Sound, Chowan River, Inland Waterway, Inland Waterway (Brunswick), Inland Waterway (Onslow), Lockwood Folly, Masonboro Sound, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, Stump Sound, Topsail Sound, and Unknown.

Table 7.1.37 Yearly value of shedder (peeler and soft blue crabs combined) landings for top 15 reported waterbodies from North Carolina, 1994–2009.

	Year									
Waterbody	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Albemarle Sound	$526,488	$804,917	$971,103	$913,780	$1,024,921	$1,252,757	$2,087,976	$2,713,265	$1,505,799	$1,387,653
Roanoke Sound	$639,700	$545,932	$555,704	$1,234,064	$1,087,928	$886,070	$1,141,941	$1,436,440	$958,976	$1,134,695
Pamlico Sound	$557,109	$496,903	$509,871	$779,976	$1,009,435	$797,263	$956,067	$1,353,615	$320,511	$515,620
Croatan Sound	$499,046	$786,004	$465,719	$894,316	$494,382	$488,178	$390,232	$651,072	$315,153	$164,712
Currituck Sound	$80,214	$153,186	$139,932	$148,321	$289,911	$135,460	$138,268	$328,429	$228,735	$376,548
Neuse River	$77,683	$72,600	$151,351	$148,834	$149,809	$156,087	$79,110	$93,655	$45,993	$79,715
Pamlico River	$108,635	$67,091	$60,217	$130,728	$139,205	$141,440	$88,537	$65,386	$67,441	$93,568
Core Sound	$60,980	$71,970	$72,223	$51,282	$57,123	$80,994	$74,533	$90,316	$47,824	$54,099
Alligator River	$14,281	$27,501	$59,912	$30,904	$50,057	$78,890	$84,619	$81,690	$86,197	$127,075
Cape Fear River	$29,061	$30,336	$25,748	$30,962	$42,015	$40,100	$42,325	$72,331	$48,087	$40,374
Newport River	$49,099	$29,202	$37,307	$35,044	$29,378	$53,785	$42,021	$66,343	$38,701	$35,862
White Oak River	$5,708	$18,753	$14,761	$18,460	$24,056	$37,339	$31,744	$45,717	$36,710	$38,005
Bay River	$21,334	$16,495	$19,986	$31,472	$40,194	$46,119	$34,959	$32,982	$21,805	$34,965
New River	$14,336	$22,751	$10,002	$20,443	$10,322	$15,761	$15,687	$31,211	$17,547	$34,475
Pungo River	N/C	$4,004	$6,609	$19,340	$17,577	$18,280	$21,002	$11,987	$21,908	$26,574
Other*	$19,998	$37,837	$68,434	$32,241	$26,450	$57,594	$54,338	$77,899	$37,796	$59,474
Total	$2,703,672	$3,185,481	$3,168,880	$4,520,166	$4,492,761	$4,286,119	$5,283,359	$7,152,340	$3,799,182	$4,203,416

N/C=No landings data collected.
*Other category includes: Back Bay (VA), Bogue Sound, Chowan River, Inland Waterway, Inland Waterway (Brunswick), Inland Waterway (Onslow), Lockwood Folly, Masonboro Sound, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, Stump Sound, Topsail Sound, and Unknown.

Table 7.1.37 (cont) Yearly value of shedder (peeler and soft blue crabs combined) landings for top 15 reported waterbodies from North Carolina, 1994–2009.

	Year								Percent
Waterbody	2004	2005	2006	2007	2008	2009	Total	Average	of total
Albemarle Sound	$1,568,467	$1,716,453	$1,177,032	$1,345,269	$768,170	$1,067,089	$20,831,142	$1,301,946	33.23
Roanoke Sound	$904,326	$1,147,860	$647,632	$773,906	$427,696	$335,846	$13,858,718	$866,170	22.11
Pamlico Sound	$501,298	$578,189	$273,067	$343,412	$199,747	$97,797	$9,289,879	$580,617	14.82
Croatan Sound	$659,614	$774,981	$243,864	$346,355	$250,329	$156,771	$7,580,726	$473,795	12.09
Currituck Sound	$205,684	$283,814	$113,899	$146,094	$157,585	$343,615	$3,269,695	$204,356	5.22
Neuse River	$63,485	$96,594	$83,457	$74,888	$69,386	$63,215	$1,505,861	$94,116	2.40
Pamlico River	$48,682	$64,686	$111,742	$89,282	$71,795	$72,343	$1,420,777	$88,799	2.27
Core Sound	$66,093	$35,277	$84,029	$21,642	$16,989	$19,692	$905,065	$56,567	1.44
Alligator River	$30,545	$47,859	$47,242	$30,954	$23,497	$39,588	$860,811	$53,801	1.37
Cape Fear River	$38,551	$33,174	$31,054	$31,504	$29,715	$52,835	$618,174	$38,636	0.99
Newport River	$25,696	$24,044	$35,657	$21,151	$33,375	$30,955	$587,619	$36,726	0.94
White Oak River	$23,885	$23,479	$25,509	$26,418	$22,512	$13,534	$406,589	$25,412	0.65
Bay River	$18,439	$16,736	$9,893	$14,173	$16,389	$22,973	$398,915	$24,932	0.64
New River	$17,179	$20,460	$15,428	$19,676	$15,782	$28,723	$309,785	$19,362	0.49
Pungo River	$12,974	$8,986	$8,618	$17,178	$8,410	$13,163	$216,609	$14,441	0.35
Other*	$32,593	$26,607	$32,680	$20,556	$14,778	$31,478	$630,753	$39,422	1.01
Total	$4,217,510	$4,899,198	$2,940,804	$3,322,458	$2,126,155	$2,389,616	$62,691,117	$3,918,195	100.00

N/C=No landings data collected.

*Other category includes: Back Bay (VA), Bogue Sound, Chowan River, Inland Waterway, Inland Waterway (Brunswick), Inland Waterway (Onslow), Lockwood Folly, Masonboro Sound, North River/Back Sound, Ocean less than 3 miles, Ocean more than 3 miles, Pasquotank River, Perquimans River, Roanoke River, Shallotte River, Stump Sound, Topsail Sound, and Unknown.

Table 7.1.38 Monthly landings (pounds) of shedders (peeler and soft crabs combined) for North Carolina,1994–2009.

Month	Pounds	Average lbs	% of Total lbs
January	1,567	174	0.01
February	1,766	177	0.01
March	102,083	6,380	0.47
April	1,807,257	112,954	8.35
May	12,127,375	757,961	56.01
June	3,470,490	216,906	16.03
July	1,149,438	71,840	5.31
August	1,949,468	121,842	9.00
September	864,840	54,052	3.99
October	157,542	9,846	0.73
November	17,580	1,099	0.08
December	1,950	130	0.01
Total	21,651,357	1,353,210	100.00

7.1.2.1 POTS

Pots (hard crab and peeler) account for 98% of shedder landings (Table 7.1.39). The percent contribution of hard crab pots to total shedder landings was 98% in 1994 and 1995, while in 2009 this gear contributed 57% to the total. The peeler pot contribution to the shedder harvest has increased from 4% in 1996 (first year landings for this gear were collected) to 41% in 2009 (Table 7.1.39). Monthly shedder landings from pots follow overall trends with peak landings occurring in May and June (Table 7.1.40).

Table 7.1.39 Shedder (peeler and soft blue crabs combined) landings (pounds) from single gear trip tickets for North Carolina, 1994–2009.

	Year									
Gear	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Crab pot*	1,210,619	1,376,921	1,309,420	1,547,749	1,087,711	919,408	1,138,071	1,280,637	738,589	709,236
Peeler pot	N/R	N/R	57,897	131,175	533,811	460,241	509,325	866,662	485,142	367,160
Crab trawl	24,606	19,580	15,097	22,511	20,658	18,272	19,570	13,602	5,744	7,355
Shrimp trawl	4,283	3,416	6,624	12,433	3,192	5,101	11,304	1,538	3,781	4,720
Gill net set (sink)	463	978	2,574	6,883	4,640	6,516	8,817	7,015	5,359	7,948
Other**	720	4,645	1,528	2,279	3,544	494	863	3,233	1,217	2,891
Total	1,240,691	1,405,540	1,393,140	1,723,030	1,653,556	1,410,031	1,687,950	2,172,687	1,239,833	1,099,310

	Year								Percent
Gear	2004	2005	2006	2007	2008	2009	Total	Average	of total
Crab pot*	733,318	754,301	452,033	431,271	317,940	314,517	14,321,739	895,109	67.60
Peeler pot	761,087	1,047,564	435,777	379,250	235,308	226,589	6,496,990	464,071	30.67
Crab trawl	9,835	7,506	9,396	2,765	2,607	2,021	201,124	12,570	0.95
Shrimp trawl	1,482	987	400	123	268	514	60,165	3,760	0.28
Gill net set (sink)	1,993	2,449	2,762	4,548	6,697	3,662	73,304	4,581	0.35
Other**	3,793	1,802	2,784	1,343	1,828	142	33,107	2,069	0.16
Total	1,511,508	1,814,609	903,152	819,300	564,647	547,444	21,186,428	1,324,152	100.00

N/C=No landings data collected.
*Hard and peeler pot landings were combined in 1994 and 1995.
**Other category includes: Channel Net, Trotline, Pound Net, Hand Rakes, Gill Net Set (float), Skimmer Trawl, Fyke Net, Oyster Dredge, Hand Tongs, Bull Rakes, Haul Seine, By Hand, Eel Pot, Gill Net (runaround), Cast Net.

Table 7.1.40 Monthly contribution of pot caught shedder landings from single gear trip tickets in North Carolina, 1994–2009.

	Crab pot		Peeler pot		Total pots	
Month	Pounds	% of Total	Pounds	% of Total	Pounds	% of Total
January	783	0.01	726	0.01	1,509	0.01
February	1,588	0.01	0	0.00	1,588	0.01
March	18,697	0.13	3,067	0.05	21,764	0.10
April	1,156,525	8.08	547,607	8.43	1,704,132	8.19
May	7,003,344	48.90	4,787,889	73.69	11,791,233	56.64
June	2,663,528	18.60	691,678	10.65	3,355,205	16.12
July	1,024,749	7.16	74,440	1.15	1,099,189	5.28
August	1,582,267	11.05	272,616	4.20	1,854,883	8.91
September	715,493	5.00	104,662	1.61	820,155	3.94
October	137,868	0.96	12,861	0.20	150,729	0.72
November	15,823	0.11	572	0.01	16,395	0.08
December	1,074	0.01	870	0.01	1,944	0.01
Total	14,321,739	100.00	6,496,990	100.00	20,818,728	100.00

7.1.2.2 TRAWLS

Trawls (crab, shrimp, and skimmer) account for 1.3% of the landings. Although the peeler trawl is defined by regulation [15A NCAC 03L .0202 (c)], landings for this gear are lumped with crab trawl landings. Of the three trawl gears with reported landings, crab trawls account for 1% of the total peeler landings; shrimp trawls 0.3% and skimmers 0.07% (Table 7.1.39). An abrupt peak in shedder landings from crab trawls occurs in March followed by a slow, steady decline through the rest of the year (Table 7.1.41). For the shrimp trawls, a different pattern exists. A slow increase is observed until an abrupt decline in landings of shedders after August (Table 7.1.41). Finally, skimmer trawls almost exclusively harvest shedders in March and April (Table 7.1.41).

Table 7.1.41 Monthly contribution of trawl caught shedder landings from single gear trip tickets in North Carolina, 1994–2009.

	Crab trawl		Shrimp trawl		Skimmer trawl		Total trawls	
Month	Pounds	% of Total	Pounds	% of Total	Pounds	% of Total	Pounds	% of Total
January	0	0.00	***	***	0	0.00	***	***
February	***	***	***	***	0	0.00	***	***
March	68,600	34.11	367	0.61	9,907	70.67	78,873	28.65
April	43,129	21.44	1,101	1.83	3,736	26.65	47,966	17.42
May	35,286	17.54	2,396	3.98	163	1.16	37,845	13.75
June	28,625	14.23	6,016	10.00	***	***	***	***
July	8,236	4.09	17,155	28.51	32	0.23	25,423	9.23
August	11,793	5.86	27,176	45.17	63	0.45	39,032	14.18
September	4,229	2.10	5,077	8.44	38	0.27	9,344	3.39
October	361	0.18	749	1.24	52	0.37	1,163	0.42
November	***	***	94	0.16	***	***	804	0.29
December	0	0.00	***	***	0	0.00	***	***
Total	201,124	100.00	60,165	100.0 0.00	14,018	100.0 0.00	275,307	100.0 0.00

***Landings were confidential and don't largely impact the total landings by gear. Totals include confidential landings.

7.1.2.3 POUND NETS

Peeler pound nets can be permitted under the general pound net rules [15A NCAC 03J .0502 (c)]. While more commonly used in the Chesapeake Bay, very few peeler pound sets have been tried with limited success in North Carolina, principally along the northern Outer Banks and in Albemarle and Currituck sounds. The TTP only records landings at the general pound net level, so it is not possible to distinguish which type of pound net (peeler, flounder, etc.) the peelers were caught.

7.1.2.4 OTHER GEARS

Shedder landings have been reported from 15 other gears whose combined landings are less than 0.5% of the total (Table 7.1.39).

7.2 RECREATIONAL FISHERY

Blue crabs are harvested recreationally by a variety of means. These can include crab pots (rigid and collapsible), gill nets, shrimp trawls, trot-lines, hand-lines, and dip nets. Prior to July 1999, no license was required to harvest blue crabs recreationally unless a vessel was used. As of July 1, 1999, anyone wishing to harvest blue crabs recreationally with commercial gear is required to purchase a Recreational Commercial Gear License (RCGL). Harvest methods exempt from this license are collapsible crab traps, cast nets, dip nets, hand-lines, and seines (less than 30 feet). Additionally, one pot per person may be attached to the shore along privately owned land or to a privately owned pier without possessing a valid RCGL. The bag limit on recreationally caught crabs is 50 per person per day, not to exceed 100 crabs per vessel.

Numerous recreational fishermen possessing a Coastal Recreational Fishing License (CRFL) as well as many coastal waterfront landowners target blue crabs recreationally. In a study conducted in 2002, it was estimated that nearly 30% of coastal waterfront landowners harvest blue crabs from their property and 7% harvest blue crabs away from their property. This accounted for an estimated harvest of 279,434 pounds of blue crab (Vogelsong et al. 2003). From 2007 to 2010, NCDMF surveyed approximately 20% of CRFL holders on their participation in saltwater fishing activities including gigging, use of a cast net, shellfish collection, and crabbing. The results of the survey for crabbing participants extrapolated across all CRFL holders are shown in Table 7.2.1. While data are available for the number of CRFL holders participating in the recreational blue crab fishery, there are no current data on the harvest of blue crabs by these participants.

Table 7.2.1 Estimated participants and margin of errors for Coastal Recreational Fishing License (CRFL) holders participating in blue crab fishing activities, 2007-2010 (NCDMF CRFL Program).

Year	Estimated participants	Margin of error (%)
2007	84,693	0.147
2008	71,604	0.148
2009	75,424	0.148
2010	74,225	0.145

A survey of RCGL holders conducted in 2008 by the NCDMF indicated that blue crabs were the most abundant species landed (by weight) by RCGL participants, accounting for 23% (110,234 pounds) of the total poundage (482,082 pounds) landed (Table 7.2.2). Of these landings, 92.6% were caught using crab pots, 2.7% using small mesh gill nets, 2.0% using shrimp trawls, 1.7% using large mesh gill nets, and 1.0% using fish pots. The peak months for recreational blue crab harvest were June (18%), July (21%), August (17%), and September (14%). RCGL holders using crab pots used an average of 4 pots per license.

Estimated RCGL effort and harvest data for blue crabs from 2002 to 2008 are presented in Table 7.2.2. From 2002 to 2006, blue crabs yielded the second highest landings by species, exceeded only by spot. In 2007 and 2008, blue crabs became the predominant species landed by RCGL holders. During all survey years, blue crabs accounted for the most directed fishing trips. While the number of trips taken fluctuated from year to year, there was a decreasing trend in effort. The number of blue crabs harvested also saw a decreasing trend through most of the time series with an uptick in landings in 2008. Each year, blue crab harvest from RCGL holders was considerably less than the blue crab commercial harvest (less than 1%). The harvest of exempted shore and pier based pots, as well as other non-commercial gear, is unknown. While current data is not available, NCDMF has recently started a new program to survey and estimate recreational blue crab landings from RCGL exempt gear.

Table 7.2.2 Estimates of blue crab directed trips, harvest (number and pounds), and discards for North Carolina Recreational Commercial Gear License (RCGL) holders, 2002- 2008 (NCDMF CRFL Program).

		Directed crab trips			Crab harvest			
Year	Total RCGL trips	Number of trips with crabs	Percent of total trips	Total RCGL pounds harvested	Pounds	Percent of total pounds	Number of crabs harvested	Number of crabs discarded
2002	80,159	28,324	35%	1,030,897	134,171	13%	346,550	185,939
2003	55,787	27,907	50%	517,532	157,942	31%	354,425	124,196
2004	53,488	28,021	52%	640,636	117,590	18%	329,478	138,316
2005	47,120	26,278	56%	517,532	105,179	20%	323,531	152,905
2006	43,384	24,401	56%	488,373	94,459	19%	297,875	123,787
2007	41,617	25,153	60%	433,152	98,003	23%	286,856	102,695
2008	40,556	24,732	61%	482,082	110,234	23%	311,690	132,519
Average	51,730	26,402	51%	587,172	116,797	20%	321,486	137,194

8.0 PROTECTED SPECIES

Protected species is a broad term that encompasses a host of species that are identified by federal or state protective statutes. The federal protective authorities are paramount and the dominant ones are the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and Migratory Bird Treaty Act. Protected species in FMPs are generally discussed in their relationship to fisheries being prosecuted for the FMP species and specifically whether these fisheries have an incidental take of protected species. The protected species discussion herein intends to identify the principle fisheries, describe the various federal and state laws that deal with protected species, and discuss the ongoing management programs and implications of protected species interactions in blue crab fisheries.

8.1 PROTECTED SPECIES LEGISLATION

8.1.1 FEDERAL ENDANGERED SPECIES ACT (ESA)

The Endangered Species Act (ESA) was enacted in 1973, "to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, (and) to provide a program for the conservation of such endangered species and threatened species." The ESA is a comprehensive act with eighteen sections that cover many aspects of endangered species protection and management (STAC 2006).

The ESA defines a species as threatened when it is likely to become an endangered species within the foreseeable future. An endangered species is defined as any species which is in danger of extinction throughout all or a significant part of its range. A take is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (STAC 2006). Candidate species are species that appear to warrant consideration for addition to the federal ESA list. They are sometimes referred to as "species of special concern". These species receive no substantive or procedural protection under the ESA.

Section 10 of the ESA provides for exceptions to the take prohibitions in the form of permits. These permits can be for either an intentional take or for an incidental take. Intentional take permits are intended for scientific purposes or to enhance the propagation or survival of the affected species. Incidental take permits (ITP) are for activities that are otherwise lawful but are expected to incidentally take a listed species. Permit holders must develop and implement conservation plans that reduce and minimize the impacts of the take. When a Section 10 permit application is reviewed and deemed appropriate, a permit is granted to authorize a specified level of takes. Along with the specified take that is authorized, the permit includes reporting requirements, and often includes other conditions that must be met (tagging, handling guidelines, data analyses, conservation plans, etc.).

Section 7 of the ESA relates to interagency cooperation amongst federal agencies. There are two primary provisions to this section: 1) all federal agencies shall utilize their authorities towards the furtherance of the goals of the ESA; 2) and each federal agency must consult with the Secretary [in practice NMFS or U.S. Fish and Wildlife Service (USFWS)] to insure that any action funded, authorized, or carried out by the agency is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of its critical habitat. Although this section relates to federal agency cooperation, it can impact state projects through a federal nexus. If a project has federal authorization, funding, or other participation, it is subject to Section 7 consultation between the federal agency and NMFS. NCDMF has received biological opinions and incidental take statements in regards to Section 7 consultations on several federally funded division research projects.

Most of the species listed as endangered or threatened fall under federal jurisdiction either with the NMFS or the USFWS. The following is a list of endangered (E), threatened (T), or federal species of concern (FSC) species that may occur in estuarine and ocean waters of North Carolina (NCDMF 2005):

Fish

Smalltooth sawfish (*Pristis pectinata*) E
Shortnose sturgeon (*Acipenser brevirostrum*) E

Reptiles

Green sea turtle (*Chelonia mydas*) T
Kemp's ridley sea turtle (*Lepidochelys kempii*) E
Hawksbill sea turtle (*Eretmochelys imbricate*) E
Leatherback sea turtle (*Dermochelys coriacea*) E
Loggerhead sea turtle (*Caretta caretta*) T (under review)
Northern diamondback terrapin (*Malaclemys terrapin terrapin*) FSC in Dare, Pamlico, and Carteret counties in North Carolina

Mammals

West Indian manatee (*Trichechus manatus)* E

Fin whale (*Balaenoptera physalus*) E
Humpback whale (*Megaptera novaeangliae*) E
North Atlantic right whale (*Eubalaena glacialis*) E
Sperm whale (*Physeter catodon*) E
Sei whale (*Balaenoptera borealis*) E

Only federally endangered or threatened species are protected by federal law.

8.1.2 MARINE MAMMAL PROTECTION ACT (MMPA)

The Marine Mammal Protection Act of 1972 was enacted in response to increasing concerns by scientists and the public that significant declines in some species of marine mammals were caused by human activities. It established a national policy to prevent marine mammal species and population stocks from declining to a point where they ceased to be significant functioning elements of the ecosystem.

The Department of Commerce through the NMFS is charged with protecting whales, dolphins, porpoises, seals, and sea lions. Walruses, manatees, otters, and polar bears are protected by the Department of the Interior through the USFWS. The MMPA established a moratorium on the taking of marine mammals in U.S. waters. It defines "take" to mean "to hunt, harass, capture, or kill" any marine mammal or attempt to do so. Exceptions to the moratorium can be made through permitting actions for take incidental to commercial fishing and other nonfishing activities, for scientific research, and for public display at licensed institutions such as aquaria and science centers.

The MMPA requires NMFS to categorize each commercial fishery into one of three categories based upon the level of serious injury and mortality to marine mammals that occurs incidental to each fishery. Category I fisheries pose the greatest threat and Category III fisheries the least threat. The category in which a fishery is placed determines whether fishermen are subject to certain provisions of the MMPA, such as registration, observer coverage and take reduction plan requirements. According to the 2011 List of Fisheries created by NOAA, the Atlantic blue crab trap/pot fishery is considered to be in Category II (occasional mortality or serious injury) due to interactions with the bottlenose dolphin (Federal Register 2010).

8.1.3 NORTH CAROLINA ENDANGERED SPECIES ACT (CHAPTER 113 ARTICLE 25)

Listing of protected species from a state perspective lies with the WRC (NC General Statutes - Chapter 113 Article 25). The WRC compiled state lists of animals deserving protection over 20 years ago based on guidance from Scientific Councils on mammals, birds, reptiles, amphibians, freshwater fishes, mollusks, and crustaceans. Endangered, Threatened, and Special Concern species of mammals, birds, reptiles, amphibians, freshwater fishes, freshwater and terrestrial mollusks, and crustaceans are protected by state law. Protection for crustaceans and certain venomous snakes was enacted in 2002. However, state law does not allow for protection of invertebrate groups other than mollusks and crustaceans.

Under the state Endangered Species Act the WRC has the following powers and duties:
1. To adopt and publish an endangered species list, a threatened species list, and a list of species of special concern, as provided for in G.S. 113-334, identifying each entry by its scientific and common name.
2. To reconsider and revise the lists from time to time in response to public proposals or as the Commission deems necessary.
3. To coordinate development and implementation of conservation programs and plans for endangered and threatened species of wild animals and for species of special concern.
4. To adopt and implement conservation programs for endangered, threatened, and special concern species and to limit, regulate, or prevent the taking, collection, or sale of protected animals.
5. To conduct investigations to determine whether a wild animal should be on a protected animal list and to determine the requirements for conservation of protected wild animal species.
6. To adopt and implement rules to limit, regulate, or prohibit the taking, possession, collection, transportation, purchase or sale of those species of wild animals in the classes Amphibia and Reptilia that do not meet the criteria for listing pursuant to G.S. 113-334 if the Commission determines that the species requires conservation measures in order to prevent the addition of the species to the protected animal lists pursuant to G.S. 113-334. This subdivision does not authorize the Commission to prohibit the taking of any species of the classes Amphibia and Reptilia solely to protect persons, property, or habitat; to prohibit possession by any person of four or fewer individual reptiles; or to prohibit possession by any person of 24 or fewer individual amphibians.

The WRC develops conservation plans for the recovery of protected wild animal species, using the procedures set out in Article 2A of Chapter 150B of the General Statutes. The North Carolina Natural Heritage Program inventories, catalogues, and supports conservation of the rarest and the most outstanding elements of the natural diversity of our state. These elements of natural diversity include those plants and animals which are so rare or the natural communities which are so significant that they merit special consideration as land-use decisions are made.

Species that appear on the 2010 Natural Heritage Program List of the Rare Animal Species of North Carolina that may interact with crab pots include the loggerhead sea turtle (T), leatherback sea turtle (E), hawksbill sea turtle (E), Kemp's Ridley sea turtle (E), Green sea turtle (T), and diamondback terrapin (SC).

8.2 SPECIES THAT MAY INTERACT WITH THE BLUE CRAB FISHERY

Of the federal and state protected species listed above, only the sea turtles, whales, bottlenose dolphins, and diamondback terrapins interact with the blue crab fishery. Crab pots are the predominant gear in the blue crab fishery, with crab trawls and crab dredges making up a small percentage of the gear utilized in this fishery. Crab pots are a passive gear and are baited, which may attract protected species that can get entangled in the buoy lines or captured in the pots. Although crab trawls are an active gear that focus on the estuarine bottom, and are restricted to areas without submerged aquatic vegetation, interactions with protected species are plausible. Crab dredges are restricted to a small, specific area of the northern Pamlico Sound and focus on digging crabs out of a mud bottom, and therefore are less likely to interact with protected species than the other two gears mentioned.

8.2.1 WHALES

Whales are cetaceans, a group which also includes dolphins and porpoises. They are relatively large marine mammals, generally characterized by streamlined bodies that glide easily through the marine environment. Approximately 78 species of whales, dolphins, and porpoises are included in the Order *Cetacea*. Cetaceans are broken into two Suborders, or main groups: *Mysticeti* (baleen whales) and *Odontoceti* (toothed whales). North Carolina has two species of baleen whales that traverse the state during their annual migration. These are the North Atlantic right whale and the humpback whale, both of which are protected under the MMPA and both have been designated endangered and depleted. They are further protected under the ESA.

Both whale species calve in the winter off the coast of Georgia and Florida and summer in the western North Atlantic and thus, have similar migration patterns as they traverse the North Carolina coast heading south to warmer waters in late fall. They remain in the warmer waters until late winter and then return to waters off the northern Atlantic. It is during this traversing of North Carolina's coastal waters that interactions can occur with ocean potting operations.

Almost all species of baleen whales were exploited by the commercial whaling industry from the 1700s to the mid-1900s; most populations have not yet recovered. Currently, ship strikes pose a threat to many baleen whales, particularly the critically endangered North Atlantic whale. Additionally, entanglement in various types of fishing gear is a primary threat to several species of cetaceans. The humpback is one of the most abundant whale species off the North Carolina coast and thereby, one of the most often affected in entanglements in this state.

From 1997 through 2009, seven humpback whale entanglements were observed in the waters from Virginia Beach, VA to Cape Fear, NC in gear from North Carolina or Virginia fisheries. Of the seven incidents, six were from gill nets and one was a hook and line incident. All of these entanglements that could be related to gill nets occurred prior to the regulations for "weak links" in vertical lines, in ground tackle, and on the top lines of gill nets. There were no fin, minke, or right whale entanglements at all off North Carolina waters. Of the North Atlantic right whale interactions that have occurred from 1997 through 2009 off the northeast coast of the US, there was no crab gear found that could be identified from North Carolina waters (Red Munden, personal communication, April 2011).

The NMFS established the Atlantic Large Whale Take Reduction Team (ALWTRT) to develop a plan to reduce the incidental serious injury and mortality of right, humpback, fin, and minke whales in the South Atlantic shark gill net fishery, the Gulf of Maine and Mid-Atlantic trap/pot fishery, (which included the North Carolina crab fishery), the Mid-Atlantic gill net fishery, and the Gulf of Maine sink gill net fishery. With the help of the ALWTRT, NMFS developed the Atlantic Large Whale Take Reduction Plan (ALWTRP) in 1997 to reduce the level of serious injury and mortality of three strategic stocks of large whales (North Atlantic right, humpback, and fin) in commercial gill net and trap/pot fisheries. The measures identified in the ALWTRP were also intended to benefit minke whales, which are not designated as a strategic stock, but are known to be taken incidentally in gill net and trap/pot fisheries. In general, the ALWTRP consists of a combination of regulatory and non-regulatory programs, including broad gear modifications, time-area closures, expanded disentanglement efforts, extensive outreach efforts in key areas, gear research, and an expanded right whale surveillance program to supplement the Mandatory Ship Reporting System. A representative from the North Carolina NCDMF and commercial fishermen from the southern region of NC and Cape Hatteras served on the ALWTRT and subsequently helped in the development of the plan. NMFS published a final rule implementing the ALWTRP on February 16, 1999, with an April 1, 1999, effective date. NMFS makes active use of the ALWTRT to review progress on reaching the goals of the ALWTRP and to make recommendations on how to continue to decrease serious injuries and mortalities due to entanglements. The plan created various gear modifications required by North Carolina fishermen setting pots in nearshore coastal waters (inside the 100-foot contour) like break-away lines, or “weak links”. Weak links in this nearshore area off North Carolina must have a breaking strength of no greater than 600 lb, while beyond the 100-foot contour to the eastern edge of the Exclusive Economic Zone (EEZ), a breaking strength of no greater than 1,500 lb is required (NOAA 2010).

8.2.2 BOTTLENOSE DOLPHIN

The bottlenose dolphin (*Tursiops truncatus*) inhabits temperate and tropical waters throughout the world. According to the 2009 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment (Waring 2009) nine bottlenose dolphin stocks have been identified in the nearshore waters of the Western North Atlantic. Two of these stocks are found in North Carolina estuaries and are identified as the Northern North Carolina Estuarine System Stock and the Southern North Carolina Estuarine System Stock. Bottlenose dolphins have been observed throughout the year in North Carolina estuarine waters but will migrate offshore when water temperatures fall below 10^{o} C.

Bottlenose dolphins are occasionally captured or entangled in various kinds of fishing gear including gill nets, seines, long-lines, shrimp trawls, and crab pot lines. Between 1994 and 1998, 22 bottlenose dolphin carcasses that displayed evidence of possible interaction with a trap/pot fishery (i.e., rope and/or pots attached, or rope marks) were recovered by the Stranding Network between North Carolina and Florida’s Atlantic coast (NMFS 2002). At least 5 other dolphins were reported to be released alive (condition unknown) from blue crab trap/pot lines during this time period. From 2004 through 2008, 13 reports of interactions between bottlenose dolphins and blue crab pot gear were confirmed, with the majority of these occurring in waters from Florida to South Carolina. In addition, there were 4 interactions documented with pot gear where the fishery could not be confirmed. In these cases, the gear was confirmed to be associated with a pot or trap, but may have been from a fishery other than blue crab (e.g., whelk

fisheries in Virginia). None of these confirmed mortalities could be assigned to the Northern Migratory stock (Barbie Byrd, personal communication, January 2011).
In North Carolina, there were 3 documented bottlenose dolphin interactions with blue crab pot fishery between Jan. 1997 and April 2009: 1) July 1999, area between Albemarle and Currituck sounds, live release-animal condition unknown, 2) July 2000, Roanoke Sound, animal died in gear, and 3) August 2004, Roanoke Sound, animal died in gear(Barbie Byrd, personal communication, January 2011).

A marine mammal species is designated as depleted if it falls below its optimum sustainable population. The MMPA requires that a Take Reduction Team (TRT) be convened for the purpose of recommending measures for inclusion in a TRP to promote recovery of a depleted stock. The Bottlenose Dolphin Take Reduction Team (BDTRT) was convened in November 2001 and was made up of fishermen, managers, scientists, and environmental groups. The BDTRT focused on reducing serious injuries and deaths of coastal bottlenose dolphins incidental to several east coast fisheries including: the North Carolina inshore gill net, Southeast Atlantic gill net, Southeastern U.S. shark gill net, U.S. Mid-Atlantic coastal gill net, Atlantic blue crab trap/pot, Mid-Atlantic haul/beach seine, North Carolina long haul seine, North Carolina roe mullet stop net, and Virginia pound net. In April 2006, NMFS published a final rule implementing the Bottlenose Dolphin Take Reduction Plan effective May 26, 2006 (FR Doc. 06-3909 Filed 4-25-06).

For the crab pot fishery, the BDTRT developed a set of non-regulatory recommendations that were included in the final rule. The first recommendation encourages states to develop, implement, and enforce a program to remove derelict (ghost pots) blue crab pots and their lines from all waters. Also, the group recommended the use of sinking or negatively buoyant line and that the minimum length of line necessary be used to reduce the overall length of line in the water column. This recommendation was addressed in the 1998 Blue Crab FMP (McKenna et al. 1998) as a means of reducing ghost pots. After the BCFMP was adopted in 1998, a MFC rule (15A NCAC 3J .0301 (k)) was passed that made it unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating to reduce interactions with boaters (see Issue Paper 11.11 floating line in crab pots).

Wayne McFee, NOAA National Ocean Service, conducted an analysis of approaches to reduce the probability of dolphin entanglement in buoy lines. Through analysis of different lines under various deployment conditions, stronger currents, slack tides, rope lengths of $\geq$ 50 feet in water depths of <10 feet, were all causes of arcing or waving in the water column, increasing chances of entanglement. He recommended reducing the length of rope to less than 50 feet when deploying in water less than 10 feet deep, deploy crab pots on an ebbing or flooding tide when water current velocities are stronger, and to avoid deploying crab pots at slack tide altogether (McFee et al. 2006). Additional studies have shown that a stiffer line (i.e., Esterpro vs. the commonly used nylon line), falls straighter in the water with fewer kinks, and may reduce opportunities for entanglement (McFee et al. 2007).

Another BDTRT recommendation encouraged the use of use inverted or modified bait wells in areas where bottlenose dolphin are tipping and stealing bait from crab pots. Research on three alternative bait well designs for crab pots (i.e. bottom opening, recessed, and inverted) showed that inverted bait wells resulted in fewer interactions with dolphins and less damage to the whole pot while the other two styles did not. However, inverted bait wells substantially increased handling time and maintenance of the crab pots (an additional 45 – 60 seconds fishing time/pot), and may not be advisable for crab fishermen experiencing few dolphin interactions with their pots (Haymans 2005).

8.2.3 SEA TURTLES

Sea turtles are air-breathing reptiles with streamlined bodies and large flippers which inhabit tropical and subtropical ocean waters throughout the world. Of the seven species of sea turtle worldwide, five occur in North Carolina. They include the Kemp's ridley sea turtle (*Lepidochelys kempii*), hawksbill sea turtle (*Eretmochelys imbricate*), leatherback sea turtle (*Dermochelys coriacea*), green sea turtle (*Chelonia mydas*), and the loggerhead sea turtle (*Caretta caretta*). Although sea turtles live most of their lives in the ocean, adult females must return to land to lay their eggs on sandy beaches. They often migrate long distances between foraging grounds and nesting beaches. Kemp's ridley, green, and loggerhead sea turtles are known to move into North Carolina coastal waters as large juveniles to forage on crustaceans, mollusks, or grasses (STAC 2006). The loggerhead and green sea turtles are federally listed as threatened, while the others are listed as endangered.

Hawksbill turtles have been reported off the coast of North Carolina during the months of June, July, October and November. This species of turtle prefers shallow coastal water with depths not greater than 66 feet. Preferred habitat includes coral reefs, rocky bottoms, reefs, and coastal lagoons. Adult hawksbills primary food source is sponges, but they also eat urchins, algae, barnacles, mollusks, jellyfish, and fish. Hawksbills exhibit a wide tolerance for nesting substrate type and nests are typically placed under vegetation. Nesting occurs principally in Puerto Rico and the U.S. Virgin Islands but does occur in the southeast coast of Florida and the Florida Keys. The largest threat to the hawksbill is the loss of coral reef habitat. The extent to which hawksbills are killed or debilitated after becoming entangled in marine debris has not been quantified, but it is believed to be a serious and growing problem. Hawksbills (predominantly juveniles) have been reported entangled in monofilament gill nets, fishing line, and synthetic rope. Hawksbills are incidentally taken by several commercial and recreational fisheries. Fisheries known or suspected to incidentally capture hawksbills include those using trawls, gill nets, traps, driftnets, hooks, beach seines, spear guns, and nooses (NMFS 1993b). There were no strandings reported of hawksbill sea turtles in North Carolina between 1991 and 1999, but there were nine between 2001 and 2010 (WRC/NMFS Sea Turtle Stranding and Salvage Network (STSSN) data).

The leatherback sea turtle is the largest turtle in the world and has a worldwide distribution in tropical and temperate waters. This species is found off the coast of North Carolina from April to October with occasional sightings into the winter. The main prey species of leatherbacks are jellyfish and tunicates and occur almost exclusively in ocean waters (STAC 2006). There is one record of a NC nesting site at Cape Lookout in 1966 (Lee and Socci 1989), and an additional nesting site was reported near Cape Hatteras in 2000. Leatherbacks become entangled fairly often in longlines, fish trap, buoy anchor lines, and other ropes and cables (NMFS 1992). Prescott (1988) implicated entanglement in lobster pot lines in 51 of 57 adult leatherback strandings in Cape Cod Bay, Massachusetts from 1977-1987. Between 1990 and 2000, there were 12 reported leatherback strandings in North Carolina, between 2001 and 2005 there were 75, and since 2006 there have been 17 reported strandings (WRC/NMFS STSSN).

The Kemp's ridley sea turtle occurs primarily in the Gulf of Mexico, but they also occur along the Atlantic coast as far north as New England. Juveniles occur year-round within the sounds, bays, and coastal waters of North Carolina. Adult Kemp's ridley turtles are primarily a bottom feeder, feeding on crabs, shrimp, urchins, starfish, jellyfish, clams, snails, and squid. Incidental take by shrimp trawls has been identified as the largest source of mortality with between 500 and 5,000 killed annually (NMFS 1993a). Manzella et al. (1988) estimated that 0.2% of the juvenile Kemp's ridleys killed by fishing gear were killed as a result of interaction with crab pots.

In North Carolina 17% of the sea turtle strandings between 1990 and 2000 were Kemp's ridleys (WRC/NMFS STSSN; 1990-2000). Since 2001, there have been 651 strandings, which represents 13.5 percent of the total sea turtle strandings during this time period (WRC/NMFS STSSN).

The green sea turtle has a circumglobal distribution in tropical and subtropical waters. In U.S. Atlantic waters, it occurs around the Virgin Islands and Puerto Rico and from Texas to Massachusetts. Green turtles are sighted in oceanic waters and within the sounds of North Carolina during the period from May through October. Due to their food preference for submerged aquatic vegetation, adult green turtles are normally found in lagoons, bays, and tidal inlets. No major nesting sites are located along the U.S. coastline however, limited annual nesting occurs in Florida from April to July. From 1979-1989, there were two reported (1987, Baldwin Island and 1989, Cape Hatteras) and one confirmed (1979, Camp Lejeune) nesting sites in North Carolina. In 2009, there were three nests in North Carolina; and in 2010, there were 18 green turtle nests (NCWRC Sea Turtle Nest Monitoring System data). In 1992, NMFS finalized regulations to require the use of Turtle Excluder Devices (TEDs) in shrimp trawl fisheries. A significant threat to the green turtle continues to be fishing gear, primarily gill nets, but also trawls, traps and pots, and dredges. Green sea turtles have been recovered entangled in trap lines with the trap in tow (NMFS 1991a). Strandings have drastically increased since 2008. From 1991-2000, green turtles accounted for 18% of the sea turtle strandings in North Carolina and between 2001-2010 they make up 32% of total strandings (WRC/NMFS STSSN).

The loggerhead sea turtle has a subtropical (and occasionally tropical) distribution, including continental shelves and estuaries along the margins of the Atlantic, Pacific, and Indian oceans. It is rare or absent far from mainland shores. The loggerhead turtle is the most common sea turtle in North Carolina (STAC, 2006) and is present throughout the year, with peak densities occurring from June to September. The loggerhead turtle diet includes algae, seaweeds, horseshoe crabs, barnacles, various shellfish, sponges, jellyfish, squid, urchins, and fish. Nesting occurs along the U.S. Atlantic coast from New Jersey to Florida, however, the majority of nesting activity occurs from South Carolina to Florida. In North Carolina, nesting activity has been reported from April to September. The highest nesting densities are reported south of Cape Lookout. In 2010, there were 847 loggerhead turtle nests in North Carolina (WRC Sea Turtle Nest Monitoring System data). The primary threat to loggerhead turtle populations worldwide is incidental capture in fishing gear, primarily in longlines and gill nets, but also in trawls, traps and pots, and dredges. While the impact of the crab pot fishery on loggerhead populations has not been quantified, this species may be particularly vulnerable since they feed on species caught in traps and on organisms growing on the traps, trap lines, and floats (NMFS 1991b). Loggerhead turtles account for over half of the sea turtle strandings in North Carolina (WRC/NMFS STSSN).

8.2.3.1 SEA TURTLES AND THE BLUE CRAB FISHERY

Sea turtles may be attracted to baited crab pots for food. Sea turtle entrapment in a pot or trap is not likely, but entanglement in the buoy lines of crab, lobster, and fish pots has been documented (Epperly et al. 2002). The entanglement of sea turtles in buoy lines is more problematic in pot fisheries that use bridles (lobster and fish pots) as opposed to single line fisheries such as the North Carolina blue crab fishery (Cheryl Ryder personal communication NOAA/NMFS/NEFSC).

Since 1998, there have been four known crab pot entanglement incidents with Loggerhead turtles in North Carolina waters. Of the four, one was released alive. On November 4, 1998 a loggerhead was observed entangled in a crab pot buoy line in Kill Devil Hills on the sound side. On June 30, 1999, another dead loggerhead was found with a crab pot buoy line wrapped around the left flipper, in Rich Inlet, near Huttaf Island. On June 22, 2005, a loggerhead was released alive in the ocean at Corolla, NC after a crab pot buoy was taken off his right front flipper. On July 28, 2009, a loggerhead was observed next to or entangled (unconfirmed) in a crab pot buoy in Croatan Sound near Manteo. On August 17, 2005, the skeletal remains of an unknown species of sea turtle was observed entangled in a crab pot buoy near Ft. Fisher on the Cape Fear River. (Matthew Godfrey, WRC, personal communication).

As sea turtles attempt to obtain either bait or crabs from crab pots, significant damage to the gear can occur. Sea turtles reportedly overturn the pot and bite the bottoms and sides, resulting in torn mesh and crushed pots. This damage also results in higher operating costs and decreased catches. In the Core Sound area, fishermen have estimated that 62% of all crab pot damage, and 37% of lost crab catch, is due to sea turtles (Marsh 2002). Crab pot damage was also reported from the Outer Banks area in 2003. In 2001, Marsh (2002) tested a low profile crab pot designed to limit the ability of sea turtles to overturn crab pots. The overall dimensions were 34” x 24” x 13.5”. This pot was tested against standard hexagonal mesh (22” x 24” x 19”), and square mesh pots (24” x 24” x 21”). There was no difference between catch rates in the low profile pot and the square mesh pot however; there was a significant decrease in catch for the low profile pot compared to the hexagonal pot. However, this decrease in catch was only seen in one of the three lines of pots. Ten types of each pot were set in repeating order (low profile, square mesh, hexagonal) in three lines. Marsh (2002) suggested that the low profile crab pot has the potential to maintain crab catch and reduce gear replacement costs.

Although shrimp and flounder trawlers have been required to use TEDs since 1992, no such regulation exists for the crab trawl fishery. Data on sea turtle and crab trawl interactions in North Carolina are limited. Of the 528 crab trawl tows examined between 1990 and 2004 [1,056 catches from individual nets; 50 characterization (McKenna and Camp 1992), 101 TED testing (Morris 2002), and 378 tailbag testing (McKenna and Clark 1993; Lupton 1996; and Hannah and Hannah 2000)] only one loggerhead sea turtle was captured (released alive). The majority of crab trawl effort takes place in the winter/spring when water temperatures and turtle numbers are low compared to the rest of the year. Also, low water temperature increases the chance of survival of turtles after gear interactions. Additionally, crab trawl tows during the warmer months are usually less than a ½ hour as the crabs must be delivered to the dealer alive. Currently, the NMFS is preparing an EIS evaluating TEDs for a wide range of non-shrimp trawl fisheries. Morris (2002) tested two types of TEDs, mini-super shooter and leatherback, in Bay River to determine the effect of TEDs on crab catches in crab trawls. The mini-super shooter had a 14% reduction in the number of legal crabs (13% by weight), and a 31% reduction in sublegal crab weight. The leatherback TED showed a 23% reduction in legal crabs (24% by weight) and a 39% reduction of sublegal crabs. These significant reductions in legal crab catch would be detrimental to the crab trawl fishery.

The Sea Turtle Advisory Committee (STAC), originally formed by the MFC in 2003, developed three categories of estuarine fisheries based on their threat level to sea turtles; gears of primary concern, gears of other concern, and gears of no concern (STAC 2006). While crab dredges were placed in the gears of no concern category, crab pots and crab trawls were placed in the gears of other concern category. This category is defined as meeting “at least two of the following criteria: infrequent fatal and/or non-fatal interactions have been documented; current regulations for the fishery decrease or eliminate the potential for interaction, but that potential could increase with a change in those regulations; there is moderate to low effort; or more observer data are needed” (STAC 2006). The reasons given for crab pots were the large industry and effort, limited evidence of capture in lines, possibility of entanglement, and fishermen reports of entanglement. The reasons for crab trawl listed as a gear of other concern were the possibility of overlapping the sea turtle distribution, lack of interactions in the Pungo or Pamlico rivers, peak effort in the winter/early spring when sea turtles are sparse, low effort in the fishery, and no TED requirements.

The STAC also developed management and research recommendations for the crab pot and crab trawl gears. Crab pot management recommendations included: (1) continue to support Marine Patrol in their efforts during the pot clean up and follow their recommendations for making the clean up more effective/efficient and (2) eliminate bait lids on crab pots when/where sea turtle interactions are occurring. Crab trawl management recommendations included implementation of observer coverage. The level of this coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring. Crab trawl management recommendations also included providing educational information on sea turtle resuscitation and reporting requirements for unharmed/injured/dead turtles and supporting gear modifications and testing that would reduce sea turtle interactions should interactions be determined to be a problem. The NCDMF supported all of these recommendations except the elimination of crab pot bait lids. Research needs where identified by the STAC in areas of limited data including sea turtle status, fishery interactions, and gear development.

8.2.4 DIAMONDBACK TERRAPINS

Diamondback terrapins are found throughout North Carolina's high salinity coastal marshes. This species is listed federally as a species of concern (FSC) in Dare, Pamlico, and Carteret counties in North Carolina, although it affords them no legal protection. The diamondback terrapin it is listed as a "Special Concern" species by the WRC, making it protected under state regulations. The WRC Scientific Council on Amphibians and Reptiles (SCAR) is currently evaluating changing the listing of the diamond back terrapin to "Threatened" (SCAR 2011).

In a South Carolina study (Bishop 1983), terrapins were captured in salinities ranging from 4.3 to 22 parts per thousand (ppt), with most captures in 10.1 to 15 ppt. Preferred habitats are the waters immediately adjacent to the marsh, small creeks, and mosquito control ditches. Terrapins are a long-lived species, probably surviving in excess of forty years. Females mature in 7 to 9 years, and fecundity is relatively low (Hildebrand 1932).

Populations of diamondback terrapins have declined throughout their range from Cape Cod, Massachusetts to southern Texas (Palmer and Cordes 1988, Seigel and Gibbons 1995). Possible reasons for this decline (Grant 1997) are: (1) degradation and loss of habitat, (2) mortality on roads (Wood 1995), (3) raccoon predation (Seigel 1980), and (4) incidental drowning in trawls, nets, and crab pots (Bishop 1983, Wood 1995). Blue crab pots may account for more adult diamondback terrapin mortalities than any other single factor (Bishop 1983).

Various studies in New Jersey (Wood 1995), Maryland (Roosenburg et al. 1997), North Carolina [Grant 1997; Crowder et al. 2000; WRC unpublished; Tom Henson (WRC), pers. comm.], and South Carolina (Bishop 1983) have documented diamondback terrapin bycatch and mortality in crab pots. In South Carolina, few captured terrapins were drowned when crab pots were checked daily, and estimated capture mortality amounted to 10% (Bishop 1983). However, in a North Carolina study Crowder et al. (2002) noted that terrapins can hold their breath for a maximum of 5 hours, and during the summer only 45 minutes. Of the 12 terrapins captured in the North Carolina study, 58% were dead [24 – 48 hour soak time (Crowder et al. 2000)].

Bishop (1983) noted that the occurrence of ghost pots is perhaps far more detrimental to terrapin populations than actively fished pots. Some observations suggest that once a terrapin is captured others may be attracted, particularly males to a female during the spring mating season.

Population size influences catchability. Estimates of capture rates and population size by Roosenburg et al. (1997), suggest that 15-78% of a local population may be captured annually. However, all coastal areas do not contain suitable terrapin habitat as outlined by Palmer and Cordes (1988). Male terrapins do not grow as large (shell depth and length) as females, and may remain vulnerable to entrapment throughout their life. Female terrapins become too large to enter crab pots by the time they reach age eight (Roosenburg 1997). However, small terrapins of either sex are vulnerable to capture.

Limiting factors affecting the catchability of terrapins in crab pots are:

(1) the abundance of terrapins,
(2) terrapin size (depth of shell),
(3) vertical height of the crab pot funnel,
(4) distance of the crab pot from shore, and
(5) season.

Each of these limiting factors and its relationship to terrapin catchability in crab pots are discussed in the issue paper 11.12 evaluating diamondback terrapin interactions and potential management options relative to the crab pot fishery.

8.3 NORTH CAROLINA DIVISION OF MARINE FISHERIES PROGRAMS

An agreement was established in 1979 with the WRC to exercise regulatory jurisdiction over any species of sea turtle, and their eggs and nests, consistent with designation of such species as endangered or threatened by the USFWS. In 1980, the MFC established a Sea Turtle Sanctuary off the coast of North Carolina to protect nesting beaches (MFC Rule – 15A NCAC 03R.0101). In 1983, proclamation authority was given to the director of NCDMF by MFC to close areas to protect endangered/threatened species (MFC Rule-15A NCAC 03I.0107). In 1989, an addition was made to the Marine Recreational Fisheries Statistics Survey (MRFSS) program to include a sea turtle sightings query on the survey form.

In the latter part of 2010, NCDMF reallocated funds to establish the Protected Resources Section within the division and obtained funding to support a statewide at-sea observer program for the gill net fishery. The new Protected Resources Section will be the lead for division actions involving protected species such as at-sea observer programs, marine mammal stranding responses and marine mammal take reduction teams, and other protected species issues that may arise (Dee Lupton, NCDMF personal communication).

Marine mammal stranding response along the central North Carolina coast, transitioned from North Carolina State University Center for Marine and Science Technology to the NCDMF in October of 2010. This project is funded year to year from the John H. Prescott Marine Mammal Rescue Assistance Foundation, pending successful proposal review and acceptance. A full-time stranding director was hired and stranding personnel responded to 52 marine mammal strandings in 2010, including one sperm whale, one fin whale, one minke whale, one beaked whale, three dwarf sperm whales, two pygmy sperm whales, one spotted dolphin, one Risso’s dolphin, 36 bottlenose dolphins and five harbor seals. North Carolina stranding response is divided into four areas: UNC Wilmington personnel respond to all strandings in the southern part of the state up to and including Camp LeJeune; NCDMF stranding personnel respond to strandings from Hammocks Beach State Park to Cape Lookout National Seashore and in Albemarle and Pamlico sounds; Cape Hatteras National Seashore (CAHA) stranding personnel respond to strandings in CAHA National Seashore, and DENR personnel respond to strandings from CAHA north to the Virginia border. Stranding personnel conduct outreach by giving public seminars at marine mammal meetings, local museums, universities, and classrooms. Stranding personnel disseminate results and tissue samples from stranded animals to collaborating researchers and agencies.

The NCDMF observer program began in 1999 when the sea turtle stranding network noted significant increases in sea turtle strandings in the southeastern portion of Pamlico Sound. The purpose of these observations was to begin the process of characterizing effort, catch, and bycatch by area and season in various fisheries. In addition, this program was established to monitor fisheries for the potential for protected species bycatch. The data collected is used for fisheries management decisions, stock assessments, and conservation efforts for protected species. Currently, the observer program focuses only on gill nets. Data collections from observer trips include: date, location, unit, time, season, gill net description (net length, number of net shots, mesh size, presence/absence of tie downs, vertical mesh height, and hang ratio), and soak time and water depth. Additionally, environmental parameters (wind, tide stage and water quality data) are collected when feasible. Total catches of target species are estimated and final disposition (kept or discarded) is recorded. Sea turtle interaction information includes species, condition, tag numbers, and final disposition. Sea turtle interactions may also be photo documented when possible. Gill net interactions involving other protected species are documented. All observers are required to adhere to these data collection parameters.

In the fall of 2010, the MFC reestablished the STAC (Sea Turtle Advisory Committee), which had originally existed from 2003 to 2006 and was comprised of a number of stakeholders with a mission to address sea turtle bycatch. As noted in the turtle settlement agreement, the duties of the reestablished STAC include but are not limited to: reviewing observer reports, devising means for fishermen to report turtle interactions, assisting with fishermen education, determining measures to reduce the incidental take of sea turtles, monitoring observer program issues, and reviewing all future ITP provisions and take calculations prior to formal application to NMFS. The STAC will provide recommendations and guidance to the MFC and NCDMF in addressing protection of sea turtles in North Carolina.

Since the 1970s, the NCDMF has been proactive in developing ways to minimize impacts to threatened and endangered marine species. The NCDMF works closely with NMFS and other state and federal agencies to develop regulations that minimize impacts to protected species while trying to allow the prosecution of many economically important fisheries.

8.4 PROTECTED SPECIES RESEARCH AND MANAGEMENT

8.4.1 RESEARCH

1. Continue to support research to determine the status of protected species (e.g., migration patterns, habitat utilization) along the North Carolina coast to better anticipate and prevent interactions.
2. Support research on blue crab fishery interactions with protected species (e.g., identifying any seasonal or spatial peaks in potential for interactions).
3. Support gear modification research and testing that could reduce protected species interactions.

8.4.2 MANAGEMENT

1. Continue to support Marine Patrol in their efforts during the pot clean up and follow their recommendations for making the clean up more effective/efficient.
2. Provide public outreach/education on protected species issues (e.g., rules about removing abandoned pots, sea turtle resuscitation, reporting requirements for unharmed/injured/dead turtles).
3. Continue to seek funding to implement an expanded observer program to include additional gear types.

9.0 SOCIOECONOMIC STATUS OF THE BLUE CRAB FISHERY

9.1 COMMERCIAL FISHERY

9.1.1 HARVESTING SECTOR

9.1.1.1 EX-VESSEL VALUE AND PRICE

Hard blue crabs are the most important seafood product landed in North Carolina in terms of economic value. The percentage of total value of commercial landings attributable to hard crabs has risen substantially from 1972 through 2009. In 1972, hard crabs represented 11% of the total value of all seafood harvested in North Carolina. By 1992, the share had doubled. Hard crabs peaked in 1998, accounting for 40% of the value of all seafood landed. Hard crab landings have declined but still remained the most economically important seafood species landed in North Carolina, yielding 32% of the total value in 2009 (Table 9.1.1).

The value of North Carolina's hard crab landings increased from $1.3 million in 1972 to a peak of nearly $40.5 million in 1998. The increase in value can be attributed to increases in price per pound as well as more landings. Landing values for hard crabs decreased to $14.1 million in 2006, but then saw a rise in value to more than $25 million in 2008 and 2009. Inflation adjusted values for hard crabs peaked at $10.6 million in 1996; but, have since decreased 54% to $4.88 million in 2009 (Figure 9.1.1, Table 9.1.2).

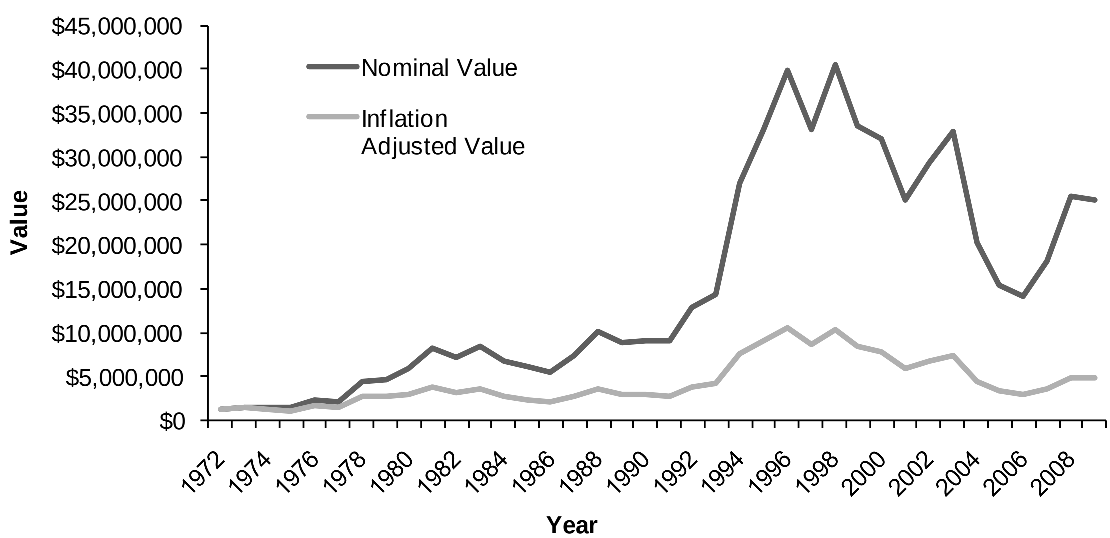

Figure 9.1.1 Ex-vessel value of hard blue crab landings in North Carolina, 1972 to 2009[1] (NCDMF Trip Ticket Program).

[1] All inflation adjustments are computed using the consumer price index generated by the US Department of Commerce.

Table 9.1.1 Landings and value of blue crabs as a percentage of the total seafood landings in pounds and total value of all seafood landed in North Carolina, 1972 to 2009 (NCDMF Trip Ticket Program).

	Total Seafood Landings		Hard Blue Crabs					Soft and Peeler Blue Crabs				
Year	Pounds	Value	Pounds	% of Total Pounds	Price/Lb.	Value	%of Total Value	Pounds	% of Total Pounds	Price/Lb.	Value	% of Total Value
1972	167,901,560	$11,798,839	13,479,254	8%	$0.10	$1,345,159	11%	49,809	0.03%	$0.59	$29,186	0.2%
1973	130,452,662	$15,954,632	11,963,252	9%	$0.13	$1,536,873	10%	45,280	0.03%	$0.61	$27,762	0.2%
1974	196,049,202	$17,324,437	13,163,411	7%	$0.10	$1,373,499	8%	33,439	0.02%	$0.69	$23,130	0.1%
1975	231,703,491	$19,452,677	11,072,059	5%	$0.13	$1,454,456	7%	20,234	0.01%	$0.84	$16,996	0.1%
1976	220,447,235	$27,409,284	11,731,946	5%	$0.21	$2,405,635	9%	20,065	0.01%	$1.32	$26,549	0.1%
1977	244,750,585	$28,374,435	12,220,812	5%	$0.18	$2,148,346	8%	15,974	0.01%	$1.06	$17,000	0.1%
1978	299,541,347	$40,608,865	23,558,546	8%	$0.18	$4,326,084	11%	46,826	0.02%	$1.92	$89,718	0.2%
1979	390,472,084	$58,454,065	26,623,723	7%	$0.17	$4,622,539	8%	80,367	0.02%	$1.62	$129,908	0.2%
1980	356,192,806	$68,783,510	34,322,937	10%	$0.17	$5,975,221	9%	87,482	0.02%	$1.51	$132,448	0.2%
1981	432,005,883	$57,520,010	37,927,573	9%	$0.22	$8,172,428	14%	77,748	0.02%	$1.30	$100,860	0.2%
1982	307,967,923	$63,823,852	38,206,327	12%	$0.19	$7,184,748	11%	148,364	0.05%	$2.00	$296,838	0.5%
1983	287,732,830	$57,424,985	34,689,455	12%	$0.24	$8,444,863	15%	87,570	0.03%	$2.15	$188,223	0.3%
1984	277,168,991	$57,263,068	32,490,769	12%	$0.21	$6,664,731	12%	199,771	0.07%	$1.38	$276,302	0.5%
1985	214,874,088	$64,592,866	29,329,547	14%	$0.21	$6,089,982	9%	326,978	0.2%	$1.07	$350,373	0.5%
1986	168,881,625	$63,230,849	23,159,779	14%	$0.23	$5,429,534	9%	595,468	0.4%	$1.15	$684,822	1.1%
1987	157,323,919	$65,707,286	31,760,413	20%	$0.23	$7,345,210	11%	663,191	0.4%	$3.41	$2,263,437	3.4%
1988	192,693,176	$77,756,754	35,136,232	18%	$0.29	$10,211,661	13%	468,191	0.2%	$1.97	$921,403	1.2%
1989	165,197,479	$73,957,607	33,935,992	21%	$0.26	$8,790,304	12%	788,681	0.5%	$1.99	$1,567,298	2.1%
1990	174,992,869	$70,692,290	36,985,206	21%	$0.25	$9,156,390	13%	1,085,122	0.6%	$1.97	$2,136,942	3.0%
1991	212,641,148	$66,787,706	41,074,063	19%	$0.22	$9,154,358	14%	755,613	0.4%	$1.84	$1,389,140	2.1%
1992	154,429,821	$58,024,644	40,507,415	26%	$0.32	$12,836,836	22%	560,959	0.4%	$1.78	$996,904	1.7%
1993	170,697,467	$64,603,792	42,867,109	25%	$0.33	$14,262,152	22%	805,623	0.5%	$1.88	$1,515,569	2.3%
1994	192,912,325	$91,270,554	52,260,168	27%	$0.51	$26,896,282	29%	1,252,956	0.6%	$2.16	$2,703,672	3.0%
1995	175,765,022	$109,367,976	45,033,543	26%	$0.73	$33,053,805	30%	1,409,997	0.8%	$2.26	$3,185,481	2.9%
1996	191,122,565	$105,530,665	65,682,500	34%	$0.61	$39,873,553	38%	1,397,700	0.7%	$2.27	$3,168,881	3.0%
1997	228,565,330	$108,988,117	54,353,545	24%	$0.61	$33,165,872	30%	1,736,564	0.8%	$2.60	$4,520,166	4.1%
1998	180,230,384	$101,018,264	60,402,332	34%	$0.67	$40,466,879	40%	1,673,838	0.9%	$2.68	$4,492,761	4.4%
1999	153,742,151	$99,681,050	56,094,091	36%	$0.60	$33,526,081	34%	1,452,585	0.9%	$2.95	$4,286,119	4.3%
2000	154,220,098	$108,314,811	38,889,273	25%	$0.83	$32,154,369	30%	1,749,111	1.1%	$3.02	$5,283,359	4.9%
2001	137,166,335	$88,143,189	29,939,494	22%	$0.84	$25,079,256	28%	2,240,896	1.6%	$3.19	$7,152,340	8.1%
2002	160,174,305	$94,747,541	36,461,890	23%	$0.80	$29,349,251	31%	1,274,429	0.8%	$2.98	$3,799,182	4.0%
2003	139,423,505	$87,112,832	41,644,612	30%	$0.79	$32,904,677	38%	1,125,185	0.8%	$3.74	$4,203,416	4.8%
2004	134,107,766	$79,705,628	32,592,768	24%	$0.62	$20,248,333	25%	1,537,840	1.1%	$2.74	$4,217,510	5.3%
2005	79,628,687	$64,889,272	23,571,451	30%	$0.65	$15,374,714	24%	1,858,668	2.3%	$2.64	$4,899,198	7.6%
2006	68,743,347	$70,085,519	24,408,932	36%	$0.58	$14,146,592	20%	934,227	1.4%	$3.15	$2,940,804	4.2%
2007	62,926,359	$82,331,523	20,562,159	33%	$0.88	$18,109,497	22%	862,801	1.4%	$3.85	$3,322,457	4.0%
2008	71,213,006	$86,822,064	32,338,889	45%	$0.79	$25,429,231	29%	577,802	0.8%	$3.68	$2,126,155	2.4%
2009	68,970,923	$77,248,374	29,140,473	42%	$0.86	$25,039,379	32%	566,758	0.8%	$4.22	$2,389,616	3.1%
Average	193,500,797	$68,021,153	33,146,893	20%	$0.42	$15,361,810	19%	753,003	1%	$2.16	$1,996,630	2%

Table 9.1.2 Nominal and inflation adjusted value of commercial hard, peeler and soft blue crab landings, North Carolina, 1972 to 2009 (NCDMF Trip Ticket Program).

	Hard Blue Crabs				Peeler and Soft Blue Crabs			
Year	Nominal Value	Adjusted Value	Nominal Price/Lb.	Inflation Adjusted Price/Lb.	Nomial Value	Adjusted Value	Nominal Price/Lb.	Inflation Adjusted Price/Lb.
1972	$1,345,159	$1,345,159	$0.10	$0.10	$29,186	$29,186	$0.59	$0.59
1973	$1,536,873	$1,446,876	$0.13	$0.12	$27,762	$26,136	$0.61	$0.58
1974	$1,373,499	$1,164,549	$0.10	$0.09	$23,130	$19,611	$0.69	$0.59
1975	$1,454,456	$1,130,042	$0.13	$0.10	$16,996	$13,205	$0.84	$0.65
1976	$2,405,635	$1,767,233	$0.21	$0.15	$26,549	$19,503	$1.32	$0.97
1977	$2,148,346	$1,481,862	$0.18	$0.12	$17,000	$11,726	$1.06	$0.73
1978	$4,326,084	$2,773,471	$0.18	$0.12	$89,718	$57,519	$1.92	$1.23
1979	$4,622,539	$2,661,462	$0.17	$0.10	$129,908	$74,796	$1.62	$0.93
1980	$5,975,221	$3,031,119	$0.17	$0.09	$132,448	$67,188	$1.51	$0.77
1981	$8,172,428	$3,758,058	$0.22	$0.10	$100,860	$46,380	$1.30	$0.60
1982	$7,184,748	$3,112,150	$0.19	$0.08	$296,838	$128,579	$2.00	$0.87
1983	$8,444,863	$3,544,129	$0.24	$0.10	$188,223	$78,993	$2.15	$0.90
1984	$6,664,731	$2,681,287	$0.21	$0.08	$276,302	$111,159	$1.38	$0.56
1985	$6,089,982	$2,365,811	$0.21	$0.08	$350,373	$136,111	$1.07	$0.42
1986	$5,429,534	$2,070,753	$0.23	$0.09	$684,822	$261,182	$1.15	$0.44
1987	$7,345,210	$2,702,727	$0.23	$0.09	$2,263,437	$832,849	$3.41	$1.26
1988	$10,211,661	$3,608,178	$0.29	$0.10	$921,403	$325,568	$1.97	$0.70
1989	$8,790,304	$2,963,183	$0.26	$0.09	$1,567,298	$528,331	$1.99	$0.67
1990	$9,156,390	$2,928,363	$0.25	$0.08	$2,136,942	$683,429	$1.97	$0.63
1991	$9,154,358	$2,809,487	$0.22	$0.07	$1,389,140	$426,329	$1.84	$0.56
1992	$12,836,836	$3,824,517	$0.32	$0.09	$996,904	$297,011	$1.78	$0.53
1993	$14,262,152	$4,125,661	$0.33	$0.10	$1,515,569	$438,414	$1.88	$0.54
1994	$26,896,282	$7,586,131	$0.51	$0.15	$2,703,672	$762,574	$2.16	$0.61
1995	$33,053,805	$9,065,939	$0.73	$0.20	$3,185,481	$873,708	$2.26	$0.62
1996	$39,873,553	$10,622,782	$0.61	$0.16	$3,168,881	$844,227	$2.27	$0.60
1997	$33,165,872	$8,637,592	$0.61	$0.16	$4,520,166	$1,177,215	$2.60	$0.68
1998	$40,466,879	$10,377,396	$0.67	$0.17	$4,492,761	$1,152,131	$2.68	$0.69
1999	$33,526,081	$8,411,706	$0.60	$0.15	$4,286,119	$1,075,389	$2.95	$0.74
2000	$32,154,369	$7,805,184	$0.83	$0.20	$5,283,359	$1,282,488	$3.02	$0.73
2001	$25,079,256	$5,919,328	$0.84	$0.20	$7,152,340	$1,688,130	$3.19	$0.75
2002	$29,349,251	$6,819,337	$0.80	$0.19	$3,799,182	$882,745	$2.98	$0.69
2003	$32,904,677	$7,475,084	$0.79	$0.18	$4,203,416	$954,906	$3.74	$0.85
2004	$20,248,333	$4,480,573	$0.62	$0.14	$4,217,510	$933,255	$2.74	$0.61
2005	$15,374,714	$3,290,645	$0.65	$0.14	$4,899,198	$1,048,574	$2.64	$0.56
2006	$14,146,592	$2,933,172	$0.58	$0.12	$2,940,804	$609,750	$3.15	$0.65
2007	$18,109,497	$3,651,602	$0.88	$0.18	$3,322,457	$669,941	$3.85	$0.78
2008	$25,429,231	$4,936,958	$0.79	$0.15	$2,126,155	$412,782	$3.68	$0.71
2009	$25,039,379	$4,879,469	$0.86	$0.17	$2,389,616	$465,669	$4.22	$0.82
Average	$15,361,810	$4,320,762	$0.42	$0.13	$1,996,630	$511,755	$2.16	$0.71

When examining the price received by fishermen, it is helpful to note that crabs are sold by poundage as well as quantity. The NCDMF uses conversion factors to obtain a price per pound for crabs that provides a common unit of value for use in comparison of value from year to year. The price per pound paid to fishermen for hard crabs increased substantially between 1972 and 2009. In 1972, the average price was $0.10 per pound. By 1981, the price per pound had more than doubled to $0.22. Between 1981 and 2001, the price fishermen received more than tripled, rising from $0.22 per pound to $0.84. Much of this rise in price can be contributed to the creation of a live crab or "basket" market where buyers were willing to pay higher prices for live crabs. After seeing a drop to below $0.60 per pound in 2006, the price recovered to $0.86 per pound in 2009. When accounting for the effects of inflation, the inflation adjusted price per pound of hard crabs remained fairly constant from 1972 to 1993 at roughly $0.10 in 1972 dollars. From 1993 to 2000, the inflation adjusted price per pound doubled to $0.20 per pound. The inflation adjusted price per pound has since dropped slightly but remains fairly constant around $0.16 per pound (Figure 9.2, Table 9.2).

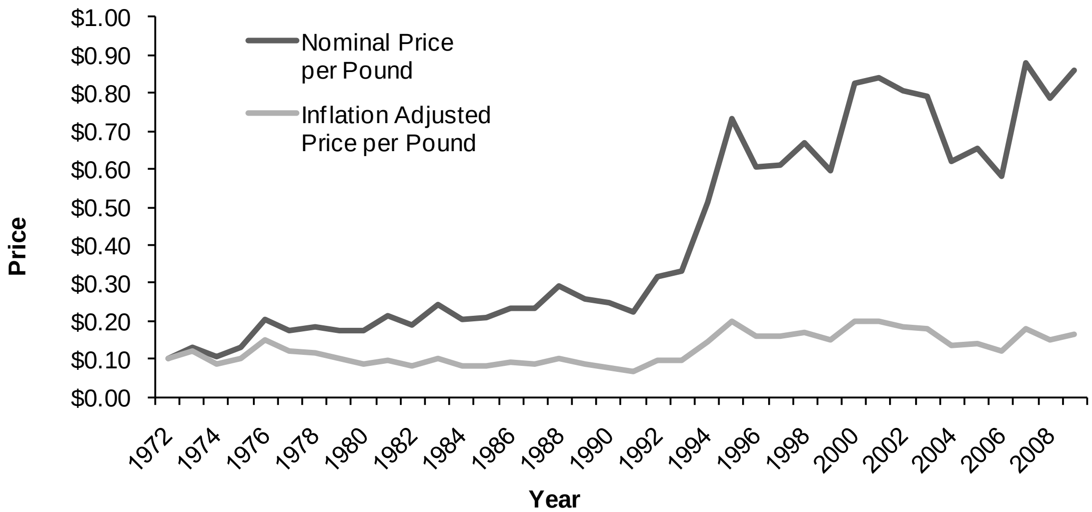

Figure 9.1.2 Average price per pound of hard blue crab landings in North Carolina, 1972 to 2009 (NCDMF Trip Ticket Program).

Peeler and soft blue crab landings have never amounted to much more than 2% of the total annual seafood landings by weight (Table 9.1.1). Nevertheless, when compared to their percent of the total landings by weight, their percentage of total value of North Carolina seafood landed is much larger. The percentage of total landings value attributed to peeler and soft crabs has been 3 to 14 times larger than their percentage of total annual landings by weight.

The value of peeler and soft crabs was relatively stable in the years from 1972 to 1977. Peeler and soft crab value increased from almost $90,000 in 1978 to a peak value of over $7.1 million in 2001 (Figure 9.1.3, Table 9.1.1). The value of peeler and soft crabs increased by 25% from 2000 to 2001 alone, largely attributable to an increase in the numbers of peeler and soft crabs landed. Since 2001, the overall value of soft and peeler crabs has seen a declining trend, principally associated with decreased landings, to a value of almost $2.4 million in 2009, 66% percent below the peak value of 2001. Inflation adjusted values experienced a general upward trend increasing from $29,186 in 1972 to a peak of $1.69 million in 2001 (Table 9.1.2). Since then, inflation adjusted values have fallen over 70% to approximately $465,669 in 2009.

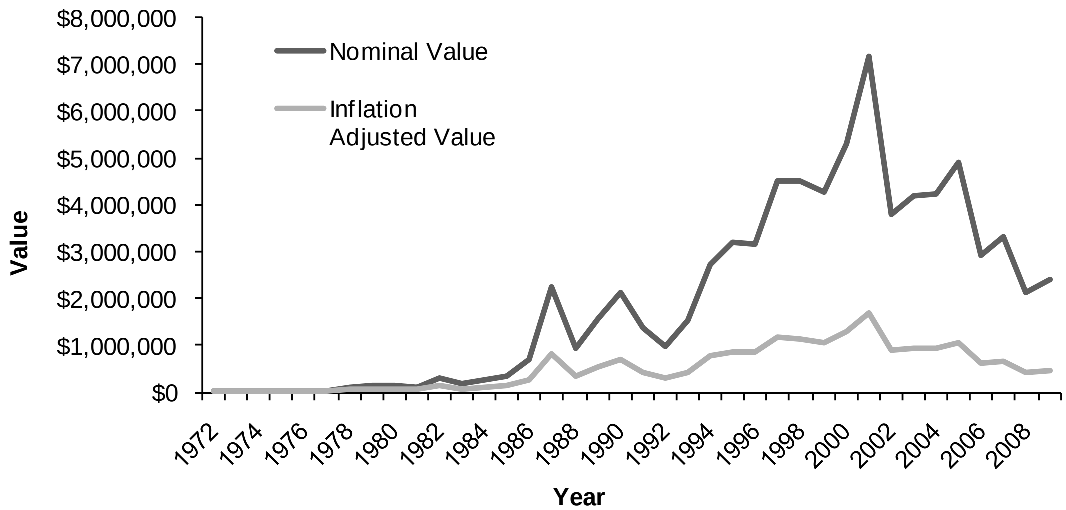

Figure 9.1.3 Ex-vessel value of soft and peeler blue crab landings in North Carolina, 1972 to 2009 (NCDMF Trip Ticket Program).

Like many species, the price per pound of peeler and soft crabs has fluctuated greatly. In 1972, peeler and soft crab fishermen received an average of $0.59 per pound. By 1978, the price had tripled to $1.92. The price has fluctuated but has followed a general increasing trend, extending to $4.22 per pound in 2009. In terms of real, inflation adjusted price per pound, the price per pound in recent years is about 40% higher than what it was in 1972. There was a great deal of fluctuation in the inflation adjusted price per pound from 1972 to 1988, with an overall peak in 1987 of $1.26. This was followed by a decrease until 1992 when the inflation adjusted price began to rise again. The inflation adjusted price per pound for peeler and soft crabs was $.82 in 2009 (Figure 9.1.4, Table 9.1.2).

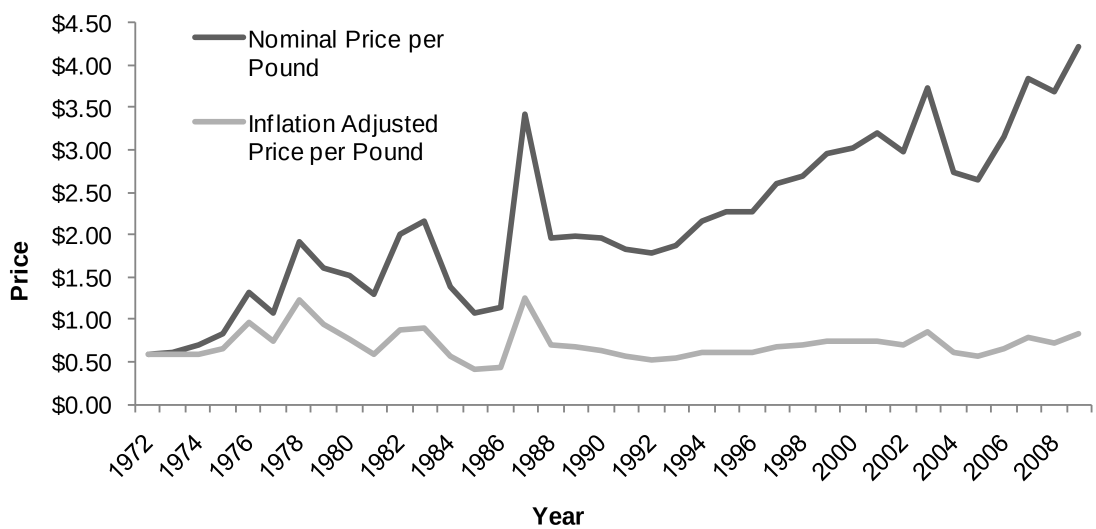

Figure 9.1.4 Average price per pound of peeler and soft blue crab landings in North Carolina, 1972 to 2009 (NCDMF Trip Ticket Program).

9.1.1.2 FISHING INCOME

Annual income derived from crabbing (all gears) was estimated using landings from the NCDMF Trip Ticket Program. Value data were derived from NCDMF voluntary dealer surveys of ex-vessel prices paid to fishermen at the point of initial sale to seafood dealers. Income derived from crabbing, as indicated in Table 9.1.3, varied substantially among fishermen and among segments within the blue crab fishery.

Table 9.1.3 Estimated income from blue crab landings by North Carolina commercial fishermen, 1994 to 2009 (NCDMF Trip Ticket Program)[2]. The number and percentages in each cell of the table represent those fishermen whose income from crabbing matched the category for that year.

		Year															
Crab Type		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hard Crabs																	
	$500 or less	484	547	490	603	370	350	233	252	287	240	238	174	191	172	155	148
		24.1%	26.0%	22.4%	27.6%	19.5%	19.1%	13.9%	14.7%	18.0%	15.9%	16.6%	15.2%	20.2%	19.3%	18.1%	15.7%
	$500.01 to $5,000	529	496	570	507	400	439	381	455	416	353	382	320	245	213	192	225
		26.3%	23.6%	26.1%	23.2%	21.1%	23.9%	22.8%	26.5%	26.0%	23.4%	26.7%	28.0%	25.9%	23.9%	22.4%	23.9%
	$5,000.01 to $10,000	302	278	240	265	239	230	221	268	220	168	195	188	128	118	88	112
		15.0%	13.2%	11.0%	12.1%	12.6%	12.5%	13.2%	15.6%	13.8%	11.1%	13.6%	16.4%	13.5%	13.3%	10.3%	11.9%
	$10,000.01 to $20,000	350	301	319	312	301	314	280	312	234	238	261	190	140	108	93	131
		17.4%	14.3%	14.6%	14.3%	15.9%	17.1%	16.8%	18.1%	14.7%	15.8%	18.3%	16.6%	14.8%	12.1%	10.9%	13.9%
	$20,000.01 to $30,000	192	166	200	195	176	188	193	173	107	138	144	118	90	72	76	74
		9.6%	7.9%	9.1%	8.9%	9.3%	10.2%	11.5%	10.1%	6.7%	9.1%	10.1%	10.3%	9.5%	8.1%	8.9%	7.8%
	$30,000.01 to $50,000	111	188	214	210	230	212	195	164	155	170	137	102	86	98	86	90
		5.5%	8.9%	9.8%	9.6%	12.1%	11.5%	11.7%	9.5%	9.7%	11.3%	9.6%	8.9%	9.1%	11.0%	10.0%	9.5%
	More than $50,000	41	128	154	95	180	103	168	96	178	202	73	51	65	109	167	163
		2.0%	6.1%	7.0%	4.3%	9.5%	5.6%	10.1%	5.6%	11.1%	13.4%	5.1%	4.5%	6.9%	12.2%	19.5%	17.3%
Total Number of Fishermen		2,009	2,104	2,187	2,187	1,896	1,836	1,671	1,720	1,597	1,509	1,430	1,143	945	890	857	943
Soft and Peeler Crabs																	
	$500 or less	491	593	675	663	501	463	471	451	468	361	404	393	277	246	226	237
		55.7%	55.6%	56.7%	51.8%	43.6%	40.1%	41.1%	39.1%	44.0%	36.2%	45.2%	48.8%	43.5%	38.9%	37.6%	37.1%
	$500.01 to $5,000	262	329	361	443	444	475	451	419	405	433	312	233	214	237	260	280
		29.7%	30.8%	30.3%	34.6%	38.6%	41.2%	39.4%	36.4%	38.1%	43.4%	34.9%	28.9%	33.6%	37.4%	43.3%	43.8%
	$5,000.01 to $10,000	50	53	66	64	91	120	102	91	88	92	50	44	61	58	59	52
		5.7%	5.0%	5.5%	5.0%	7.9%	10.4%	8.9%	7.9%	8.3%	9.2%	5.6%	5.5%	9.6%	9.2%	9.8%	8.1%
	$10,000.01 to $20,000	43	51	49	51	59	61	61	83	52	59	68	52	44	46	35	44
		4.9%	4.8%	4.1%	4.0%	5.1%	5.3%	5.3%	7.2%	4.9%	5.9%	7.6%	6.5%	6.9%	7.3%	5.8%	6.9%
	$20,000.01 to $30,000	25	23	28	25	32	18	26	40	29	30	23	35	21	21	10	16
		2.8%	2.2%	2.4%	2.0%	2.8%	1.6%	2.3%	3.5%	2.7%	3.0%	2.6%	4.3%	3.3%	3.3%	1.7%	2.5%
	$30,000.01 to $50,000	7	13	9	24	18	12	20	42	16	16	27	30	14	20	11	6
		0.8%	1.2%	0.8%	1.9%	1.6%	1.0%	1.7%	3.6%	1.5%	1.6%	3.0%	3.7%	2.2%	3.2%	1.8%	0.9%
	More than $50,000	4	5	3	9	4	5	14	26	5	6	10	18	6	5	*	4
		0.5%	0.5%	0.3%	0.7%	0.3%	0.4%	1.2%	2.3%	0.5%	0.6%	1.1%	2.2%	0.9%	0.8%	*	0.6%
Total Number of Fishermen		882	1,067	1,191	1,279	1,149	1,154	1,145	1,152	1,063	997	894	805	637	633	601	639

There has been a declining trend in participation in the hard crab fishery. The number of fishermen decreased 53% from 2,009 fishermen in 1994 to 943 fishermen in 2009 (Table 9.1.3). The number of participants in the peeler and soft crab fisheries increased from 882 fishermen in 1994 to 1,279 fishermen in 1997. This was followed by a decreasing trend in participation with 639 fishermen reporting soft or peeler crab landings in 2009 (Table 9.1.3). This decrease in the number of fishermen reporting landings has been observed in the overall commercial fishery of North Carolina, with participation down over the past decade.

[2] Values with a "*" were combined with previous income category for confidentiality

Of the two fisheries, hard blue crabs tend to generate more income for fishermen than the soft and peeler crabs. For hard crab fishermen, 56% to 70% had $10,000 or less in income from crab fishing, while soft and peeler crabbers saw values ranging from 83% to 95% in the $10,000 or less category (Table 9.1.3). A substantially larger percentage of fishermen reported hard crab landings worth more than $50,000 than fishermen reporting equivalent sales in soft and peeler crabs. The percentage of fishermen reporting hard crab landings worth more than $50,000 ranged between 2% and 20% while percentages for soft and peeler crab fishermen were 0.3% to 2.3% across the time series. In most years, less than 1% of fishermen reported soft or peeler crab landings worth more than $50,000.

9.1.1.3 EMPLOYMENT AND PARTICIPATION

A total of 990 fishermen reported landings of blue crab in 2009. Crew members involved in these landings are not included in this number, but still gain employment from the blue crab fishery. Total participant estimations (reporting fishermen as well as crew) are based on the average crew for blue crab fishing vessels calculated by the NCDMF Trip Ticket Program. Participant estimations as well as the number of fishermen, the number of trips, and average crew size are included in Table 9.1.4 below.

Table 9.1.4 Number of fishermen, number of trips, average blue crab crew, and total participants in the blue crab harvest sector, 1994 to 2009 (NCDMF Trip Ticket Program).[3]

Year	Number of Fishermen	Number of Trips	Average Crew	Total Participants
1994	2,060	121,833		
1995	2,211	125,974		
1996	2,288	123,900		
1997	2,284	132,493		
1998	2,004	143,063		
1999	1,919	124,378	1.42	2,718
2000	1,756	111,221	1.40	2,463
2001	1,787	113,572	1.42	2,535
2002	1,681	93,620	1.48	2,483
2003	1,578	91,730	1.45	2,289
2004	1,489	80,828	1.47	2,182
2005	1,216	64,029	1.43	1,744
2006	1,010	52,886	1.43	1,442
2007	952	53,833	1.46	1,388
2008	914	52,641	1.53	1,402
2009	990	59,072	1.60	1,582

Based on the number of fishermen reporting landings and the average crew size estimates, there were 2,719 participants in the blue crab fishery in 1999. Despite a slight uptick in 2001, there was decreasing participation in the blue crab fishery through 2007, when participation

[3]Crew size was not obtained on trip tickets prior to 1998. Crew includes the reporting fisherman and additional participants per vessel.

dropped to 1,388 individuals. Total participation has seen a slight increase to 1,580 individuals in 2009. This recent trend of increased participation in 2008 to 2009 has been observed in other North Carolina fisheries, possibly as result of people coming from other employment sectors that have been more drastically affected by the current economic slowdown. Despite the recent increase, overall participation in the blue crab fishery has seen a drastic drop of more than 40% since 1999.

9.1.2 DISTRIBUTION AND PROCESSING SECTOR

9.1.2.1 UNPROCESSED PRODUCT CRAB DEALERS

Blue crabs harvested in North Carolina are required to be sold through licensed seafood dealers. This group includes fishermen who have a dealer's license as well as wholesalers, processors, retailers, and restaurants possessing dealer licenses. All of the soft blue crab harvest and hard blue crab harvest first goes to in-state seafood dealers who then sell directly to out-of-state dealers and processors, North Carolina dealers and processors, and retail markets.

The number of licensed dealers reporting landings of blue crabs increased in the 1990's from 286 dealers in 1994 to 396 dealers in 1999. Following a peak in 1999, there was a decreasing trend in the number of dealers reporting blue crab landings with the lowest number seen in 2008 of 241 dealers followed by a slight uptick to 274 dealers in 2009 (Table 9.1.5).

Table 9.1.5 Number of dealers reporting landings of blue crabs in North Carolina, 1994 to 2009. (NCDMF Trip Ticket Program)

Year	Number of Dealers
1994	286
1995	303
1996	333
1997	346
1998	356
1999	396
2000	330
2001	337
2002	331
2003	319
2004	326
2005	286
2006	262
2007	247
2008	241
2009	274

9.1.2.2 PROCESSED PRODUCT DEALERS

Processing is an important component of the blue crab fishery. Processing facilities, otherwise known as "picking houses", extract and package crab meat which is later sold in state, national, and international markets. Some facilities also clean and freeze crabs, leaving the shell intact. The number of processor licenses issued by NCDMF and the number of processing plants certified by the Shellfish Sanitation Program (North Carolina Division of Environmental Health) fluctuated little from 1980 to 1997. The NCDMF stopped issuing crab-processing licenses in 1997 when the Fisheries Reform Act went into effect. The Shellfish Sanitation Program continues to certify processing plants.

The number of processing plants certified from 1998 through 2009 is shown in Table 9.1.6, which indicates there were roughly 50% fewer certified processing plants in 2009 as there were in 1998. The blue crab processing sector has faced increasing challenges that affect profitability. The declining trend in the number of processing plants can be attributed to several factors including:

1. A lack of steady supply of blue crabs from local fishermen due to an apparent shift to the live basket market as well as reduced overall landings in some years;
2. Competition from lower cost crabmeat imported from overseas as well as other parts of the U.S.;
3. A large percentage of North Carolina crabs being shipped out of state for processing;
4. More stringent federal HACCP requirements, thereby increasing costs; and
5. Increasing labor costs and shifts in local and migrant labor supply.

Table 9.1.6 Blue crab processing plants certified by the NC Shellfish Sanitation Program from 1998 to 2009. (NC Shellfish Sanitation Program).

Year	Number of License Processing Facilities
1998	31
1999	27
2000	23
2001	21
2002	20
2003	24
2004	21
2005	16
2006	15
2007	16
2008	15
2009	15

9.1.3 ECONOMIC IMPACTS OF THE COMMERCIAL FISHERY

The commercial fishing industry in North Carolina produces ripple effects in the state's economy. Each dollar earned within the industry generates a more vigorous economy by stimulating additional activity that foster jobs, income, and output. These impacts are calculated using IMPLAN, an economic modeling software.

In 2009, the commercial blue crab industry in North Carolina contributed, directly and indirectly, an estimated $47.9 million to the state's economy (Table 9.1.7). In addition to the fishermen and crew, an estimated 180 additional jobs were sustained in supporting industries. These estimates are limited and must be viewed as conservative, as they do not include wholesale (seafood dealers), retail, and foodservice sectors because of a lack of blue crab specific economic data for those sectors.

Table 9.1.7 Economic impact of commercial blue crab landings in North Carolina 2009 (NCDMF Socioeconomics Program, IMPLAN economic modeling software).

Economic inputs	$27,428,995
Additional economic activity	$20,460,455
Additional jobs sustained	180
Total economic impact	$47,889,450

9.1.4 SOCIOECONOMIC CHARACTERISTICS OF COMMERCIAL FISHERMEN

The socioeconomics program at the NCDMF has been conducting a continuing series of in-depth surveys with commercial fishermen along the coast since 2000. Data from these interviews were added to a growing database of socioeconomic information to give profiles of North Carolina commercial fishermen. Using the most up to date data from each region, a total of 297 of the fishermen in the database indicated they targeted blue crabs commercially. This group was used to provide a snapshot of North Carolina commercial fishermen who may have participated in the blue crab fishery.

The fishing and demographic characteristics of the commercial fishermen surveyed by the NCDMF Socioeconomics Program over the past five years are shown in Table 9.1.8. Three quarters of the fishermen had a high school diploma and 28% had some college education. Approximately 44% of the fishermen indicated $30,000 or less in household income when surveyed, with 26% bringing in more than $50,000. Almost 60% of respondents indicated that more than 75% of their income came from fishing and 46% reported that fishing is their sole source of income. Nearly all were white males, with an average age of 50 and over 25 years of commercial fishing experience. One interesting observation in the blue crab fishery has been a recent increase in the number of fishermen of Asian ethnicity. This trend in the ethnicity of the fishermen has not shown up in the socioeconomic surveys most likely due to language barriers.

Table 9.1.8 Characteristics of North Carolina blue crab commercial fishermen (NCDMF Socioeconomics Program).

Category	Category Values	Frequency	Percent or Average	Category	Category Values	Frequency	Percent
Age				Marital Status			
	16 years or less	0	0%		Married	224	76.2%
	17 to 25 years	4	1.4%		Divorced	40	13.6%
	26 to 40 years	69	23.4%		Widowed	6	2.0%
	41 to 60 years	156	52.9%		Separated	7	2.4%
	More than 60 years	66	22.4%		Never Married	17	5.8%
	Average		50	Gender			
Ethincity					Male	280	94.9%
	Caucasian/White	276	93.6%		Female	15	5.1%
	African American/Black	11	3.7%	Education			
	Hispanic/Latino	4	1.4%		Less than High School	73	24.7%
	Pacific Islander or Asian	4	1.4%		High School Diploma	139	47.1%
Years Fishing					Some College	57	19.3%
	10 years or less	36	12.1%		College Diploma	26	8.8%
	11 to 20 years	100	33.7%	Dealer Too			
	21 to 30 years	80	26.9%		No	225	78.9%
	31 to 40 years	46	15.5%		Yes	60	21.1%
	More than 40 years	35	11.8%	HH Income			
	Average		25		$5,000 or less	2	0.8%
Income From Fishing					$5,001 to $15,000	25	10.0%
	10% or less	14	4.8%		$15,001 to $30,000	83	33.2%
	11 to 25%	19	6.6%		$30,001 to $50,000	76	30.4%
	26 to 50%	60	20.7%		$50,001 to $75,000	40	16.0%
	51 to 75%	30	10.3%		$75,001 to $100,000	21	8.4%
	More than 75%	167	57.6%		More than $100,000	3	1.2%

9.1.5 HISTORICAL IMPORTANCE OF THE COMMERCIAL FISHERY

A historical overview of the blue crab commercial fishery can be found in section 7.1. The socioeconomic interviews asked commercial fishermen participating in the blue crab fishery how important commercial fishing has been historically in their communities. Almost all fishermen interviewed felt that commercial fishing had been vital historically, ranking it on average a 9.3 on a 10 point scale. Perceptions of the present economic importance were lower, with fishermen ranking the current economic importance of commercial fishing in their communities at 7.8 out of 10.

9.2 RECREATIONAL FISHERY

Blue crabs are harvested recreationally by a variety of means. These can include crab pots (rigid and collapsible), gill nets, shrimp trawls, trot-lines, hand-lines, and dip nets. Prior to July 1999, no license was required to harvest blue crabs recreationally unless a vessel was used. As of July 1, 1999, anyone wishing to harvest blue crabs recreationally with commercial gear is required to purchase a Recreational Commercial Gear License (RCGL). Harvest methods exempt from this license are collapsible crab traps, cast nets, dip nets, hand-lines, and seines (less than 30 feet). Additionally, one pot per person may be attached to the shore along privately owned land or to a privately owned pier without possessing a valid RCGL. The bag limit on recreationally caught crabs is 50 per person per day, not to exceed 100 crabs per vessel.

Numerous recreational fishermen possessing a Coastal Recreational Fishing License (CRFL) as well as many coastal waterfront landowners target blue crabs recreationally. In a study conducted in 2002, it was estimated that nearly 30% of coastal waterfront landowners harvest blue crabs from their property and 7% harvest blue crabs away from their property. This accounted for an estimated harvest of 279,434 pounds of blue crab (Vogelsong et al. 2003). From 2007 to 2010, NCDMF surveyed approximately 20% of CRFL holders on their participation in saltwater fishing activities including gigging, use of a cast net, shellfish collection, and crabbing. The results of the survey for crabbing participants extrapolated across all CRFL holders are shown in Table 9.2.1. While data are available for the number of CRFL holders participating in the recreational blue crab fishery, there are no current data on the harvest of blue crabs by these participants.

Table 9.2.1 Estimated participants and margin of errors for Coastal Recreational Fishing License (CRFL) holders participating in blue crab fishing activities, 2007-2010 (NCDMF CRFL Program).

Year	Estimated participants	Margin of error (%)
2007	84,693	0.147
2008	71,604	0.148
2009	75,424	0.148
2010	74,225	0.145

A survey of RCGL holders conducted in 2008 by the NCDMF indicated that blue crabs were the most abundant species landed (by weight) by RCGL participants, accounting for 23% (110,234 pounds) of the total poundage (482,082 pounds) landed (Table 9.10). Of these landings, 92.6% were caught using crab pots, 2.7% using small mesh gill nets, 2.0% using shrimp trawls, 1.7% using large mesh gill nets, and 1.0% using fish pots. The peak months for recreational blue crab harvest were June (18%), July (21%), August (17%), and September (14%). RCGL holders using crab pots used an average of 4 pots per license.

Estimated RCGL effort and harvest data for blue crabs from 2002 to 2008 are presented in Table 9.2.2. From 2002 to 2006, blue crabs yielded the second highest landings by species, exceeded only by spot. In 2007 and 2008, blue crabs became the predominant species landed by RCGL holders. During all survey years, blue crabs accounted for the most directed fishing trips. While the number of trips taken fluctuated from year to year, there was a decreasing trend in effort. The number of blue crabs harvested also saw a decreasing trend through most of the time series with an uptick in landings in 2008. Each year, blue crab harvest from RCGL holders was considerably less than the blue crab commercial harvest (less than 1%). The harvest of exempted shore and pier based pots, as well as other non-commercial gear, is unknown. While current data is not available, NCDMF has recently started a new program to survey and estimate recreational blue crab landings from RCGL exempt gear.

Table 9.2.2 Estimates of blue crab directed trips, harvest (number and pounds), and discards for North Carolina Recreational Commercial Gear License (RCGL) holders, 2002- 2008 (NCDMF CRFL Program).

		Directed crab trips			Crab harvest			
Year	Total RCGL trips	Number	Percent of total trips	Total RCGL pounds harvested	Pounds	Percent of total pounds	Number of crabs harvested	Number of crabs discarded
2002	80,159	28,324	35%	1,030,897	134,171	13%	346,550	185,939
2003	55,787	27,907	50%	517,532	157,942	31%	354,425	124,196
2004	53,488	28,021	52%	640,636	117,590	18%	329,478	138,316
2005	47,120	26,278	56%	517,532	105,179	20%	323,531	152,905
2006	43,384	24,401	56%	488,373	94,459	19%	297,875	123,787
2007	41,617	25,153	60%	433,152	98,003	23%	286,856	102,695
2008	40,556	24,732	61%	482,082	110,234	23%	311,690	132,519
Average	51,730	26,402	51%	587,172	116,797	20%	321,486	137,194

9.2.1 ECONOMIC IMPACTS OF THE RECREATIONAL FISHERY

Blue crabs are not a major target species for a majority of recreational anglers fishing in North Carolina. Most fishermen targeting blue crabs use commercial gear authorized for use through the N.C. Recreational Commercial Gear License (RCGL). RCGL fishermen land blue crabs primarily using four different gears: crab pots, shrimp trawl, gill nets, or trotline. Since these fishermen by law, are not allowed to sell their catch, the true economic impact of RCGL fishing is in other sectors of the economy that support their fishing activities.

In 2007, NCDMF collected socioeconomic data from fishermen who are licensed to use limited commercial gear. Table 9.2.3 gives an indication of the expenditures of the recreational blue crab fishery by RCGL fishermen in 2007. The data is shown for those who made overnight trips compared to those who made day trips. The economic figures are based on the actual values reported by RCGL fishermen and are considered the best available estimates.

Table 9.2.3 Average trip expenditures by trip type for Recreational Commercial Gear License (RCGL) participants fishing for blue crabs in North Carolina, 2007 (NCDMF RCGL Program).

	Overnight	Day
Number of Nights	4.70	
Miles Traveled	150.77	29.29
Number Who Fished	2.13	1.89
Lodging	$102.25	
Food	$107.36	$11.93
Ice	$13.80	$3.40
Bait	$15.26	$4.50
Fuel and Oil	$64.73	$34.65
Equipment Rental	$64.86	

Overnight trips averaged slightly less than five nights and involved approximately 150 miles of travel by land. An average of two people fished on the overnight trips. Not all overnight trips resulted in costs associated with paying for lodging; however, when averaged across all overnight trips, lodging per trip was estimated to be $102.25. Food expense for the trip was on average $107.36. Many trips required the rental of equipment and when averaged by all overnight trips, the cost was $64.86 per trip.

Day trips involved an average land travel of 29.29 miles. Slightly fewer people went on day trips compared to overnight trips. Average trip costs were less across all categories compared to overnight trip costs. There were a very small number of fishermen who reported having rental equipment. Due to the small sample size (21 observations) combined with a standard deviation several times larger than the mean, it was decided to not include cost measurements for day trip equipment rentals in the economic impacts.

Based on the survey information, the cost of an average overnight trip was $368.26. For a day trip, the average cost was $54.48. Blue crabs were landed in 2,096 trips in 2007. Day trips accounted for 65% of the total number of trips taken. Based on the survey data, the total economic impact in 2007 for RCGL fishing activities involving blue crab landings is estimated to be approximately $337 thousand (Table 9.2.4).

Table 9.2.4 Economic impact of blue crab landing Recreational Commercial Gear License (RCGL) trips in North Carolina, 2007 (NCDMF Socioeconomics Program, IMPLAN economic modeling software).

Economic inputs	$187,578
Additional economic activity	$149,406
Additional jobs sustained	3
Total economic impact	$336,983

9.2.2 SOCIOECONOMIC CHARACTERISTICS OF RECREATIONAL FISHERMEN

Data on socioeconomic characteristics of recreational crabbers is available only for those recreational fishermen who use a Recreational Commercial Gear License (RCGL). There are many recreational crabbers in North Carolina who fish with hand-lines or have only a single crab pot and therefore, are not required to be licensed. There are no data available for these unlicensed individuals at this time, but NCDMF has recently initiated an ongoing survey that targets recreational crabbers to get better information on catch and effort.

The most recent survey of RCGL license holders took place in 2007. This survey included responses from 511 individuals. The average RCGL fisherman was 56 years old (see Table 9.2.5). Almost 60% were born in North Carolina. Over 80% were currently married, 7.7% were divorced and 5.7% never married. This group of fishermen was predominantly white (98.8%) and male (91.5%). Over 90% had at least a high school diploma and approximately 44% had a college diploma. The majority (88.6%) of these fishermen had a total household income of greater than $30,000 and only 4% had incomes of $15,000 or less.

Table 9.2.5 Characteristics of Recreational Commercial Gear Licenses (RCGL) blue crab fishermen, North Carolina, 2007 (NCDMF RCGL Program).

Category	Category Values	Frequency	Percent or Average	Category	Category Values	Frequency	Percent
Age	16 years or less	3	0.6%	Born in NC	Yes	298	59%
	17 to 25 years	11	2.2%		No	207	41%
	26 to 40 years	57	11.3%	Gender	Male	462	91.5%
	41 to 60 years	225	44.5%		Female	43	8.5%
	More than 60 years	210	41.5%	Education	Less than High School	35	7.0%
	Average		56		High School Diploma	78	15.6%
Marital Status	Married	410	80.7%		Some College	168	33.5%
	Divorced	39	7.7%		College Diploma	220	43.9%
	Widowed	19	3.7%	HH Income	$5,000 or less	3	0.6%
	Separated	11	2.2%		$5001 to $15,000	16	3.4%
	Never Married	29	5.7%		$15,001 to $30,000	34	7.2%
Ethnicity	Caucasian/White	499	98.8%		$30,001 to $50,000	108	23.0%
	African American/Black	2	0.4%		$50,001 to $75,000	101	21.5%
	Pacific Islander or Asian	2	0.4%		$75,001 to $100,000	94	20.0%
	Native American	2	0.4%		More than $100,000	113	24.1%

9.3 SOCIOECONOMIC RESEARCH RECOMMENDATIONS

1. Continue socioeconomic surveys of blue crab harvesters and include wholesale and retail benefits, the entire support industry for this fishery including suppliers, picking houses, and restaurants..
2. Update Recreational Commercial Gear License (RCGL) survey.
3. Continue survey and compile data of recreational crabbers not possessing a RCGL license.
4. Determine the economic effects of imported crabmeat, including the mixture of imported meat with local crabmeat, on processing and demand.
5. Determine the costs associated with crab processing. Identify the factors and their relative importance in predicting processor closures.
6. Research the changing demographics of the commercial blue crab fishery.

10.0 ENVIRONMENTAL FACTORS

Habitat and water quality are critical elements linked in the ecology of estuarine systems. Degradation or improvement in one aspect of habitat or water quality may have a corresponding impact elsewhere. Steele and Perry (1990) suggested that habitat loss might be a significant factor in determining blue crab production. Maintenance and improvement of suitable estuarine habitat and water quality are probably the most important factors in providing a sustainable blue crab stock.

10.1 HABITAT

The blue crab life cycle consists of an offshore phase and an estuarine phase that occurs in a wide range of habitats based on its life stage, sex, maturity, and associated salinity preferences. High salinity ocean waters provide habitat for spawning females as well as ensuring larval development and dispersal. Estuarine sounds, rivers and creeks contain a range of habitats which function as refuge, settlement, nursery, and foraging.

Seasonal abundance of blue crabs for different habitat types in Core Sound, N.C. was documented by Dudley and Judy (1973). Juvenile blue crabs were most abundant from late fall through early spring in shallow soft-bottomed creeks bordered by marshlands. Peak juvenile abundance in shallow, sandy grass-bottomed areas at or near the mouths of small creeks occurred during the fall and again in spring. Samples from the ocean inlets during June, July, and August were composed mainly of mature females, most having either a sponge (egg mass on the abdomen) or remnant sponge (after the eggs have hatched).

The importance of these habitats varies with location along the coast. Shallow sand bottom, shell bottom and woody debris become more important along the southern coast where seagrasses are more seasonal, sparse or absent. Along the Cape Fear River, smaller crabs (juvenile and sub adult) are common just outside the inlet as well as in structural habitats and shallow areas of the estuary, probably reflecting the small size of the southern estuaries (Posey et al. 2005)

Blue crabs utilize five of the six habitats identified by the North Carolina Coastal Habitat Protection Plan (CHPP) including: water column, wetlands, submerged aquatic vegetation (SAV), soft bottom, and shell bottom. These habitats may be impaired by physical degradation by dredges, watercraft, and fishing practices or through poor water quality caused by freshwater drainage, land use changes, eutrophication (excessive nutrients), high organic loading, and chemical pollution. Sea level rise, subsidence, invasive species, storms, disease, and erosion are natural processes, perhaps exacerbated by human activities, but also responsible for loss of critical habitat (Steele and Perry 1990).

The CHPP, mandated by the Fisheries Reform Act of 1997 (FRA), describes and documents the use of habitats by species supporting coastal fisheries, the status of these habitats, and the threats to the condition of those habitats. The FRA stipulates that habitat and water quality considerations in FMPs be consistent with CHPP. For more information about each of the habitats discussed below, refer to the 2010 CHPP (Deaton et al. 2010).

10.1.1 WATER COLUMN

Blue crabs use the water column habitat, defined as "the water covering a submerged surface and its physical, chemical and biological characteristics" (Deaton et al. 2010), for spawning, transport of progeny, foraging, and movement throughout the estuary to ocean system. The water column provides a transport mechanism for larval blue crabs from inlet-spawning, to continental shelf development, and megalopal stage settlement in shallow estuaries. Physical and chemical water column parameters (i.e., temperature and salinity) are influential factors in all portions of the life of the blue crab (see Section 6.1 General Life History).

Blue crab populations are significantly affected by water column conditions in creeks, estuaries, and the coastal ocean. Salinity, which is a determining factor in the distribution of the blue crab, is affected by rainfall, season, estuarine morphology, wind, tides, and freshwater discharge (Deaton et al. 2010). Changes in the amount and timing of freshwater inflow may have major effects on that segment of the blue crab life cycle taking place in the estuary (Steele and Perry 1990). Development of land results in increased impervious surface area that results in a watershed with "flashy" stormwater flows. This results in large pulses of freshwater flowing into creeks and estuaries that may contain large amounts of eroded sediments, nutrients, and pollutants. Human alteration of hydrology through ditching, development, water withdrawals or discharges can also affect salinity. Pate and Jones (1981) compared nursery areas that were unaltered and anthropogenically altered by upland drainage (ditching) and found that blue crab and other species were more abundant in nursery habitats with no man-made drainage. They attributed this to the unstable salinity conditions that occurred in areas adjacent to channelized systems following moderate to heavy rainfall (>1 inch/24 hr).

Luczkovich et al. (2008) compared changes in blue crab abundance in estuarine Primary Nursery Areas (data from NCDMF Estuarine Trawl Survey-Program 120) with land use change in local catchments between 1980 and 2000 using satellite imagery for tidal and non-tidal estuaries. Most of the land use change in the catchments associated with Program 120 sampling in Hyde, Beaufort, Pamlico, Carteret, and Onslow Counties was conversion of forest to agriculture. Researchers found a negative correlation between change in land use and change in blue crab abundance at stations in the non-tidally flushed catchments. These locations likely experience increased freshwater runoff due to the land use changes and have the potential to accumulate large amounts of nutrients and sediments that can result in degradation of habitat and water quality. They also noted there were many stations that showed an increase in number of crabs per trawl, but these tended to be in watersheds where less than 10% of land use area was changed.

In developing coastal counties, water treatment plants produce salty effluent from desalination (membrane filtration) and water softening (ion exchange), that when discharged into fresh or low salinity surface water environments, can create isolated pockets of higher salinity water. Aside from the preference of the male and female blue crab for certain salinity ranges, the vertical salinity stratification produced from these discharges in the estuarine water column creates unfavorable low dissolved oxygen (DO) conditions. Low DO conditions serves to degrade bottom habitat, cause stress or mortality in benthic species, and forces mobile species to move (Stanley and Nixon 1992; Buzzelli et al. 2002).

Water temperature and water flow affect blue crab distribution, recruitment, and survival. Blue crab spawning is triggered primarily by increasing water temperatures during spring and declines as water temperatures drop in fall (Deaton et al. 2010). Using data from a winter crab dredge survey in Chesapeake Bay, researchers found a negative correlation between the percentage of dead crabs and January water temperature (Sharov et al. 2003). Bauer and Miller (2010) also found that winter survival rate varies with winter severity. Experiments showed that time to death increased with increasing temperature and salinity, and that small juveniles are at a higher risk of dying in the winter than larger juveniles.

In a study of post-larval blue crab dispersal, Reyns et al. (2007) found that most post larval blue crabs were found in surface waters at night. Using particle tracking simulations the model suggests that Oregon Inlet was the primary supplier of post-larval blue crabs to the northern basin. The model indicated that dispersal to across-sound nursery habitats only resulted from the combination of tidal and wind-driven currents. Ramach et al. (2009) found that in a small embayment, female crabs congregated in the deeper area near the mouth while the males stayed in the shallow upper areas. Females with late stage eggs were found closest to the mouth while 92% of ovigerous crabs left the embayment before larval release. Since salinity was homogeneous throughout, the authors attribute this pattern to tidal activity rhythms (Ramach et al. 2009).

Hurricanes may play a key role in the dispersal of post-larval blue crabs in the Albemarle-Pamlico estuarine system. Etherington and Eggleston (2000) showed that during a period of no storm events, juvenile recruitment occurred in the extensive seagrass beds in the eastern region of the system, but after a tropical cyclone, dispersal was widespread throughout the system. They conclude that eastern seagrass beds act as a consistent initial recruitment site and that the Northern and Western regions serve as episodic post-settlement recruitment areas after tropical cyclones. Eggleston et al. (2010) found that certain hurricane situations are responsible for expanding the blue crab nursery capacity of the Albemarle-Pamlico estuarine system. They conclude that the spatiotemporal variation in settlement was dependent on the number of tropical storm days during the fall recruitment season, the frequency and duration of northeast winds, and to some degree, hours of dark flood tide (Eggleston et al. 2010). The highest settlement events were generally associated with storm tracks that made landfall from the ocean travelling northwest or storms parallel to the coastline and greater than 300 km offshore (Eggleston et al. 2010).

Jetties and groins are both hardened structures positioned perpendicular from shore to control sand movement. In association with inlets, these structures can potentially interfere with the passage of larvae from offshore into estuarine nursery areas because successful transport of larvae through the inlet occurs within a narrow zone parallel to the shoreline and is highly dependent on along-shore transport processes (Blanton et al. 1999; Churchill et al. 1999; Hare et al. 1999). Obstacles such as jetties adjacent to inlets block the natural passage for larvae into inlets and reduce recruitment success (Kapolnai et al. 1996; Churchill et al. 1997; Blanton et al. 1999). Miller (1992) and Settle (NMFS, unpub. data), in reviewing the potential impacts of a dual jetty system at Oregon Inlet, estimated that successful passage of winter-spawned, estuarine-dependent larvae through Oregon Inlet could be reduced 60-100%. Although there is uncertainty regarding the magnitude of fisheries impacts, jetties and groins would likely reduce larval recruitment into estuarine nurseries (Kapolnai et al. 1996; Churchill et al. 1997; Blanton et al. 1999).

Water quality parameters such as dissolved oxygen, nutrients, turbidity, heavy metals, and toxins can also determine the quality of a blue crab habitat. Many of these parameters are greatly influenced by human activity. These aspects of the water column habitat will be discussed further in Section 9.2 Water Quality.

10.1.2 WETLANDS

Wetlands are defined as "…areas that are inundated or saturated by an accumulation of surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (Deaton et al. 2010). Wetlands are considered one of the most biologically productive ecosystems in the world (Teal 1962). The primary productivity associated with wetlands is converted into secondary production of fishes and invertebrates through detrital and microalgal pathways (Peterson and Howarth 1987). In coastal regions, wetlands typically are found in both estuarine and freshwater areas. Estuarine wetlands generally occur in low energy environments of bays, sounds, and rivers in polyhaline and mesohaline waters. Freshwater wetlands, including freshwater marshes, bottomland hardwood forest and swamp forests, generally occur in low-salinity to freshwater areas of creeks, streams, and rivers.

Wetlands are particularly valuable as nurseries and foraging habitat for blue crab as well as other fishes and shellfish (Graff and Middleton 2003; Weinstein 1979). The combination of shallow water, thick vegetation, and high primary productivity provides juvenile and small fishes with appropriate physicochemical conditions for growth, refuge from predation, and abundant prey resources (Boesch and Turner 1984; Mitsch and Gosselink 1993; Beck et al. 2001). It is estimated that over 95% of finfish and invertebrates commercially harvested in the United States are wetland dependent (Feierabend and Zelazny 1987). Additionally, wetlands, predominantly riparian wetlands, have been recognized for their ability to slow and spread stormwater runoff as well as filter and trap pollutants entering surface waters (Mitsch and Gosselink 1993).

In general, juvenile blue crabs have wide distributions, but they are most abundant in middle and upper estuarine waters of low to intermediate salinity (Perret et al. 1971; Swingle 1971; Adkins 1972; Daud 1979; Perry and Stuck 1982). Optimum sediment for small crabs is detritus, mud, or mud-shell bottom (Adkins 1972). Subtidal sand and mud bottoms have been documented as overwintering habitat for juvenile blue crabs (Thomas et al. 1990). Small creeks and rivers in and around salt marshes provide shallow-water habitats for larger juveniles and mature crabs for feeding and refuge during molting (Orth and van Montfrans 1987; Hines et al. 1987; Thomas et al. 1990). Coarse woody debris (wood particles more than 2 centimeters or 0.8 inches in diameter) in shallow waters adjacent to forested riparian zones provides valuable shelter for large crabs, particularly during molting phases, when SAV is not present (Everett and Ruiz 1993; Wolcott and Hines 1989).

Transition zones between habitats may be especially important for the blue crab. Blue crabs were found to be more abundant along salt marsh edge for refuge, foraging, and corridor to other habitats (Minello 1999; Micheli and Peterson 1999; Clark et al. 2003). Micheli and Peterson (1999) found that adult blue crabs utilized marsh edge habitat in preference to unvegetated, open water habitat in a North Carolina estuary. Predation on infaunal bivalves was greater along vegetated edges of salt marshes and SAV than on unvegetated intertidal flats. A study in Galveston Bay was able to predict a substantial decline in shrimp and blue crab populations following a decline in salt marsh edge relative to open water (Rozas et al. 2007).

It is estimated that approximately 66% (4.7 million acres) of historical wetlands remain in North Carolina including 88% (183,000 acres) of historical salt or brackish marsh (DWQ 2000a). Additionally, 29,560 acres (11.6%) of existing salt, brackish, and freshwater marsh appear to be physically altered (DCM unpublished data). Human population growth and the associated land use changes are the primary cause of wetland habitat loss today (Dahl 2000). Prior to the

1990's, wetland losses were principally related to ditching and draining for agriculture as well as deforestation and fill activities associated with silviculture. Since 1990, activities such as dredging, water control projects and hydrological alterations are the primary threats to wetland habitats.

One human alteration of particular concern for wetland habitats is shoreline stabilization. Hard structure stabilization techniques along estuarine shorelines cause gradual, long-term decreases in wetland vegetation through decreased sedimentation, accelerated erosion, increased wave scour, and by preventing landward migration of vegetation. Increased scour and turbulence was shown to cause a mortality rate of 63% for marsh vegetation waterward of newly constructed bulkheads (Garbisch et al. 1973). The added turbulence at the base of bulkhead structures and increased water depth prevents vegetative recolonization and expansion post bulkhead construction (Knutson 1977). Several studies have indicated lowered species richness, diversity, and abundances of juvenile fishes and invertebrates adjacent to bulkheaded shorelines than adjacent to naturally vegetated shorelines (Mock 1966; Gilmore and Trent 1974; Peterson et al. 2000). The lower value of the bulkheaded shorelines to juvenile fishes and invertebrates was attributed to the reduction of benthic food resources and the deeper waters and lack of vegetated refuge allowing for the infiltration of large piscivorous fishes into these areas.

10.1.3 SUBMERGED AQUATIC VEGETATION

Submerged aquatic vegetation habitat is "bottom that is recurrently vegetated by living structures of submerged, rooted vascular plants (e.g. roots, rhizomes, leaves, stems, propagules), as well as temporarily unvegetated areas between vegetated patches" (Deaton et al. 2010). Submerged aquatic vegetation occurs in both subtidal and intertidal zones, and is generally separated into two types of communities: high salinity estuarine communities including species such as eelgrass (*Zostera marina*) and shoalgrass (*Halodule wrightii*), and low salinity/freshwater communities including species such as wild celery (*Vallisneria americana*) and sago pondweed (*Potamogeton pectinatus*). The spatial structure of SAV habitat can be quite variable, ranging from small isolated patches of plants less than a meter in diameter to continuous meadows covering several acres (Deaton et al. 2010). By nature, the extent of SAV coverage tends to fluctuate on the scale of days to decades, depending on species and physical conditions (Fonseca et al. 1998) (Figure 10.1.1). In addition, SAV abundance, biomass, and species composition in North Carolina waters varies seasonally with changes in temperature and light conditions (Dawes et al. 1995; SAFMC 1998). Figure 10.1.1 shows the mapped areas of SAV coverage as of 2009, although as of 2011, the presence of large SAV beds is known as far south as New Hanover County.

In Bogue Sound, *Zostera* beds that are established in the cold months may be replaced by *Halodule* in the warm months. These seagrasses have very different structures and seine/trawl studies suggest they may be used differently by crustaceans (Dr. Martin Posey, UNC-Wilmington, personal communication). South of Bogue Sound to northeast New Hanover County waters, seagrasses are not as abundant, patchier, and limited to shallow shoals and shoreline edge. Where seagrasses become sparser, other habitats, especially intertidal oyster, marsh channel, and detritus/woody debris become more utilized as juvenile habitat.

The ecological services SAV provides maintain and enhance the overall functionality of estuaries and coastal rivers. The above- and below-ground structures of SAV modify wave energy regimes, stabilize sediments and adjacent shorelines, and cycle nutrients within the system (Thayer et al. 1984; SAFMC 1998). These processes generally increase water clarity, decrease the frequency of nuisance algal blooms, and promote conditions favorable for growth and expansion of SAV (Thayer et al. 1984). Furthermore, because of their high rate of primary production, SAV provides an important source of organic matter. The large quantities of organic material produced by SAV support the base of a complex food web necessary for the maintenance of fish and invertebrate populations (Thayer et al. 1984).

Blue crabs use seagrasses during post-larval settlement, juvenile development and overwintering, as well as for protection during molting and soft shell phases of all size classes. In the Albemarle-Pamlico estuarine system, the majority of initial recruitment of juvenile crabs occurs in SAV beds around inlets behind the Outer Banks, unless there is a major storm event. In years with large storm events, crabs are dispersed into additional lower salinity habitats across the sound (Etherington and Eggleston 2000). In the Chesapeake Bay region, juvenile crabs grow faster, occur more densely, and have higher survival rates in SAV beds (Heck and Orth 1980; Chesapeake Bay Commission 1997). Survival of blue crabs in a New Jersey estuary was attributed to the ability of the species to overwinter in SAV (Wilson et al. 1990).

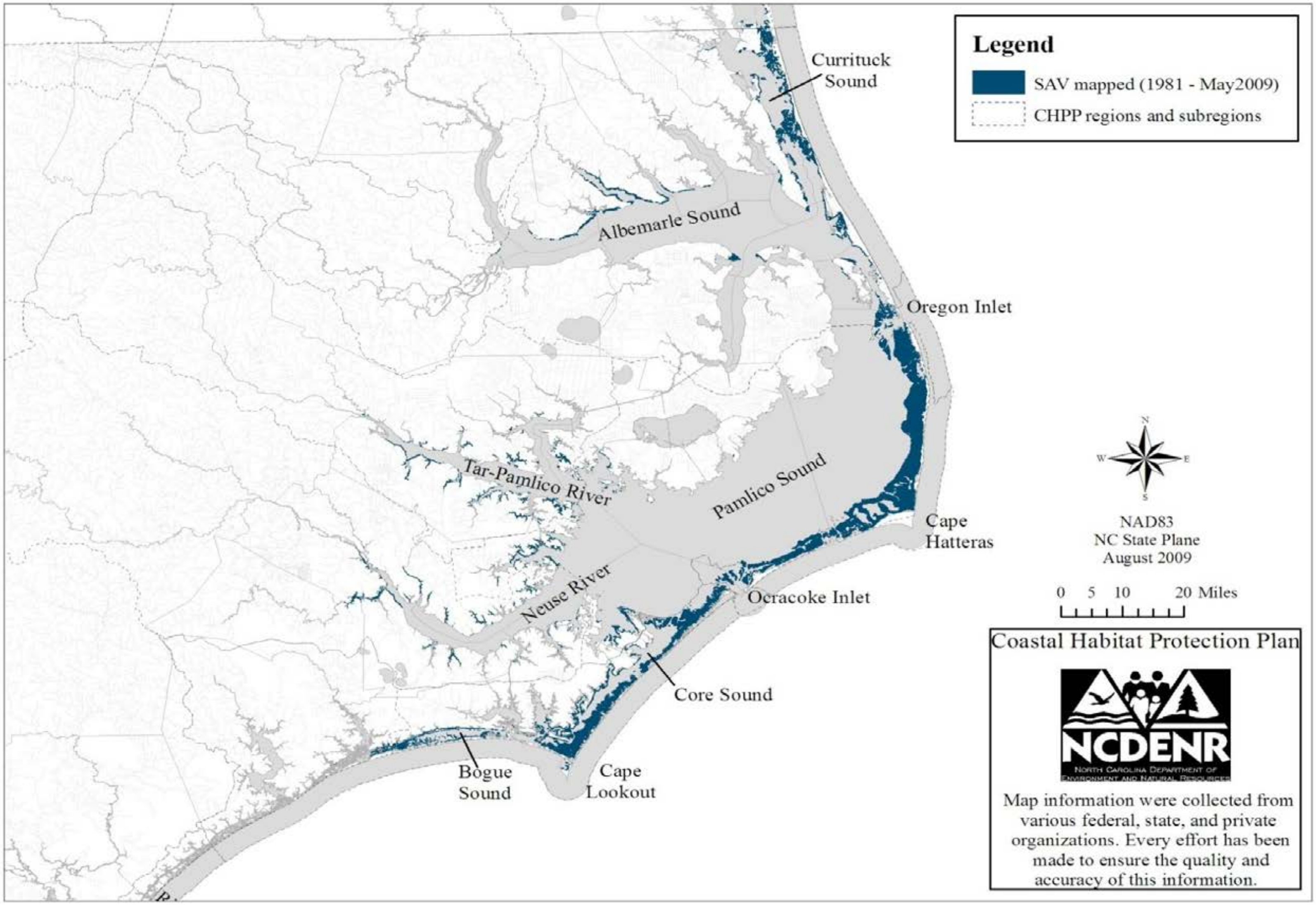

Figure 10.1.1 Location of mapped submerged aquatic vegetation (SAV) habitat in coastal North Carolina (1981-2009) (from 2010 CHPP).

SAV functions as a safe refuge and corridor between habitats; thereby, reducing predation of juvenile blue crabs (Micheli and Peterson 1999). Several studies in estuarine SAV beds also found that blue crabs were more abundant in large or continuous SAV beds than in small or patchy SAV beds, (Murphey and Fonseca 1995; Irlandi and Crawford 1997; Eggleston et al. 1998; Hovel 2003). At sites near Ocracoke and Hatteras inlets, the density of juvenile blue crabs increased significantly with increasing seagrass blade length, but not with biomass or shoot abundance (Etherington and Eggleston 2000). According to Orth (1992), high densities of seagrass shoots and increased plant surface area inhibit predator efficiency and provide shelter to juvenile blue crabs. Hovel (2003) found the density of juvenile blue crabs in Back Sound, North Carolina, increased with seagrass shoot density, but was negatively correlated with crab survival due to cannibalism that resulted from the high crab densities.

Within the Albemarle-Pamlico estuarine system, shallow detrital habitats and Eurasian watermilfoil (Myriophyllum spicatum) are important habitat alternatives to nursery areas composed of native SAV (Etherington and Eggleston 2000). Fully-grown adult male blue crabs and juvenile blue crabs also utilize Lake Mattamuskeet as well as other areas where there are aquatic freshwater beds. As with seagrasses, this habitat also provides primary productivity and structural complexity to the ecosystem.

The majority of SAV in North Carolina occurs in the high salinity, shallow (< 1 m depth) waters of eastern Pamlico and Core Sounds (Figure 10.1.1). The persistence of these high salinity seagrass beds seems to be relatively stable over time (Ferguson and Wood 1994). Since approximately 2004, there have been observations of increasing high salinity SAV coverage in some areas south of New River. In contrast, qualitative reports from the mid to late 1990's indicated large-scale reductions of low salinity SAV habitats, primarily along the western shores of Albemarle and Pamlico sounds (North Carolina Sea Grant 1997). Beginning in the early 2000's, native SAV beds in the Albemarle Sound area recovered and expanded significantly into areas that have not historically supported SAV (i.e., western Albemarle Sound, bays, and Chowan River). Hydrilla, an exotic invasive SAV, found in many locations in 2010; now, threatens to compete with and supplant native SAV in the western Albemarle Sound area.

While threats to the stability of SAV health and distribution are many, water quality degradation, including nutrient enrichment and sediment loading, is the greatest threat to SAV (Orth et al. 2006). The impacts from nutrient enrichment and sediment loading, including increased turbidity, increased epiphytic loads, and sedimentation, and increased concentrations of toxic hydrogen sulfide, directly reduce SAV growth, survival, and production (Dennison et al. 1993; Fonseca et al. 1998; SAFMC 1998). Effects of eutrophication are generally most severe in sheltered, low flow areas with concentrated nutrient loads and large temperature fluctuations (Burkholder et al. 1994).

Once SAV habitat is lost, the associated sediments are destabilized which can result in accelerated shoreline erosion and increased turbidity. This can lead to conditions that are not favorable to SAV recolonization and expansion in the affected area. Submerged aquatic vegetation in adjacent areas may also be impacted by the resulting increase of turbidity in surrounding habitats, thus increasing the total area affected (Durako 1994; Fonseca 1996). Losses of SAV on much larger scales are particularly problematic because the rate of SAV recovery though propagation, recolonization, etc. is often much slower than the rate of SAV loss (Fonseca et al. 1998). Nevertheless, recovery of SAV habitat may be possible with improvements to water quality as evidenced by the net gain of SAV acreage in Tampa Bay, Florida and Hervey Bay, Australia following stricter water quality standards (Orth et al. 2006).

Human development of open water areas threatens SAV abundance and coverage. Dredging for navigational purposes, marinas, or infrastructure can directly impact SAV through large-scale removal or destruction of existing grass beds. Docks constructed over SAV and the associated shading can lead to the gradual loss of SAV both beneath and in a perimeter adjacent to the docking structure (Loflin 1995; Schafer 1999; Florida Department of Environmental Protection, unpublished data). In North Carolina, current dock designs have been found to result in the reduction of shoalgrass coverage and density when constructed over existing SAV habitat (Connell and Murphey 2004). In addition to the impacts of shoreline development and dredging on SAV, the associated increase in boating activity can lead to increased prop scarring through vegetated areas. The propeller cuts leaves, shoots, and root structures and creates a narrow trench through the sediment. Recovery of SAV from prop scarring can take upwards of 10 years, depending on SAV species and local conditions (Zieman 1976). Wakes associated with an increase in boating activity can lead to the destabilization of sediments, which can increase turbidity, thus impacting SAV growth potential.

Use of bottom disturbing fishing gears also have the potential to damage or destroy SAV. Gears that result in belowground disturbance may cause total loss of SAV and require months to years for the affected area to recover. However, the Marine Fisheries Commission (MFC) imposed regulations restricting the use of gears that severely damage SAV, including oyster, crab and hydraulic clam dredges; bottom trawls; clam kicking; and bull rakes.

Regulatory designations protecting SAV from fishing gear include crab spawning sanctuaries, mechanical methods prohibited areas, military protected areas, Shellfish Management Areas, Oyster Sanctuaries, Primary Nursery Areas (PNA), Secondary Nursery Areas (SNA), Special Secondary Nursery Areas (SSNA), and trawl net prohibited areas protect SAV in those areas from potential physical disturbance associated with bottom fishing gear (Figures 10.1.2 – 10.1.4). Crab spawning areas protect an area from crab dredging, crab trawling, and other methods disturbing the substrate. Oyster dredging is restricted in Mechanical Methods Prohibited areas, Oyster Sanctuaries and PNAs. Fishing activities in military protected areas are by permission only. Trawling of all kinds is prohibited in Shellfish Management Areas, Oyster Sanctuaries, PNAs, SNAs, and periodically in SSNAs. Trawl net prohibited areas apply to trawling of all kinds, whereas some areas are closed to shrimp trawling only (Figures 10.1.2-10.1.4). Areas open to clam trawling (“kicking”) were delineated to avoid SAV impacts. The efficiency of most mechanical fishing gears is reduced when pulled through dense SAV beds, therefore discouraging the practice. Only scallop dredging is both conducted and allowed in SAV habitat. Hand assisted methods (rakes <12 inches wide and <6 pounds, tongs) are prohibited in established SAV beds [MFC rule 15A NCAC 03K .0102 and 15A NCAC 03K .0304].

Areas closed to both oyster dredging and trawling protect 70% of mapped SAV in coastal North Carolina (Table 10.1.1). An additional 10% of SAV is protected from oyster dredging only. The area of SAV protected from only trawling or shrimp trawling was <1%. Crab Spawning Areas protected 5% of mapped SAV followed by Special Secondary Nursery Areas at 2%. Military designations and planted Shellfish Management Areas and Oyster Sanctuaries protect <1% of SAV. Areas open to hand harvest (approved, conditionally approved-open, and conditionally approved-closed) include 134,812 acres (90%) of mapped SAV. However, high densities of shell bottom and SAV do not generally overlap.

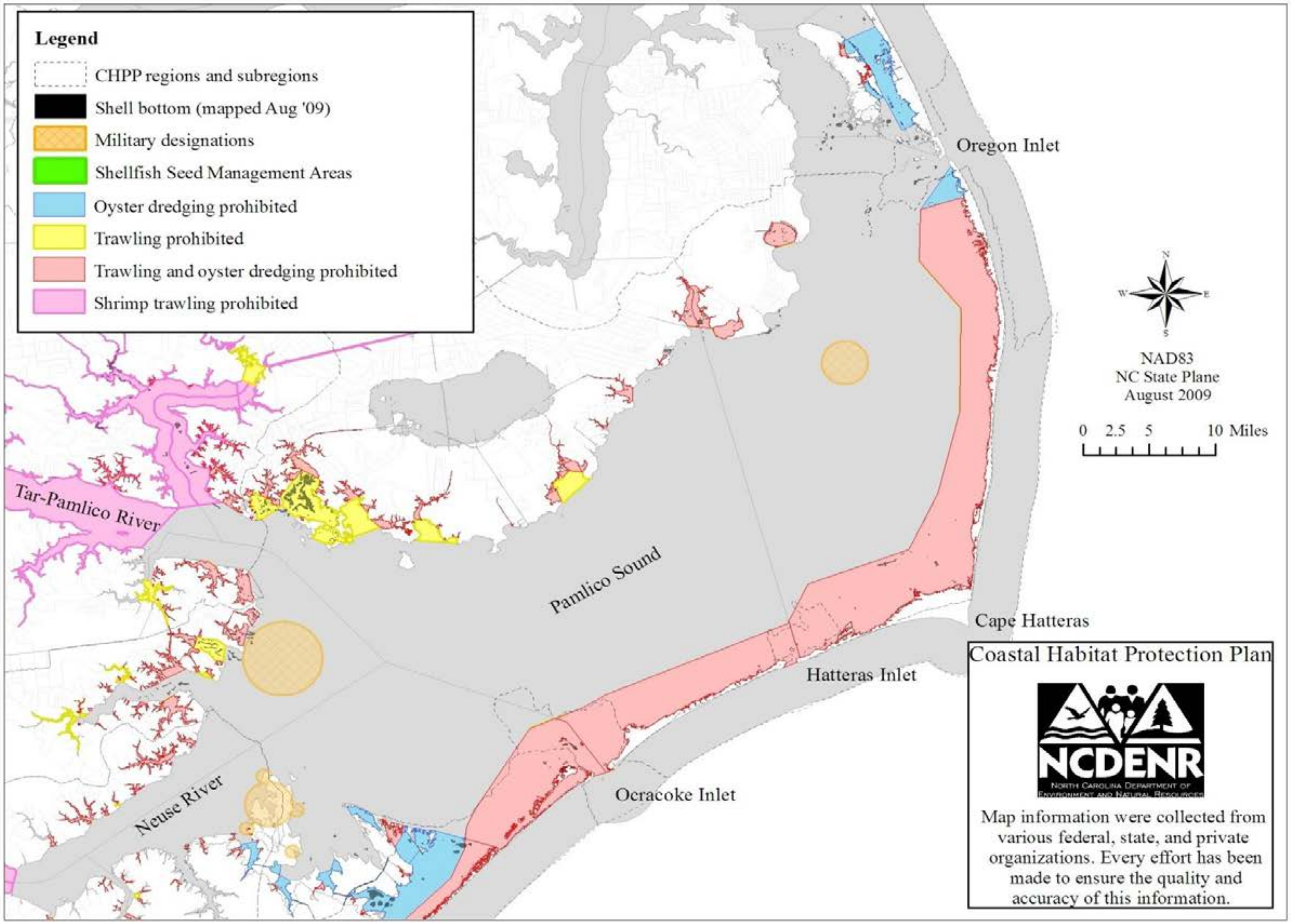

Figure 10.1.2 Areas protected from different gear uses on the northern coast of North Carolina (from 2010 CHPP).

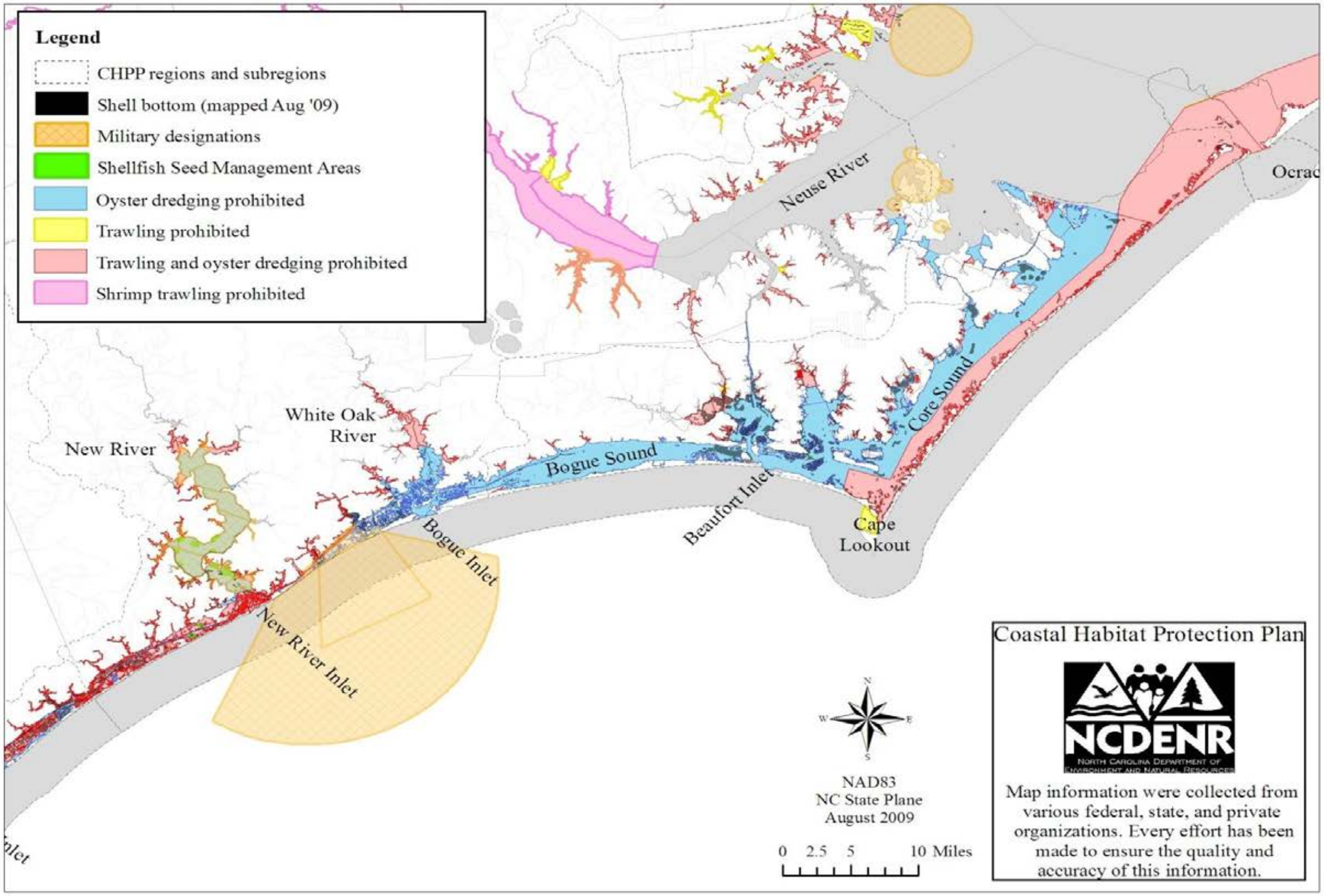

Figure 10.1.3 Areas protected from different gear uses on the central coast of North Carolina (from 2010 CHPP).

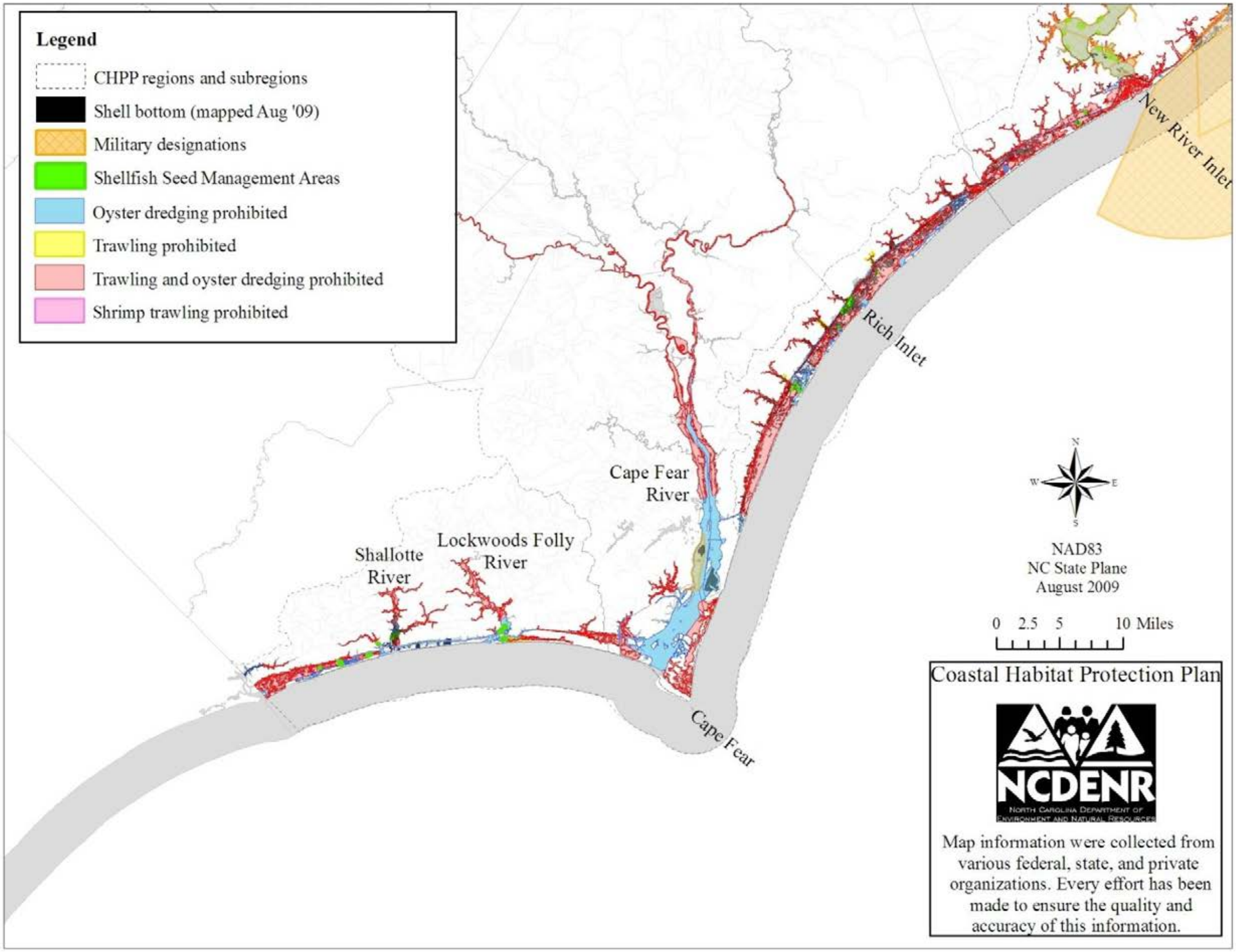

Figure 10.1.4 Areas protected from different gear uses on the southern coast of North Carolina (from 2010 CHPP).

Table 10.1.1. Amount of mapped SAV within areas receiving specific North Carolina Marine Fisheries Commission designations that restrict fishing activities (as of September 2008).

Bottom disturbing fishing gear prohibited	Acres of SAV covered	Percent of mapped SAV
Only oyster dredging[1]	15,556	10%
Only trawling[2]	552	<1%
Only shrimp trawling	1,142	<1%
Both trawling and oyster dredging[3]	105,601	70%
Other MFC designations		
Crab Spawning Sanctuaries	7,684	5%
Military designations	80	<1%
Planted Shellfish Management Areas and Oyster Sanctuaries	19	<1%
Special Secondary Nursery Areas	2,683	2%

[1] Designations include Primary Nursery Areas and Mechanical Methods Prohibited

[2] Designations include Permanent Secondary Nursery Areas and Trawl Net Prohibited

[3] PNAs + overlap of SNAs or No Trawling Areas with Mechanical Methods Prohibited areas

Though a large portion of SAV is protected from dredging and trawling, the spatial distribution of protection leaves some areas relatively unprotected. The great majority of SAV beds along the eastern perimeter of the Albemarle-Pamlico estuarine system are protected within these areas. However, trawling is technically allowed over much of the SAV present in western Core Sound, southern Bogue Sound, both sides of Roanoke Sound, and along the shoreline of West Bay in the southern Pamlico Sound area (Figures 10.1.2 – 10.1.4). Exceptions occur within PNAs, along the northern shoreline of Bogue Sound and one small area in western Bogue Sound (NCDMF 2007 - Bay Scallop FMP). However, the majority of trawling in Bogue and Core sounds occurs in or near the Atlantic Intracoastal Waterway, with some commercial trawling during the high tide in shallow regions outside the ICW. Eleuterius (1987) noted that shallow SAV beds were not affected by trawling except during high tides when beds were more accessible. Most of the SAV occurring in western portions of the Albemarle-Pamlico estuarine system is protected from shrimp trawling. However, crab trawling is allowed in the Pungo River, upper Neuse and Pamlico rivers (Figures 10.1.2-10.1.4). The number of participants and trips for crab trawling has been declining in recent years; 1,780 trips in 2004 to only 157 trips in 2007 (NCDMF 2008c). Cunningham et al. (1992) reported that peeler crab trawls (16-20 feet in head rope length) are pulled in shallow areas such as creeks and grass beds. However, only a small portion of peeler crabs landings are from trawls (NCDMF 2004).

As part of 2005 CHPP implementation, the NCDMF prepared maps identifying areas where allowed use of bottom disturbing fishing gear does or could overlap with sensitive estuarine habitat (CHPP IP database 2009 – Action #223). The largest spatial gap in SAV protection from fishing gear impacts was in northern Pamlico Sound where dredging for crabs is allowed [MFC rule 15A NCAC 03R.0109]. This area included SAV beds in the sound immediately west of Pea Island National Wildlife Refuge. Based on SAV data from the late 1980s and early 1990s

(Ferguson and Wood 1994), there are 15,560 acres (6,296.91 ha) of SAV within the designated crab dredging area. In 2004, the MFC removed the portion of crab dredge area that overlapped with the no trawl area in northeastern Pamlico Sound. This was one of the earliest accomplishments of the 2005 CHPP. Now crab dredging is allowed in one area of primarily soft bottom in northern Pamlico Sound (approximately 100,653 acres) (Figure 10.1.5), and is opened by rule from January 1 to March 1 [15A NCAC 3L .0203].

The shrimp (3/06), bay scallop (11/07), and oyster FMPs (6/08) also identified and resolved conflicts where gear may be used over sensitive habitats. No trawl areas were expanded along the banks side of northern Core Sound, and no shrimp trawl areas were established in the Pamlico, Neuse, and Pungo rivers (NCDMF 2006) (Figures 10.1.2-10.1.4). Bay scallop dredges, which are smaller dredges and contain no teeth, are allowed over SAV when bay scallop fishing is open (NCDMF 2007). The MFC supported modifying no trawl areas as needed to protected SAV habitat (NCDMF 2007) and expanded Mechanical Methods Prohibited areas in Pamlico Sound (NCDMF 2008).

A newly emerging threat to SAV is the potential impacts of global climate change on this sensitive habitat. While climate change has occurred throughout history, the rate at which sea surface temperature, sea-level, and carbon dioxide concentrations are increasing is much faster than experienced in the last 100 million years (Orth et al. 2006). These changes may be occurring at a rate too fast to allow SAV species to adapt. If SAV is indeed able to adapt to the pace of climate change, shoreline stabilization projects in many coastal areas impede the shoreward migration of SAV necessitated by rising sea-level (Orth et al. 2006). Additionally, the increased frequency and intensity of coastal storms and hurricanes, and the associated delivery of freshwater, nutrients, and sediments, threaten to further degrade water quality in estuaries and coastal rivers, thus reducing SAV health and potential distributional extent (Scavia et al. 2002; Orth et al. 2006).

10.1.4 SHELL BOTTOM

Shell bottom is defined in the CHPP as "estuarine intertidal or subtidal bottom composed of surface shell concentrations of living or dead oysters (*Crassostrea virginica*), hard clams (*Merceneria merceneria*), and other shellfish" (Deaton et al. 2010). Common terms to describe shell bottom in North Carolina include "oyster beds," "oyster rocks," "oyster reefs," "oyster bars," and "shell hash." Shell hash can be described as a mixture of sediments with unconsolidated broken shell (oyster, clam and/or other shellfish). In North Carolina, shell bottom can be either intertidal or subtidal, and can consist of fringing or patch reefs (ASMFC 2007). Subtidal oyster mounds in Pamlico Sound may have been several meters tall, while intertidal oyster reefs in the central and southern estuaries may be only a few oysters thick (Lenihan and Peterson 1998; NCDMF 2008). Generally, oyster spat attach to existing oyster beds and other hard structures, as well as *Spartina alterniflora* roots creating a conglomeration of individuals (NCDMF 2008).

The presence of shell bottom in estuarine systems provides a number of ecological services that enhance the health and productivity of the ecosystem. Oysters enhance the water quality of estuaries through filtration of sediments and pollutants from the water column (ASMFC 2007). Additionally, the structure provided by shell bottom decreases wave energy, stabilizes sediments, and decreases erosion of immediate and adjacent areas (Lowery and Paynter 2002). Oyster reefs also function as important sinks for nutrients and other pollutants (ASMFC 2007).

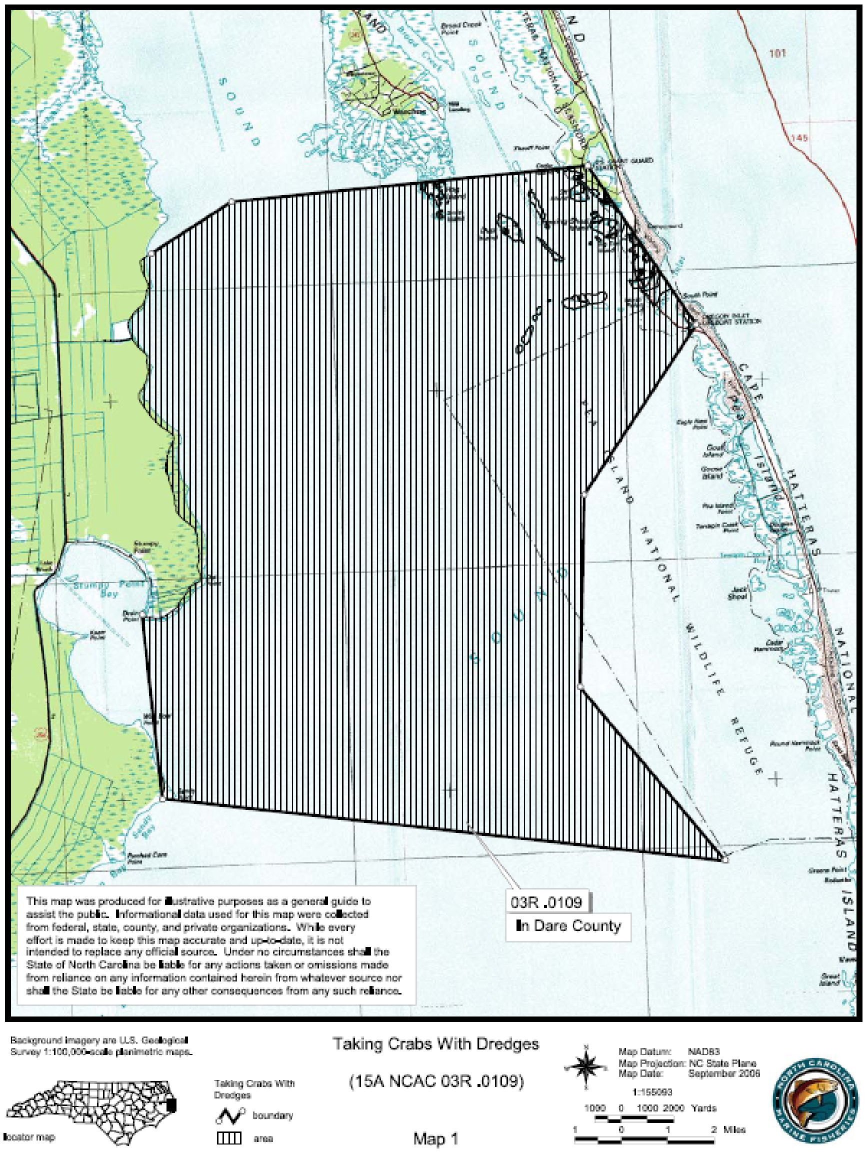

Figure 10.1.5 Crab dredging area in northern Pamlico Sound.

Much of the natural shell bottom in North Carolina is built by and consists primarily of oysters. Oyster distribution and abundance is generally limited by ambient water quality conditions, such as salinity and high temperatures (Funderburk et al. 1991). Additionally, predators such as boring sponges, oyster drills, and whelks further restrict the distribution of oysters, especially in higher salinity waters (Bahr and Lanier 1981). In North Carolina, oyster distribution is limited to areas between extreme southeastern Albemarle Sound and the South Carolina border (NCDMF 2008). In southeastern Albemarle and Pamlico sounds, oyster reefs consist primarily of subtidal beds concentrated along the western shore (Epperly and Ross 1986). Subtidal beds also are present in the Newport, White Oak and New rivers in the central estuaries. Intertidal beds dominate most areas south of Cape Lookout (NCDMF 2008). The southern coastal area has greater tidal amplitude than the mid and northern coasts and oysters occupy a central location between subtidal channels and mid-upper intertidal marshes. These intertidal reefs along the southeastern coast are utilized as juvenile habitat by blue crabs and may form important habitat connections from subtidal areas to the intertidal marshes.

Blue crabs forage heavily on oyster reefs, functioning as important predators of oyster spat and juvenile hard clams (Menzel and Hopkins 1955; Krantz and Chamberlin 1978; Eggleston 1990; Mann and Harding 1997; Coen et al. 1999; Grabowski and Powers 2004; Posey et al. 2004; Grabowski and Kimbro 2005). Studies of restored oyster reefs in the Neuse River demonstrated that restored oyster reefs in shallow water as well as tall reefs in deep water provide refuge from low oxygen disturbances (Hunter 1998). Marshes and SAV located near restored oyster reefs enhance movement of foraging blue crabs by providing a corridor for this movement (Micheli and Peterson 1999).

The current distribution of shell bottom habitat in North Carolina is much less than historical accounts from the late 19th century, when subtidal oyster rocks were so prevalent they were considered navigation hazards (Newell 1988). The initial decline of shell bottom habitat coincided with the introduction of mechanical dredge harvesting techniques in 1889 (NCDMF 2008). Most of the losses of shell bottom were on the subtidal oyster reefs in Pamlico Sound, where over 90% of the oyster fishery was concentrated through the mid 20th century (Chestnut 1955; NCDMF 2008). Mechanical harvesting of oysters directly impacts oyster populations and health by removing both spawning stock biomass, as well as decreasing settlement areas for oyster larvae (Lenihan and Peterson 1998; Lenihan et al. 1999). Currently, mechanical harvesting of oysters is restricted by the MFC to approximately 222,224 acres of temporarily open shellfish bottom in the Neuse, Pamlico, Tar-Pamlico, and Albemarle management units. However, even with these restrictions, oyster populations have been extremely slow to recover. Hand harvest methods, such as rakes and tongs, can be just as destructive to shell bottom as mechanical harvest, only on a much smaller scale.

In addition to the direct impacts of shellfish harvesting on shell bottom, human development and the associated watershed alterations can indirectly impact shell bottom habitat distribution and health. Increased sediment load in stormwater runoff from construction, forestry, and agricultural activities can harm shellfish by clogging gills, increasing survival of pathogens, and increasing ingestion of non-food items (SAFMC 1998). Additionally, increased nutrient concentrations leading to an increase in phytoplankton blooms can lower bottom water DO concentrations, thus stressing or killing shellfish in the affected area (Funderburk et al. 1991). Of particular importance to the health of oyster populations has been the increase in prevalence of the oyster parasites Dermo (*Perkinus marinus*) and MSX (*Haplosporidium nelsoni*), predominantly in areas of moderate salinity (16 to 20 ppt). Physiological stress induced by water quality alterations such as low dissolved oxygen increase the susceptibility of oysters to parasitism and disease (Lenihan et al. 1999).

10.1.5 SOFT BOTTOM

Soft bottom habitat is defined as “unconsolidated, unvegetated sediment that occurs in freshwater, estuarine, and marine systems” (Deaton et al. 2010). The soft bottom habitat is separated into freshwater, estuarine, and marine habitats due to differing geomorphology, sediment type, water depth, hydrography, and/or salinity regimes (Deaton et al. 2010). Underlying geology, basin morphology, and physical processes influence the physical and chemical makeup of the soft bottom habitat, which may influence aquatic organism distribution. In general, coarse sands are concentrated along high-energy and eroding shorelines, while fine muds are concentrated along low-energy shorelines and deepwater basins (Wells 1989; Riggs 1996).

One of the most important functions of soft bottom habitat is as a foraging area for herbivores, detritivores, secondary consumers, and larger predators. This high value as foraging habitat is related to the high concentrations of organic matter transported to and produced on soft bottom. Soft bottoms are generally considered “unvegetated” and lack visible structure; however, the sediment surface supports an abundance of benthic microalgae that supports a diverse array of benthic infauna and epifauna (Peterson and Peterson 1979; Hackney et al. 1996). Hackney et al. (1996) found over 300 species of benthic invertebrates inhabiting the soft bottoms of North Carolina. In addition to benthic microalgae, primary production in bottom sediments is also derived from deposition of detrital material derived from salt marsh vegetation, submerged grasses and macroalgae (Currin et al. 1995). Natural and human-induced nutrients and toxins are also trapped and reprocessed in soft bottom areas through biogeochemical processes. The fate of these materials depends strongly on freshwater discharge, density stratification, and salt wedge formation (Matson and Brinson 1985; Matson and Brinson 1990; Paerl et al. 1998). These materials are processed both within the sediments and from the sediments into the overlying water column through microbial and biogeochemical processes. Increased nutrient and organic inputs exacerbate microbial activity, often leading to declining dissolved oxygen concentration, potentially affecting the distribution of benthic organisms within this habitat.

Although structured habitat such as marsh, SAV, and shell bottom is continually demonstrated to have higher densities of blue crabs than unstructured riverine and subtidal soft bottoms, these areas also provide habitat to blue crabs. Intertidal and subtidal mud flats provide an area of low energy, low predation, and a high amount of benthic prey that lives in or on the sediment. Grabowski et al. (2000) found that crabs would remain in structured habitat (seagrass, salt marsh, oyster rock) during the day, but would migrate onto mud flats at night where they could forage with less risk of becoming prey. Proximity of soft bottoms to vegetation as well as water depth may influence use of these areas by blue crabs. Rozas and Zimmerman (2000) found that the nonvegetated areas adjacent to marshes contained higher densities of most animals, including blue crabs than shallow bay waters. Subtidal sand and mud bottoms have also been documented as overwintering habitat for juvenile blue crabs (Thomas et al. 1990).

Water depth appears to play a role in predation by limiting larger predators to deeper waters. It was noted in Ruiz et al. (1993) that larger predatory fish and blue crabs stayed in deeper water (>70 cm) probably to avoid avian and mammal type predation. They also noted that mortality rates of tethered juvenile blue crabs increased significantly as depth increased. In Chesapeake Bay, Pile et al. (1996) concluded that as small juvenile blue crabs increase in size to larger adult crabs, they move out of vegetated areas to non-vegetative areas. They found that the densities of 0+ year class crabs were significantly higher in vegetated habitats, while the density of 1+ year class crabs was significantly higher in nonvegetated habitats. This shift occurs when the risk of predation on the older crabs is higher than the energy value gained by remaining in the habitat. This move is probably associated with the antagonistic behavior of the older blue crab; thus reducing the risk of predation in these unvegetated areas (Pile et al. 1996).

In a large-scale study of blue crab recruitment in the Albemarle-Pamlico estuarine system, Etherington and Eggleston (2000) found that the majority of initial recruitment occurred in the eastern region, especially around Oregon Inlet and the extensive seagrass beds located nearby. Also, in association with the passage of tropical storms and hurricanes, significant pulses of recruitment would occur along the mainland shoreline in areas of shallow detrital habitat. Shallow, low relief, intricate detrital habitats are primarily located on the western side of the sound in areas of moderate salinity and high energy. Densities of early juvenile crabs in these detritus habitats were similar to those found in seagrasses.

Crab spawning sanctuaries are located around the five northern-most inlets of North Carolina to protect spawning female blue crabs. During the blue crab spawning season (March-August), trawls or mechanical shellfish gear are prohibited inside the boundaries of the sanctuaries (Figure 10.1.6). In a tagging study of female blue crabs, Medici et al. (2006) found that females begin migration toward the inlets during September through November but probably do not complete the journey until the next spring. Ovigerous females were found to meander over scales far larger than the spawning sanctuary boundaries (Medici et al. 2006). In a 2002 trawl survey in Croatan and Pamlico Sounds, Eggleston et al. (2009) found female blue crab abundance to be no different inside the crab spawning sanctuaries than 1 km to 2 km outside the boundaries. Female blue crab abundance was found to be higher at the northern and southernmost inlets than those in the central portion of the sound. The authors suggest an expansion of the sanctuary boundaries to include migration corridors coupled with rules to reduce fishery effort on female blue crabs (Eggleston et al. 2009).

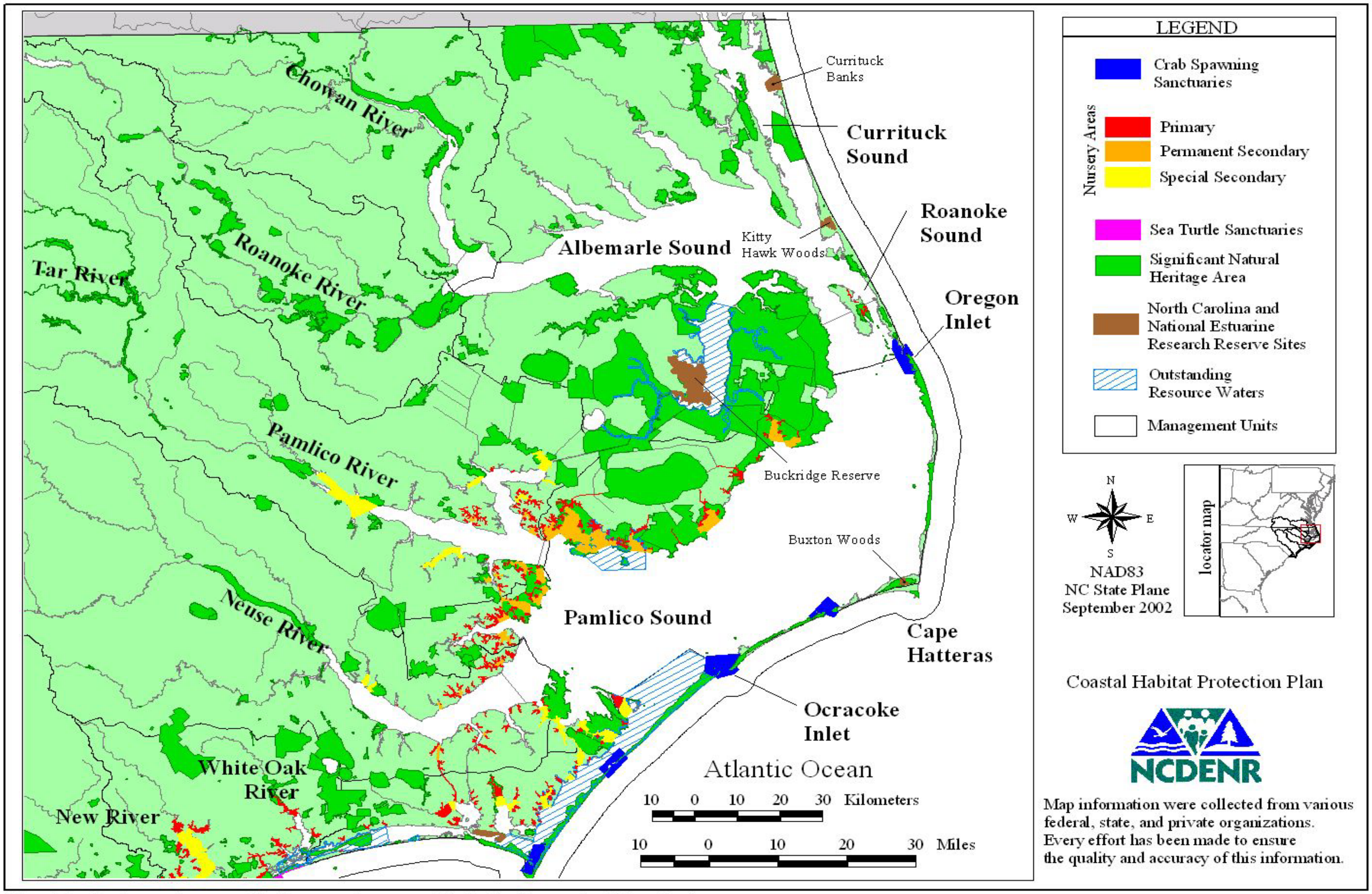

Figure 10.1.6 Crab Spawning Sanctuaries and other protected areas on the northern coast of North Carolina (from 2005 CHPP).

10.1.5.1 THREATS

The primary physical threat to the quality and condition of soft bottom is dredging for navigational purposes and the construction of marina basins. Dredging of inlets and navigational channels directly removes benthic infauna and epifauna; thus, temporarily reducing or destroying prey resources for benthically oriented fish and invertebrates (Hackney et al. 1996; Peterson et al. 2000). Deepening of shallow-water habitats can result in a loss of nursery habitat for some estuarine-dependent species (Rozas 1992). For this reason, Division of Coastal Management (DCM) rules restrict new dredging in MFC-designated Primary Nursery Areas. Dredged channels may also accumulate fine silt and pollutants that can be easily re-suspended by boat wakes, prop wash, strong winds, and/or channel maintenance (DEHNR 1990). Chemicals, metals, nutrients, and organic matter stored in the sediment can then re-enter the water column, causing short-term increases in toxicity, turbidity, algal blooms, and biological oxygen demand (BOD) (Lalancette 1984). Habitat alteration from dredging may have been responsible for major reductions noted in brown shrimp (*Farfantepenaeus aztecus*)(-88%), blue crab (-75%), Atlantic croaker (*Micropogonias undulatus*)(-45%), and spot (*Leiostomus xanthurus*)(-19%) following dredging for a marina site on Pierces Creek (Neuse River) (Deaton et al. 2010). Ebb and flood tide deltas, formed around inlets, are important overwintering habitat for the female blue crabs. Inlet-deepening dredge projects in winter may kill or displace female blue crabs that are burrowed in the inlet sediments. Disturbance associated with inlet dredging may also deter or alter summer spawning activity of the blue crab or impact egg and larval transport through the inlets.

Commonly used gears, such as trawls, have the potential to severely impact soft bottom habitat productivity in both the marine and estuarine environments. Trawling over soft bottom reduces habitat complexity and productivity by removing or damaging benthic invertebrates, smoothing sediment features, re-suspending sediments, and increasing bottom water turbidity (Collie et al. 1997; Auster and Langton 1999; NCDMF 1999). Over 99% of crab trawling occurs in estuarine waters (Deaton et al. 2010). The majority of crab trawling occurs in Pamlico Sound and adjacent estuarine rivers, followed by Core/Bogue sounds and estuaries. The number of crab trawl trips has decreased dramatically since 2004 as crab trawlers have switched to other fisheries such as scallop trawling in Virginia (S. McKenna/NCDMF, personal communication, 2009). In a literature review of the effects of trawling on estuarine soft bottom habitats, NCDMF (1999) noted a discrepancy in the conclusions of multiple studies, noting that minimal long-term effects were reported in some studies (Van Dolah et al. 1991; Currie and Parry 1996), while other studies reported significant long-term impacts to bottom communities (Collie et al. 1997; Engel and Kvitek 1998). In an effort to gain more information on the effects of bottom trawling in North Carolina, Cahoon et al. (2002) examined the changes in benthic micro- and macroalgae, and demersal zooplankton in the Pamlico River estuary. The authors concluded that trawling in this area was not detrimental to the benthic community but, due to the discrepancies of conclusions among a number of studies, more long-term, spatially extensive studies are needed to accurately quantify the effects of bottom disturbing fishing gear on soft bottom communities in North Carolina. Collie et.al (2000) suggest that the dynamic soft bottom community found in nearshore ocean communities is less impacted by trawling and recovers much quicker than in estuarine systems. However, some long-term impacts to the benthic community may occur, especially to the epibiota, depending on the frequency of trawling and site-specific characteristics. Repeated and prolonged trawling over muddy ocean bottom will negatively influence the benthic fauna, decreasing the abundance and diversity of epifauna invertebrates, possibly altering the marine food web (Hinz et al 2008).

Although shellfish and crustacean dredges that dig into the bottom are considered the most destructive fishing gear used in North Carolina, the limited use of this gear over soft bottom areas indicates the overall impact of dredges is low. Crab dredges are used in the winter to obtain crabs buried in sediments. Crab dredges are similar to oyster dredges, although the dredge teeth are sometimes longer on the crab dredge. Because of the gears' teeth, crab and oyster dredges can dig deep into the sediment and cause extensive sediment disturbance (Deaton et al. 2010). In a review of gear impacts by Johnson (2002), toothed dredging activities in soft bottom habitat appear to have a significant physical impact on the benthic organisms and topography in the dredge path, but there were few long term impacts. Most studies reported recovery of taxa and topography in 3 to 6 months. There is an associated increase in turbidity immediately after use which quickly dissipates in a near-inlet area but persists in mud bottom (Johnson 2002). Crab dredging is allowed in one area of primarily soft bottom in northern Pamlico Sound (approximately 100,653 acres) (Figure 10.1.5), and is opened by rule from January 1 to March 1 [15A NCAC 3L .0203]. In recent years, fishing effort has been very low, with fewer than 10 crab dredge trips reported per year. Although the low fishing effort results in a small area of impact due to crab dredging, the destruction potential of the gear to all habitats, combined with the spatial preference for harvesting female blue crabs, results in a net adverse impact to blue crabs from the use of this gear. Since less habitat damaging methods are available for harvesting crabs, the CHPP recommends the MFC consider if prohibition of crab dredging is advisable.

Numerous studies from Chesapeake Bay to the Gulf of Mexico have documented lower relative abundance and diversity of fishes and invertebrates adjacent to bulkheaded shorelines compared to unaltered marsh, beach, or forested wetland habitats (Deaton et al. 2010). Because of the documented ecological problems associated with vertical hardening of estuarine shorelines, the CHPP recommends the assessment and promotion of incentives for alternatives to vertical shoreline stabilization measures. Several alternatives to traditional vertical stabilization have been developed that use a natural "living shorelines" approach to reduce the habitat and ecosystem impacts of shoreline erosion control (Broome et al. 1992; Rogers and Skrabal 2001; Berman et al. 2007; CBF 2007; NRC 2007). In North Carolina, Currin et al. (2008) found no significant difference in the mean number of fish, crabs, or shrimp between stone sill-protected and natural marshes. In addition, the study found that sediment accretion rates in marshes protected by a stone sill were 1.5- to 2-fold greater than in controls.

10.1.5.2 TOXINS

Sediment contamination is also of particular concern for soft bottom habitats. While toxins such as heavy metals, polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, pesticides, polychlorinated biphenyls (PCBs), and ammonia can fluctuate between sediments and the water column, concentrations of toxins tend to accumulate in sediments to several orders of magnitude greater than the overlying waters (Kwon and Lee 2001). Although toxins enter the water column through point and non-point sources, marina operation often leads to the introduction of heavy metals, petroleum hydrocarbons, and bacteria (Chmura and Ross 1978; Marcus and Stokes 1985; Voudrias and Smith 1986). Introduction of toxic chemicals into soft bottom habitats can have profound effects on the productivity of both benthic dwelling invertebrates and fish fauna. Exposure to hydrocarbons, heavy metals, and other toxins can cause direct mortality of benthic fish and invertebrates, as well as cause sublethal responses such as hormone alterations, mutations, and altered growth and reproduction (Weis and Weis 1989; Wilbur and Pentony 1999; White and Triplett 2002; Johnson et al. 2002).

Studies examining sediment contamination in North Carolina's estuaries have found various levels of contamination, although the extent of this contamination is not well known. The EPA Environmental Assessment Program surveyed 165 sites in North Carolina's sounds and rivers during 1994 to1997 to evaluate environmental conditions (Hackney et al. 1998). The highest levels of contamination occurred in low salinity areas with low flushing and high river discharge. Benthic communities in these areas were typically species poor and were dominated by a few opportunistic species, while in many areas sediments were toxic to biological life. Fine-grained sediments act as a reservoir for heavy metals and pesticides (Riggs et al. 1991). Re-suspension of contaminated sediments can thus be problematic, particularly in the small trunk estuaries and deeper regions of the larger estuaries in North Carolina where fine –grained sediments dominate. In general, the Neuse River was more severely contaminated with heavy metals including zinc, copper, lead, and arsenic but concentrations of arsenic, cobalt, and titanium in the Pamlico River exceeded levels reported in the Neuse River. Heavy metal concentrations have been measured in Durham Creek, Porter Creek, South Creek, Pamlico River, Jacks Creek, Huddles Cut, and Tooley Creek by Potash Corporation's phosphate mining operation in Aurora as a permit compliance requirement. Arsenic, cadmium, molybdenum, selenium, and zinc were all found to be higher in concentration than continental crust concentrations (CZR 1999). The presence of these heavy metals has been directly linked to shell disease in blue crabs found in the Pamlico River (Weinstein et al. 1992). Collectively, these studies suggest that sediment contamination in North Carolina's estuaries could affect fish populations through toxicity and altered food web structures.

10.2 WATER QUALITY

Certain water quality parameters are necessary to maintain the appropriate physicochemical conditions for blue crab growth and survival, as well as sustain habitats that the blue crab population depends on. Over the past 20 years, there has been substantial human population growth in North Carolina's coastal river basins. Physical alterations to water bodies such as channelization and shoreline stabilization have increased with increasing human population, resulting in altered hydrography and change in temperature, salinity, and DO regimes. These alterations can have profound effects on the abundance and distribution of mobile species (Peterson et al. 2000; Waters and Thomas 2001). Furthermore, the increase in population has resulted in increased stormwater runoff, the addition of new septic tanks, and the need for additional wastewater treatment capacities and water supply resources.

Water pollution associated with human population growth can be classified into two categories: point source and nonpoint source pollution. Point source pollution originates from a defined point such as industrial waste discharges and requires a National Pollution Discharge Elimination System (NPDES) permit, while nonpoint source pollution, such as stormwater runoff, has an undefined origin. However, both types of pollution sources can substantially affect the overall water quality of a watershed through the addition of sediments, nutrients, and toxins. The DWQ use support assessments to measure the status of water quality. The last available assessment (2004 to 2006) indicated little change in impairment. However, DWQ ambient monitoring coverage for estuaries remains low and only about 30% of freshwater streams are assessed where the majority of ambient stations are located. A major drought from 2007 to 2008, the worst recorded since 1895, most likely had an effect on coastal water quality. River discharges were below normal from 2006 to 2008. High abundance of SAV reported in 2007 to 2008 and minimal change in water quality impairment may be partially due to low runoff conditions during drought. Salinities were also higher in coastal rivers, bringing estuarine fish further upstream. Fish kill events, which can be an indication of eutrophication and hypoxia, did not show an increasing trend from 2005 to 2010, though total mortality of fish was greater in recent years. Drought conditions from 2006 to 2008, which reduced stormwater runoff, could have contributed to better water quality during the past few years. There was, however, an increase in reported wastewater treatment plant Notices of Violation and sewage spills, which contribute substantially to pollutant loading in coastal waters. Completion of several studies indicates that sea level rise is expected to increase in North Carolina at least 1 m per 100 yr. The effect of this rise, along with other weather changes associated with climate change will have a great influence on water quality, salinity, water depth, and temperature, all of which will alter fish distribution and abundance (Deaton et al. 2010).

10.2.1 EUTROPHICATION AND LOW DISSOLVED OXYGEN

Several of North Carolina's major coastal river basins, including the Chowan, Tar-Pamlico, Neuse, and Cape Fear, are designated as "nutrient sensitive". Eutrophication, or excessive nutrient loading, can create an ecological imbalance resulting in nuisance and frequent algal blooms. Respiration and decomposition of algal blooms and organic loading can cause hypoxic (low levels of dissolved oxygen) and/or anoxic (absence of oxygen) conditions. Although hypoxic and anoxic conditions can develop naturally through flushing of swamp waters or from stratification of the water column, these conditions are often exacerbated by human-induced nutrient enrichment. Algal blooms deplete DO in the water column as biological oxygen demand (BOD) increases at night via plant respiration. As the algal blooms die, plant material descends to the sediment surface where bacteria further deplete DO through increased BOD necessary for the decomposition of organic material (DWQ 2000b). Chronic low dissolved oxygen, lasting from weeks to months, often develops in shallow estuaries with low flushing rates, resulting in stratification of the water column (Tenore 1972). However, in well-mixed systems, hypoxia caused by the photosynthesis/respiration cycle of phytoplankton develops daily (Tyler and Targett 2007).

Hypoxic events can play a major role in determining benthic community structure and trophic dynamics in various systems (Tenore 1972; Falkowski et al. 1980; Santos and Simon 1980; Harper et al. 1991; Holland et al. 1987; Rosenberg et al. 1992; Rabalais et al. 1994). Direct or secondary effects of hypoxia and anoxia on crabs may include: reduced suitable habitat (Selberg et al. 2001); impeding or promoting movement (Pihl et al. 1991; Das and Stickle 1994; Eby and Crowder 2001; Bell et al. 2010); reduced feeding (Das and Stickle 1991; Taylor and Eggleston 2000; Bell et al. 2003), reduced growth (Diaz and Rosenberg 1995; Sullivan and Gaskill 1999), and slower molting rate (Das and Stickle 1993); increased (Pihl et al. 1991 and 1992; Nesterode and Diaz 1998; Luettich et al. 1999; Taylor and Eggleston 2000; Sietz et al. 2003) or decreased nutrition due to prey availability (Noga et al. 1990; Pihl et al. 1991); deteriorating body condition; increased environmental stress; increased species interaction and competition (Eby and Crowder 2001; Selberg et al. 2001; Eggleston et al. 2005; Aumann et al. 2006); lower immunological competence (Noga et al. 1990) and increased susceptibility to disease; diminished reproductive capability; and increased mortality (Harper and Guillen 1989; Das and Stickle 1991 and 1993).

Oxygen deficient water and associated blue crab mortality has been reported in Mobile Bay (May 1973; Tatum 1982), Chesapeake Bay (Carpenter and Cargo 1957), Texas (More 1969), Louisiana (Guillory et al. 1996), and North Carolina (NCDENR 2009). Low levels of dissolved oxygen may restrict the use of otherwise suitable habitat and cause high local mortalities as well as influence the distribution or migration of blue crabs (Pihl et al. 1991; Das and Stickle 1994; Guillory et al. 1996; Selberg et al. 2001; Eby and Crowder 2001; Bell et al. 2003). Selberg et al. (2001) noted that blue crabs were present in the Neuse River where dissolved oxygen concentrations exceeded 2.4 mg/L, and generally absent from areas with lower oxygen concentrations. Crabbers in Chesapeake Bay have had to set traps progressively closer to shore because of hypoxic conditions in deeper water (Price et al. 1985). Crab potters in the Albemarle and Pamlico sounds indicate that hypoxic and anoxic ("dead water") conditions can be frequent and widespread, resulting in significant trap mortalities and making vast areas unfishable. Sullivan and Gaskill (1999) in a Neuse River study suggest that low dissolved oxygen can cause locally elevated mortality among crabs constrained by capture in pots. Neuse River crab potters indicated that low oxygen events cause them to move pots and alter fishing frequency. Adjustments in fishing activity were based on changing environmental observations and catch rates (Selberg et al. 2001). Conditions which suggest the presence of hypoxic and anoxic water conditions include: crabs swimming at or near the water's surface; crabs crawling out of the water on to shore; pot caught crabs clinging to the top of crab pots attempting to get out of the low oxygen water; weak crabs and reduced catches in pots; total mortality of potted crabs; and pots previously covered with aquatic organisms (marine fouling) suddenly appear clean.

Jordan et al. (1992; based on Funderburk et al. 1991) recommended a monthly average dissolved oxygen content of 5 mg/L for target species in Chesapeake Bay, including blue crabs. Blue crabs are tolerant of hypoxic (low oxygen) conditions (Lowery and Tate 1986); however, tolerance decreased with increasing temperature (DeFur et al. 1990). Juvenile crabs may be less tolerant of hypoxia than adults (Stickle et al. 1989), and may require more oxygen than was recommended by Jordan et al. (1992). Carpenter and Cargo (1957, *in* Funderburk et al. 1991) documented 50% mortality of blue crabs at DO levels <2.0 mg/L. Another study reported total mortality of crabs after 3 hours in hypoxic conditions (DO < 0.5 mg/L) (DeFur et al. 1990 *in* Funderburk et al. 1991). It has been found recently that blue crabs have a physiological response to hypoxia exposure. Bell et al. (2009) found that crabs with a certain structure of hemocyanin respiratory protein have different behavioral responses to hypoxia that increase survival. Further study showed that crabs collected from the Neuse River Estuary (frequent hypoxia) had this hypoxia-tolerant structure and survived longer exposures to hypoxia than those collected from Bogue and Back Sounds (infrequent hypoxia) (Bell et al. 2010).

Eggleston et al. (2005) found that as the water column in shallow habitats became more hypoxic, mortality rates of juvenile blue crabs increased. This was attributed to the increase in cannibalism by adult blue crabs moving into the shallow waters to avoid hypoxia in deeper waters. When hypoxia water was upwelled into shallow habitats, adult blue crab density declined and juvenile mortality did not increase (Eggleston et al. 2005). In a model developed by Aumann et al. (2006), transient patches of hypoxia led to increased cannibalism because of the temporary reductions in habitat.
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10.2.2 TURBIDITY AND SEDIMENTATION

Erosion and sedimentation of shorelines occurs naturally in estuarine systems, increasing the turbidity of the adjacent water column. These processes are mostly influenced by wave exposure, currents, and natural stormwater runoff. However, human activities have accelerated these processes through non-point source stormwater runoff from urban areas, agriculture, silviculture, and animal operations. Sedimentation from agriculture has been cited as one of the largest contributors to water pollution in the southeastern United States (SAFMC 1998). The removal of vegetated buffers and increase in impervious surfaces helps to hasten sediment loading and increases turbidity in the surrounding water (DWQ 2000b). Additionally, water based activities such as dredging, boating, and use of bottom disturbing fishing gears generate turbidity in the water column.

Increased sedimentation in water column habitats can have significant impacts on aquatic life. Increased turbidity can shade out productive flora such as phytoplankton and SAV (North Carolina Sea Grant 1997), resulting in trophic impacts for secondary and tertiary consumers. In addition, the increased sediment load in the water column can clog gills and pores of fish and invertebrates, resulting in reduced feeding capacities or even mortality (Ross and Lancaster 1996; DWQ 2000a).

10.2.3 ENDOCRINE DISRUPTING CHEMICALS

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

Pesticides and herbicides can be toxic to aquatic organisms or act as endocrine disruptors. Many insecticides are designed to interrupt the insect life cycle. Numerous studies have assessed the effect of hormone-like substances, insecticides, and juvenile hormone insecticides on crustaceans (i.e., shrimp, crabs, lobsters) (Table 10.1.2). Over the past two decades, scientists began to observe so-called “intersex” individuals among crustacean populations (Zou and Fingerman 1999; Ford et al. 2004; Brian et al. 2005). These individuals were generally males that exhibited female sexual characteristics. The incidence of intersex males was associated with areas downstream from urban wastewater outflows. Other observed impacts associated with human hormones and hormone-like substances include toxicity, increases in female/male sex ratios, molting enzyme abnormalities, abnormal larval development, and altered egg production and maturation. Analysis of the wastewater and subsequent controlled experiments indicated that the cause of these developmental abnormalities was due to both human sex hormones (predominantly estrogen – naturally occurring and from birth control and hormone replacement sources) and compounds that mimicked the structure of these sex hormones (including many insecticides and other agricultural chemicals).

Crustaceans, being bound by a rigid exoskeleton, must molt (shed the outer skeleton) in order to grow. Mating and reproduction, in addition to larval development, are intimately tied to molting and growth. Many of the hormones that control molting and reproduction in crustaceans are steroids that bear a structural resemblance to human reproductive hormones like estrogen. Thus estrogenic and estrogen-like compounds have the potential to affect molting, growth, mating, reproduction, and development of crustaceans (Robert Roer/UNC-W, personal communication, 2009).

The past few decades have also seen the emergence of insecticides that mimic insect juvenile hormones. Juvenile hormone analogs (JHA) are a substance used as insecticides to alter molting cycles and disrupt the normal growth and development of targeted pests, thus maintaining larval characteristics when insects molt, preventing the development of the adult, reproductive form. Insects and crustaceans are closely related, and crustaceans employ a hormone similar in both form and function to insect juvenile hormone. Thus, JHA insecticides have the potential to adversely affect

Table 10.1.2 Endocrine disrupting chemicals by class, sources, and effects on blue crabs.

Class	Source	Concentrations	Effects	Compounds	References
Human hormones and hormone-like substances	Birth control, anti-depressants, etc - enter from treated wastewater discharge	As low as 0.1 ppb	Altered female/male sex ratio, intersex males, molting/molt enzyme abnormalities, abnormal larval development, altered egg production & maturation	17ß-estradiol, bisphenol A, 17α-ethinylestradiol, p-octylphenol, tamoxifen, 4-(tert)-octylphenol, 4-n-nonylphenol, androstenedione, diethyl phthalate, diethylstilbestrol, PCB29 (2,4,5-trichlorobiphenyl), pyrene	Brian 2005; Ford et al. 2004; Zou and Fingerman 1999
Insecticides, nematocides & fungicides (non-hormonal)	Agricultural runoff	As low as 0.05 ppb	Molting/molt enzyme abnormalities, inc. in male/female sex ratio, intersex males, toxicity	Araclor 1242, dieldrin, Heptachlor, Lindane, endosulfan, enamectin benzoate, fenarimol, agricultural run-off	Ayaki et al. 2005; Waddy et al. 2002
Juvenile hormone insecticides (act to interrupt the insect life cycle)	Mosquito and flea control	As low as 0.1 ppb	Inc. in male/female sex ratio, abnormal/extended larval development, molting/molt enzyme abnormalities, delay in reproduction, dec. fecundity, all female broods	Fenoxycarb, methoprene, pyriproxifen	McKinney 2005; Turberty and McKinney 2005

reproduction and development in commercially important crustacean species (i.e., blue crabs, shrimp, and lobsters) (McKenney 2005; Turberty and McKenney 2005). In North Carolina, JHA is commonly used for the control of insects; particularly, mosquitoes, fleas, and fire ants. Of the various products, S-methoprene appears to be the JHA with the greatest potential to contaminate NC surface water based on registered uses as a mosquito/midge control product and as an animal feed supplement (Bob Bruss/NCDACS, personal communication, 2009). Subsequent efforts are needed to refine the details of product use to prevent its transport into surface waters.

Other studies have examined the effects of non-hormonal insecticides used in agriculture (i.e., dieldrin, heptachlor, lindane, endosulfan) on crustaceans (water fleas, crabs, and lobsters). Similar to hormone effects, these studies found molting enzyme abnormalities, increase in male/female sex ratios, intersex males, and toxicity (Ayaki et al. 2005; Waddy et al. 2002).

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

Typical municipal wastewater treatment processes are not capable of removing hormones, antibiotics, and other EDCs, making sewage effluent a major source. The current recommended federal policy for disposal of unused drugs is to flush medicines down the toilet or mix with cat litter and take to a landfill. Hospitals also routinely dump expired and unused medications into the wastewater system. The NC Department of Agriculture and Consumer Services (NCDACS) has been working to add a Prescription Drug Collection and Disposal Program to their Pesticide Disposal Assistance Program for the citizens of North Carolina. The concept is that when residents come to a one-day Pesticide Disposal Collection Event, run by NCDACS, they bring unused over the counter (OTC) or prescription medications along with traditional pesticides for secure disposal. These are dropped into a drum of reagent directly by each individual, so that there is no risk of inappropriate re-use of medications. The drum of reagent is secured for final incineration. The non-profit group, Pamlico-Tar River Foundation, has made significant progress in establishing drug-take back programs in several coastal counties through the local sheriff’s department.

10.2.4 PARASITES AND DISEASES

It has been suggested that changes and/or degradation of water quality is linked to the proliferation of parasites and disease. Many infections are contagious to other crabs and may be an indication of stress in a population. The relationship between stress and disease is a well-documented phenomenon. Sindermann (1989) found that the occurrence of disease was higher in stressed populations. Various sources suggest a link between poor water quality conditions, immunocompetence, and disease in crustaceans. Areas of high organic load and poor water quality generally contribute to an increase in bacteria numbers (Sindermann 1974). Alternatively, Noga et al. (1990) suggested the environment, and not the presence of bacteria, are responsible for the induction and development of shell disease.

A variety of pathogens can affect crustaceans, including viruses, bacteria, fungi, protozoans, and helminths. Some pathogens may cause significant mortalities, reduced fecundity, and unattractive necrotic lesions on the shell or black/white pigmentation in the meat, rendering affected crabs unmarketable.

Diseases and parasites that have been observed in blue crabs from North Carolina include bacterial infections (shell disease), a dinoflagellate parasite *Hematodinium* sp., an amoeba parasite *Paramoeba perniciosa* (gray crab disease), and a microsporidian parasite *Ameson michaelis* (cotton crab disease). In 1987, an extreme outbreak of shell disease was observed in the Pamlico River (McKenna et al. 1990). The chronic presence of shell disease was suggested as a possible factor contributing to a significant, progressive decline in blue crab landings in the Pamlico River during 1985 to1989 (Noga et al. 1990). Gray crab disease has not been a major problem, though there have been periodic outbreaks causing localized mortalities (Mahood et al. 1970). Cotton crab disease was identified as the suspected cause of excessive mortality and weakened peelers and soft crabs in northern Outer Banks, NC shedding operations during 1999

(Ed Noga, NCSU, personal communication, 2004). A listing of potential parasites, diseases, symbionts, and other associated organisms reported from blue crabs is presented in Guillory et al. (2001).

Diseases and infections in the blue crab population can bring about wide and varied effects, both actual and perceived, on the blue crab and its industry. Even the perception of diseases and pathogens, once shared with the public, can have considerable effects on the industry and on management (Chesapeake Bay Program 1997). A toxic dinoflagellate bloom in Maryland during the summer of 1997 focused attention on similar water quality issues in North Carolina, affecting blue crab markets along the east coast.

10.2.5 TROPICAL CYCLONES, STORMS, AND SIGNIFICANT WEATHER EVENTS

Tropical cyclones (hurricanes and storms) and other major weather events may have both significant short and long-term impacts on the blue crab resource and fishery. Hurricanes and are considered an important natural perturbation that is necessary for the long-term maintenance of estuarine systems (Meeder and Meeder 1989). Many of the weather related influences on the aquatic environment and resources cannot be quantified with the existing levels of scientific sampling. Impacts on the blue crab resource and interdependent ecosystem can be quite different depending on the season, storm track, duration and physical characteristics of the storm, area of influence, and blue crab life stage. The storm's characteristics determine if the impacts are widespread or localized and beneficial or detrimental to aquatic resources and users.

During September and October 1999, several noteworthy hurricanes (Dennis, Floyd, and Irene) combined to significantly impact North Carolina's weather, people, terrestrial and aquatic resources, and water quality. Statewide blue crab landings during 2000 were down considerably compared with landings in the late 1990's (Burgess et al. 2007). Lingering impacts on habitat and water quality, principally in the Pamlico estuary, associated with the flooding and massive freshwater inputs from the 1999 hurricanes likely contributed to the significant reduction in crab landings during 2000. Also, reduced crab catches in some areas resulted in lower overall effort and landings in the crab pot fishery as fishermen concentrated on other species.

10.3 HABITAT AND WATER QUALITY PROTECTION

10.3.1 MARINE FISHERIES COMMISSION AUTHORITY

Presently, the MFC has authority for the following actions with regard to marine and estuarine resources: manage, restore, develop, cultivate, conserve, protect, and regulate. Marine and estuarine resources are "All fish [including marine mammals, shellfish, and crustaceans], except inland game fish, found in the Atlantic Ocean and in coastal fishing waters; all fisheries based upon such fish; all uncultivated or undomesticated plant and animal life, other than wildlife resources, inhabiting or dependent upon coastal fishing waters; and the entire ecology supporting such fish, fisheries, and plant and animal life." (G.S. 113-129).

Although the MFC's primary responsibilities are management of fisheries (season, size and bag limits, licensing, etc.), the MFC has the authority to comment on state permit applications that may have an effect on marine and estuarine resources or water quality, regulate placement of fishing gear, develop and improve mariculture, and regulate location and use of artificial reefs. Authority for the MFC is found at G.S. 143B-289.51 and 52.

In an effort to protect SAV and other habitats from bottom-disturbing fishing gears, the MFC prohibits the use of rakes and dredges of a specific weight and type in internal coastal waters (MFC 2011; 15A NCAC 3J .0303, 3K .0102, and 3K .0503), dredges/mechanical methods to take shellfish and crabs in certain areas (15A NCAC 3K .0204, 3R .0108, and 3L .0203), and trawl nets in certain areas [15A NCAC 3J .0104 (b) (4) and 3R .0106(2)]. Harvest methods for hard clams have been established in beds of submerged aquatic vegetation (15A NCAC 3K .0304), and the Fisheries Director has been granted proclamation authority to specify means and methods for mechanical harvest of shellfish by season and area (15A NCAC 3K .0302 and 3K .0501).

The MFC has also provided habitat and fishery resource protection by prohibiting the use of various commercial gears in Primary Nursery Areas (PNAs) [15A NCAC 3N .0104 and 3R .0103], and prohibiting the use of trawl nets in Secondary Nursery Areas (15A NCAC 3N .0105, 3R .0104, and 3R .0105). Nursery areas are most threatened by non-point sources of pollution and development on nearby lands (Stanley 1992). In the early 1980s, fishery independent data from shallow creeks and bays in Pamlico Sound documented 78 fish and invertebrate species over a two-year period (Ross and Epperly 1985). Eight species, including spot, bay anchovy (*Anchoa mitchilli*), Atlantic croaker, Atlantic menhaden (*Brevoortia tyrannus*), silver perch (*Bairdiella chrysoura*), blue crab, brown shrimp, and southern flounder (*Paralichthys lethostigma*), comprised more than 97% of the total nekton abundance. Data from NCDMF's ongoing juvenile fish monitoring program, which began in 1971, show that the same eight species continue to dominate North Carolina's nekton assemblage, with pinfish (*Lagodon rhomboides*) and white shrimp (*Litopenaeus setiferus*) also among the most abundant species collected. The consistency of catch characteristics during 1990 to 2008 is an indication that these areas continue to function as healthy nurseries.

The MFC also has rules specific to the protection of oyster habitat and oyster management areas. Oyster dredges may weigh no more than 100 pounds, with only one oyster dredge per vessel (15A NCAC 3J. 0303). Oyster beds planted and posted by the state are protected from bottom disturbing gear (15A NCAC 3K. 0203). Certain areas of internal coastal waters are closed to mechanical harvest of oysters (15A NCAC 3K. 0204 and 15A NCAC 3R. 0108).

Crab spawning sanctuaries (15A NCAC 3L. 0205) located at Oregon Inlet, Hatteras Inlet, Ocracoke Inlet, Drum Inlet and Bardens Inlet (15A NCAC 3R. 0110) are also considered important crab habitat for spawning. These areas have extensive seagrass beds and are important areas for female blue crabs that have migrated there to spawn. These areas also provide habitats for larvae as well as a means of dispersal (Etherington and Eggleston 2000). The South Atlantic Fishery Management Council (SAFMC) has designated all coastal inlets as Habitat Areas of Particular Concern (HAPC) for blue crab, estuarine-dependent snapper-grouper species, penaeid shrimp, and red drum.

10.3.2 AUTHORITY OF OTHER AGENCIES

The North Carolina Department of Environment and Natural Resources (DENR) has several divisions responsible for providing technical and financial assistance, planning, permitting, certification, monitoring, and regulatory activities, which impact the coastal water quality or habitat. The DCM is responsible for development permits along the estuarine shoreline in 20 coastal counties. Wetland development activity throughout North Carolina is permitted through the US Army Corps of Engineers (USACE) and DWQ (DWQ; 401-certification program). The DWQ has established a water quality classification and standards program for "best usage" to promote protection of unique and special pristine waters with outstanding resource values. The High Quality Waters (HQW), Outstanding Resource Waters (ORW), Nutrient Sensitive Waters (NSW), and Water Supply (WS) classifications have outlined management strategies to control point and nonpoint source pollution. Various federal and state environmental and resource agencies, including NCDMF, evaluate projects proposed for permitting and provide comments and recommendations to the DCM, DWQ, and USACE on potential habitat and resource impacts. Habitat protection relies on enforcement, the efforts of commenting agencies to evaluate impacts, and the incorporation of recommendations into permitting decisions. Habitats are also protected through the acquisition and management of natural areas as parks, refuges, reserves, or protected lands by public agencies and/or private groups.

10.3.3 COASTAL HABITAT PROTECTION PLAN

The Fisheries Reform Act of 1997 mandated the DENR to prepare CHPP (CHPP -- G. S. 143B-279.8). The legislative goal for the CHPP is long-term enhancement of the coastal fisheries associated with coastal habitats and provides a framework for management actions to protect and restore habitats critical to North Carolina’s coastal fishery resources. There are three commissions that have regulatory jurisdiction over the coastal resources, water, and marine fishery resources including: Marine Fisheries Commission (MFC), Coastal Resources Commission (CRC), and the Environmental Management Commission (EMC). The first CHPP was completed in December 2004 and implementation plans for each Division and the Department were approved in July 2005. The first update to the plan was completed in 2010. Actions taken by all three commissions pertaining to the coastal area, including rule making, are to comply “to the maximum extent practicable” with the plans. The CHPP helps to ensure consistent actions among these three commissions as well as their supporting DENR agencies.

The CHPP describes and documents the use of habitats by species supporting coastal fisheries, status of these habitats, and the impacts of human activities and natural events on those habitats. Fish habitat is defined as freshwater, estuarine, and marine areas that support juvenile and adult populations of economically important fish, shellfish, and crustacean species (commercial and recreational), as well as forage species important in the food chain (Deaton et al. 2010). Fish habitat also includes land areas that are adjacent to, and periodically flooded by riverine and coastal waters. Six fish habitats are discussed and designated based on distinctive physical properties, ecological functions, and habitat requirements for living components of the habitat: wetlands, SAV, soft bottom, shell bottom, ocean hard bottom, and water column.

The CHPP recommends that some areas of fish habitat be designated as “Strategic Habitat Areas” (SHAs). SHAs are defined as specific locations of individual fish habitat or systems of habitat that have been identified to provide critical habitat functions or that are particularly at risk due to imminent threats, vulnerability, or rarity. While all fish habitats are necessary for sustaining viable fish populations, some areas may be especially important to fish viability and productivity. Protection of these areas would therefore be a high priority. The process of identifying and designating SHAs began in 2005. The SHA identification process for Region 1-Albemarle Sound and Northeast Coastal Ocean was completed in early 2009 and should be completed for Region 2-Pamlico Sound and Central Coastal Ocean in 2011.

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

10.3.4 STATUS OF 2004 BLUE CRAB FMP AMENDMENT 1 RECOMMENDATIONS

Since the 2004 blue crab fishery management plan, habitat and water quality conditions appear to be the same or in some cases, somewhat better. The area of submerged aquatic vegetation coverage appears to be expanding in estuaries south of New River and in the lower salinity estuaries of the Neuse and Tar-Pamlico. The latter increase could be related to nutrient reduction efforts in those river basins, but may also be a result of several years of drought. Wetland acreage continues to decline from permitted losses and natural erosion associated with storms and rising sea level. Efforts have increased to restore more subtidal oyster beds in Pamlico Sound through NCDMF's oyster sanctuary program and partnerships with non-profit organizations. While attempts have been made to change NC's policy on ocean shoreline hardening, jetties and groins continue to be prohibited on the ocean, which is critical for blue crab recruitment into the estuary. Water quality degradation, in terms of aquatic life use support impairment, is greatest in freshwater streams in the Neuse and Cape Fear River basins and in estuarine creeks in the Neuse River basin. Fish kill events have declined in number but have increased in size in the last two years.

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

Habitat

1. Coast-wide imagery of SAV was taken in 2007/2008 and is in the process of being photo-interpreted.
2. Identification and designation of strategic SAV areas is underway through the SHA process.
3. Dredging of PNA, SAV and shellfish habitat is avoided through NCDMF's permit review process.
4. CRC has revised dock rules to require review by resource agencies for General Permit dock applications located over SAV, shell bottom, or PNAs, and where water depth is less than 2 ft MLW, to avoid boating related impacts.
5. Additional bottom disturbing gear restrictions have been implemented through the bay scallop, shrimp, and oyster fishery management plans to avoid damage to SAV and oysters.
6. Additional funding has supported expansion of oyster sanctuaries, development of a shell recycling program to supplement cultch planting, and acceleration of shell bottom mapping.
7. EEP is in the process of evaluating non-traditional but effective mitigation techniques for wetland, oyster, and SAV impacts, and improving the mitigation process.
8. Neuse and Tar-Pamlico NSW nutrient reduction measures have successfully reduced nutrient loading by more than their 30% reduction goals for point source dischargers and agriculture.
9. DWQ revised coastal stormwater rules that limit impervious surface and run-off in coastal areas.
10. Loss of additional riparian wetlands has been minimized through the permitting process, land acquisition, and land use planning.

Water Quality

1. NCDMF staff continues to work with the permitting and commenting agencies to enhance protection of water quality. The MFC utilizes its permit commenting authority outlined in G.S. 143B-289.52 as needed.

2. Research has been conducted to assess the extent, causes, and impacts of hypoxia and anoxia on blue crab behavior and population abundance in North Carolina's estuarine waters.
3. Some research has been conducted on the influences of significant weather events on water quality and the blue crab resource and fishery.
4. Some research has been conducted on the interaction between water quality and habitat.

10.4 RECOMMENDED MANAGEMENT STRATEGY

Suitable and adequate habitat is a critical element in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat may have a corresponding impact on water quality. Maintenance and improvement of suitable estuarine habitat and water quality is critical to successfully managing blue crab stocks. Below are the 2010 CHPP recommendations and management needs that could be beneficial to protecting and improving habitat and water quality utilized by blue crab.

Habitat

1. Identify and designate Strategic Habitat Areas (SHAs) that will enhance protection of the blue crab.
2. Identify, research, and designate additional areas as Primary Nursery Areas that may be important to blue crabs as well as other fisheries.
3. Continue to map blue crab spawning areas and evaluate any that need to adjust or expand the boundaries or restrictions of the crab spawning sanctuaries based on recent research.
4. Remap and monitor SAV in North Carolina to assess distribution and change over time.
5. Restore coastal wetlands to compensate for previous losses and enhance habitat and water quality conditions for the blue crab.
6. Work with CRC to revise shoreline stabilization rules to adequately protect riparian wetlands and shallow water habitat and significantly reduce the rate of shoreline hardening.
7. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV, wetland edge, and other habitat important to blue crab.
8. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.
9. Support oyster shell recycling and oyster sanctuary programs to provide areas of enhanced or restored shell bottom habitat.
10. Consider if prohibition of crab dredging is advisable.
11. Protect "recruitment bottlenecks", like inlets for the blue crab, from trawling or other impacts including natural channel modification using hardened structures like groins and jetties.
12. Shallow areas where trawling is currently allowed should be re-examined to determine if additional restrictions are necessary.

Water Quality

1. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.
2. Increase on-site infiltration of stormwater through voluntary or regulatory measures.
3. Provide more incentives for low-impact development.
4. Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant

upgrading.

5. Provide proper disposal of unwanted drugs, prevent the use of harmful JHA insecticides near-surface waters or in livestock feed, and develop technologies to treat wastewater for antibiotics and hormones.

10.5 RESEARCH NEEDS

1. Continue research on the impacts of endocrine disrupting chemicals (EDCs) on the various life stages of the blue crabs and way to reduce introduction of EDCs into estuarine waters.
2. Assess the impact of winter inlet deepening dredge activities on the overwintering female blue crabs and their habitat.
3. Determine the spatial and biological characteristics of SAV beds that maximize their ecological value to the blue crab for restoration or conservation purposes.
4. Identify, research, and map shallow detrital areas important to blue crabs.
5. Additional research is needed on the extent, causes, and impacts of hypoxia and anoxia on blue crab behavior and population abundance in North Carolina's estuarine waters.
6. Conduct research on the water quality impacts of zincs, bait discard, and alternative baits in the pot fisheries.

11.0 PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

11.1 ADAPTIVE MANAGEMENT FRAMEWORK FOR THE NORTH CAROLINA BLUE CRAB STOCK[4]

I. ISSUE

Establish an adaptive management framework to maintain the North Carolina blue crab stock in a viable condition.

II. ORIGINATION

North Carolina Division of Marine Fisheries (NCDMF)

III. BACKGROUND

In the 2004 Blue Crab FMP Amendment 1, uncertainty of estimates of maximum sustainable yield as well as data and modeling limitations led the NCDMF to conclude that the status of the blue crab stock could not be accurately assessed at the time (NCDMF 2004). The management tool that was adopted in the 2004 FMP was the implementation of restrictions to protect the blue crab spawning stock when the defined spawning stock biomass trigger was reached. In addition, an overfished stock definition for blue crabs was adopted based on commercial landings trends. The blue crab resource was considered overfished when annual commercial landings declined for five consecutive years. No definition of overfishing was developed.

In 2005, a rule was established for the FMP management strategy to provide some protection for the female blue crab spawning stock. This rule (15A NCAC 03L .0201(c)) established proclamation authority for a seasonal maximum size limit from September 1 through April 30 for mature female (6 ¾ inches) and female peeler blue crabs (5 ¼ inches), if the adjusted catch-per-unit-effort (CPUE) spawner index of mature females captured in the Pamlico Sound Fishery Independent Trawl Survey during the September cruise falls below the lower 90% confidence limit for two consecutive years. These maximum size limits were implemented on January 16, 2006, and have remained in effect seasonally since that time. In addition, the management strategy adopted in the FMP provided that this management measure will be removed when the September adjusted CPUE of mature females rises above the lower 90% confidence limit for two consecutive years. However, the CPUE spawner index for mature females has not risen above the threshold for two consecutive years since 2005 (Figure 11.1.1). Compliance with the female seasonal maximum size limits has been marginal and largely ineffective at protecting these large mature females. Even when crabbers comply with the rule by releasing large females, these females may be captured multiple times and injured, or ultimately harvested by another crabber during their migration to the lower estuaries.

[4] Presented to PDT 8/15/11, 9/26/11, and 1/4/12; Presented to BCAC 8/22/11, 9/19/11, 10/3/11, and 1/10/12. Reviewed by RAT Subgroup on 9/7/11; Reviewed by RAT on 9/15/11, 9/28/11 and 1/19/12 via email; Presented to MRT on 9/28/11 and 1/18/12.

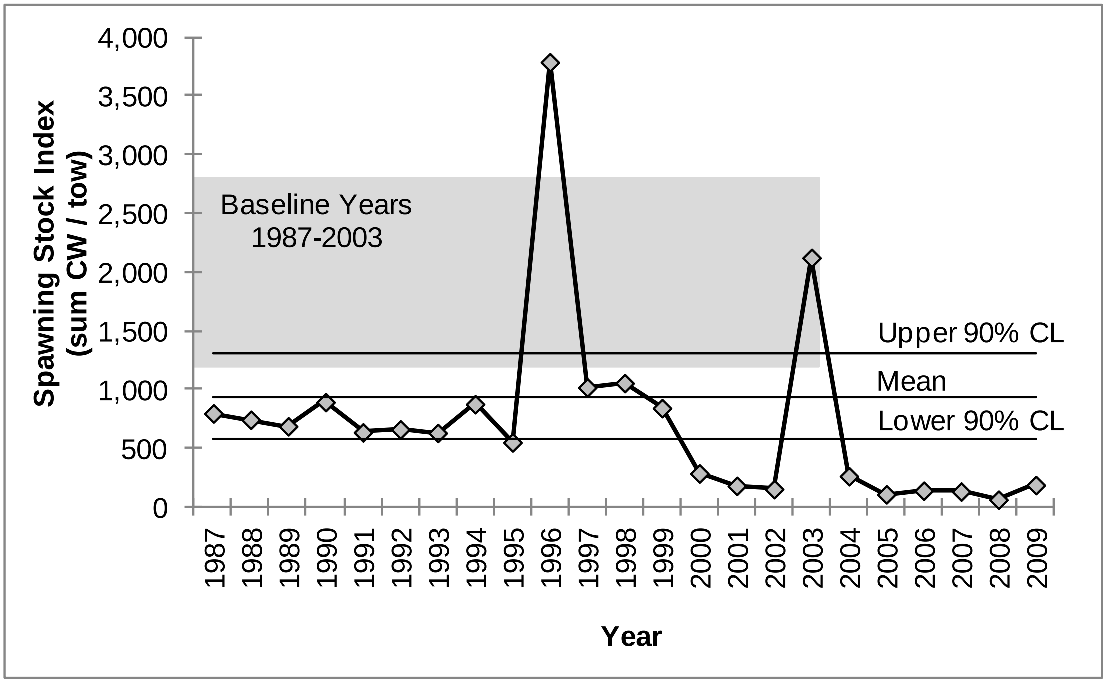

Figure 11.1.1 Annual spawning stock index for mature female blue crabs collected from Pamlico Sound Fishery Independent Trawl Survey by NCDMF Program 195, 1987–2009.

In an attempt to better assess and manage the blue crab fishery during the development of Amendment 2, the NCDMF considered alternative methods to evaluate the blue crab stock condition. Multiple NCDMF data collection programs were evaluated for their utility in helping to determine the status of the stock. The PDT acknowledged that the collection and accurate interpretation of both fisheries dependent and fisheries independent data are important to understanding blue crabs, and both should be viewed together in order to gain a full understanding of the nature of changes in the magnitude of landings and productivity of the stock. However, for the purpose of determining stock condition, dependent data (landings) had its limitations due to these data being influenced by many variables specific to how fishermen harvest their catch, including: area fished, number of fishermen, intensity of fishing effort, gear specifications, level of expertise of the fishermen, and the availability of the crabs. Available fisheries independent data included surveys that were not directly influenced by harvesting activities. Surveys are designed such that each segment of the resource has an equal chance of being sampled (randomly picked) and in this way one can make a valid inference about the unsampled fraction of the resource. Over the long term, the proportion of stations with and without crabs in the sample should approximate what is found in the population. It is the control of the survey design and the consistent application of that design that allows one to minimize sampling bias and produce relative trends in abundance over time. See Attachment A to this paper for a more in-depth discussion of this topic.

Due to confounding aspects of the blue crab life history and data limitations, it was determined that a traditional stock assessment could not be conducted on the blue crab stock and an index-based assessment using mainly independent fisheries data (NCDMF surveys) was chosen instead. The Traffic Light method was used for the current stock assessment (See Appendix 14.8 for the assessment).

The Traffic Light method synthesizes a variety of information to provide a description of the stock condition. The indicator value in each year for each data series was assigned a green, yellow, or red ‘signal’ based on the state of the indicator relative to stock condition. Typically, the color green is indicative of a favorable stock condition, yellow of an uncertain or transitioning stock condition, and red of an unfavorable stock condition. Similar indicators were aggregated into three stock characteristics: adult abundance, recruit abundance, and production. The main assumptions of the Traffic Light method are that the indicators reflect the characteristic to which they are assigned and that the characteristics adequately reflect the feature of the stock they represent. The base years (1987-2009) for assigning these signals (green, yellow, or red) will remain constant until the next amendment of the FMP. Plans are for the Traffic Light review to be updated on an annual basis for the stock status update that occurs in July of each year. Data would be verified and ready for the analysis each year no later than April 1 to extend the annual traffic light series, complete the status update, and reassess management needs. The Traffic Light method provides a more robust indicator of the overall blue crab stock condition because the data inputs are from multiple statewide surveys encompassing all aspects of the blue crab’s life history and distribution rather than the 2004 FMP management trigger that is based solely on the spawner index of mature females captured in the Pamlico Sound Trawl Survey during the September cruise.

The Traffic Light analyses showed that adult and recruit abundance characteristics were better overall before 2000 (Figure 11.1.2). There have been some negative trends in recent years, especially in both adult and recruit abundance. The production characteristic (monitoring spawning stock, median size, and pre-recruits) was variable, but the Traffic Light gave evidence of increasingly positive trends in recent years (Figure 11.1.2).

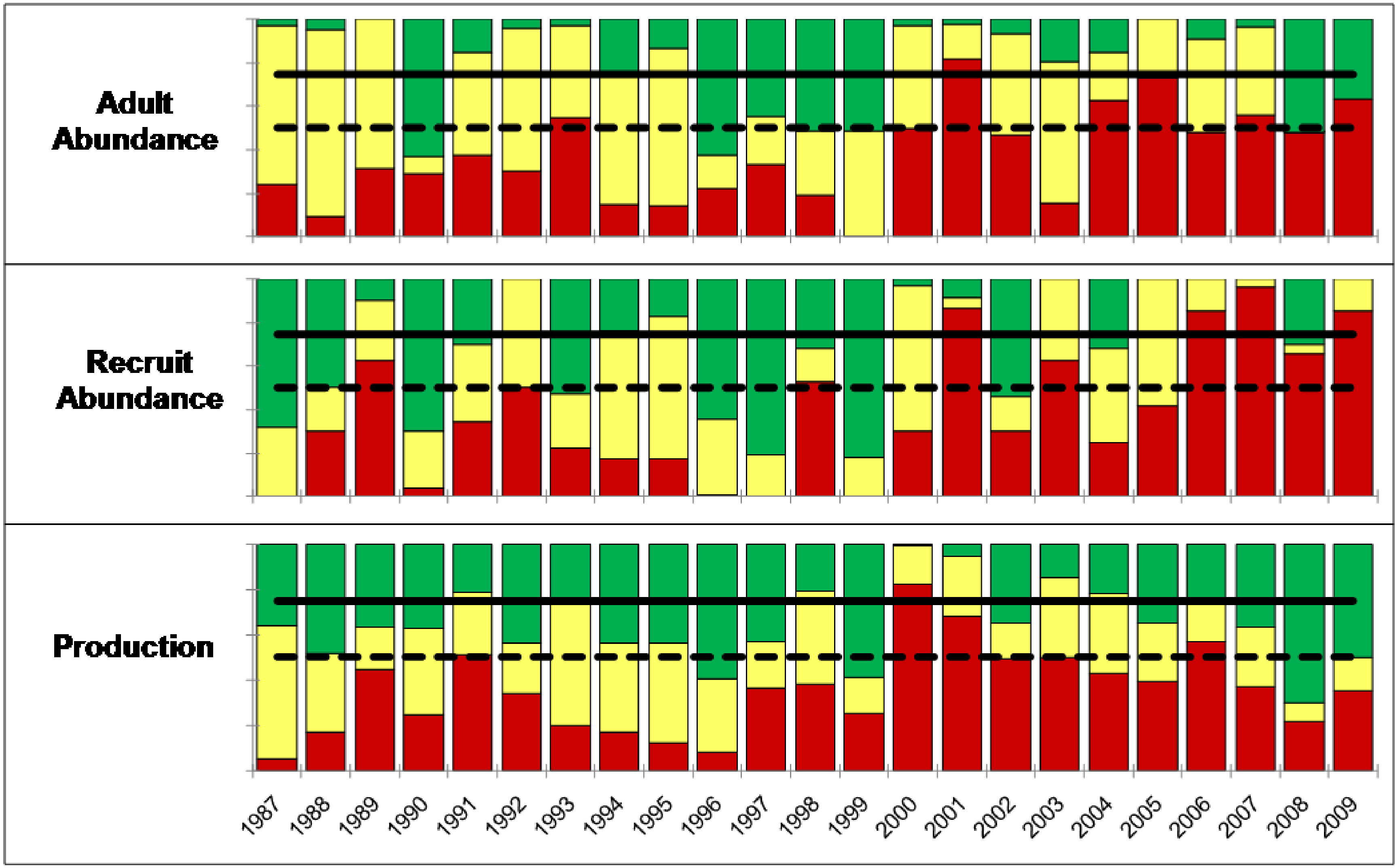

Figure 11.1.2 Traffic Light representations of adult abundance, recruit abundance, and production characteristic for the blue crab stock. The dashed (– –) and solid (—) lines represent the 50% and 75% quartiles for the proportion of red. ● = Favorable stock condition; ● = Uncertain or transitioning stock condition; and ● = Unfavorable stock condition.

The NCDMF proposes the blue crab stock is considered overfished when the proportion of red in the production characteristic of the Traffic Light method is greater than or equal to the third quartile ($\geq$0.75) for three consecutive years (see below for discussion of three-year quartile approach). With these criteria, the results of the 2010 traffic light assessment suggest the North Carolina blue crab stock is not overfished (Figure 11.1.2). While the overfished definition is based only on the production characteristic, it is also recommended to annually evaluate the adult and recruit characteristics for warning signs that the stock may be approaching an undesirable state.

In the 2010 stock status report, the stock was listed as one of concern due to reduced commercial landings of hard blue crabs during 2000 through 2002 and 2005 through 2007 following record-high commercial landings observed during 1996 through 1999 (NCDMF 2011). Commercial blue crab landings in 2010 were the fifth lowest during the 10-year period of 2001 through 2010. Harvest from Pamlico and Core sounds and tributaries continue to remain significantly less than historical levels. Albemarle Sound is the dominant contributor to landings; landing 13.6 million pounds (44%) of the state's total blue crab commercial harvest of 30.7 million pounds in 2010.

Proposed adaptive management levels for the adult abundance, recruit abundance, and production characteristics are based on a three-year quartile approach. The NCDMF proposed the 3 year timeframes and quartile criteria based on several intuitive factors. Two years seemed too brief to reveal a consistent trend or account for normal annual variation. A longer time frame (e.g., 5 years) was likely to jeopardize the stock by delaying needed actions, so 3 years was picked as a reasonable compromise. In regards to the selection of quartiles, other traffic light assessments have used thirds. However, the Division felt it was more understandable to use quartiles where the concept of greater than half or 50% was more readily related to by the general public. Also, the resulting quartile trends appeared to reflect the phases the fishery as gone through during the reviewed period of 1987 to 2009. Other criteria combinations could be considered for achieving a designated management level.

After further evaluation it was determined that the recruit abundance characteristic would not be used to trigger management actions due to inadequate spatial and temporal survey coverage (e.g., the absence of recruit survey data for the Albemarle Sound area; timing of surveys do not provide statewide coverage during the prolonged summer or significant fall recruitment periods). Therefore, only the adult abundance and production characteristics will be utilized to trigger management actions, and the recruit abundance characteristic will be used as a supplement to further direct conservation management actions, if deemed necessary. Thus, if management is triggered for either the adult abundance or production characteristics, then the level of red in the Traffic Light for the recruit abundance characteristic will be evaluated and appropriate recruit abundance management measures may be implemented in combination with management actions for the adult abundance or production characteristics. Recruit abundance management actions implemented in combination with adult abundance or production actions will remain in effect until other management actions are triggered (elevated or relaxed) for these respective actions.

The following protocol is proposed to be used to initiate management using the Traffic Light assessment results. If the proportion of red in the adult abundance or production characteristics is less than the second quartile (less than 50%) for three consecutive years, no management action is considered necessary for that characteristic. Any consecutive three-year combination of red proportions for the adult or production characteristics in the Traffic Light exceeding the 50% quartile will result in implementing management actions for that characteristic. The management level for a characteristic exceeding the 50% but less than 75% red is termed moderate and termed elevated if greater than 75% red. Also, the characteristic is considered in an elevated level when 2 or more of 3 consecutive years above 50% are greater than 75% red.

The suite of management actions would be based on either the moderate or elevated management levels. One or more of several management actions could be taken, specific to the adult abundance or production characteristic exceeding the moderate or elevated management level. Once moderate or elevated management actions are implemented, they would remain in place for three years; then the three-year evaluation periods would resume beginning with the first year the management actions were implemented.

The adaptive management framework must take into consideration what actions will be taken after management measures are implemented, if the stock condition does or does not show improvement. A scenario indicating a potentially unviable stock condition is if both the adult abundance and production characteristics fall into the elevated management level for three concurrent consecutive years. If this situation occurs the FMP supplement process would be started to investigate the stock condition, evaluate additional management options, and gather comments from the public due to serious concern for the viability of the stock.

The decision making flowchart for implementing management of the different scenarios and outcomes is presented in Figure 11.1.3. If management measures have been in place for the moderate threshold for three consecutive years and the stock condition in that characteristic continues at the moderate threshold or rises to the elevated threshold, then management measures would increase to the elevated threshold for another three years. If after three more years this characteristic shows no further improvement, then it will start the FMP supplement process. If management measures have been in place at the moderate threshold and the stock improved to a viable condition in three consecutive years, then the management measures would be relaxed. If management measures have been in place at the elevated threshold for three consecutive years and show improvement, but only to the moderate threshold, then management measures would drop down to the moderate threshold measures. If after three consecutive years the characteristics improved from the elevated threshold to a viable stock condition, then management measures would be relaxed.

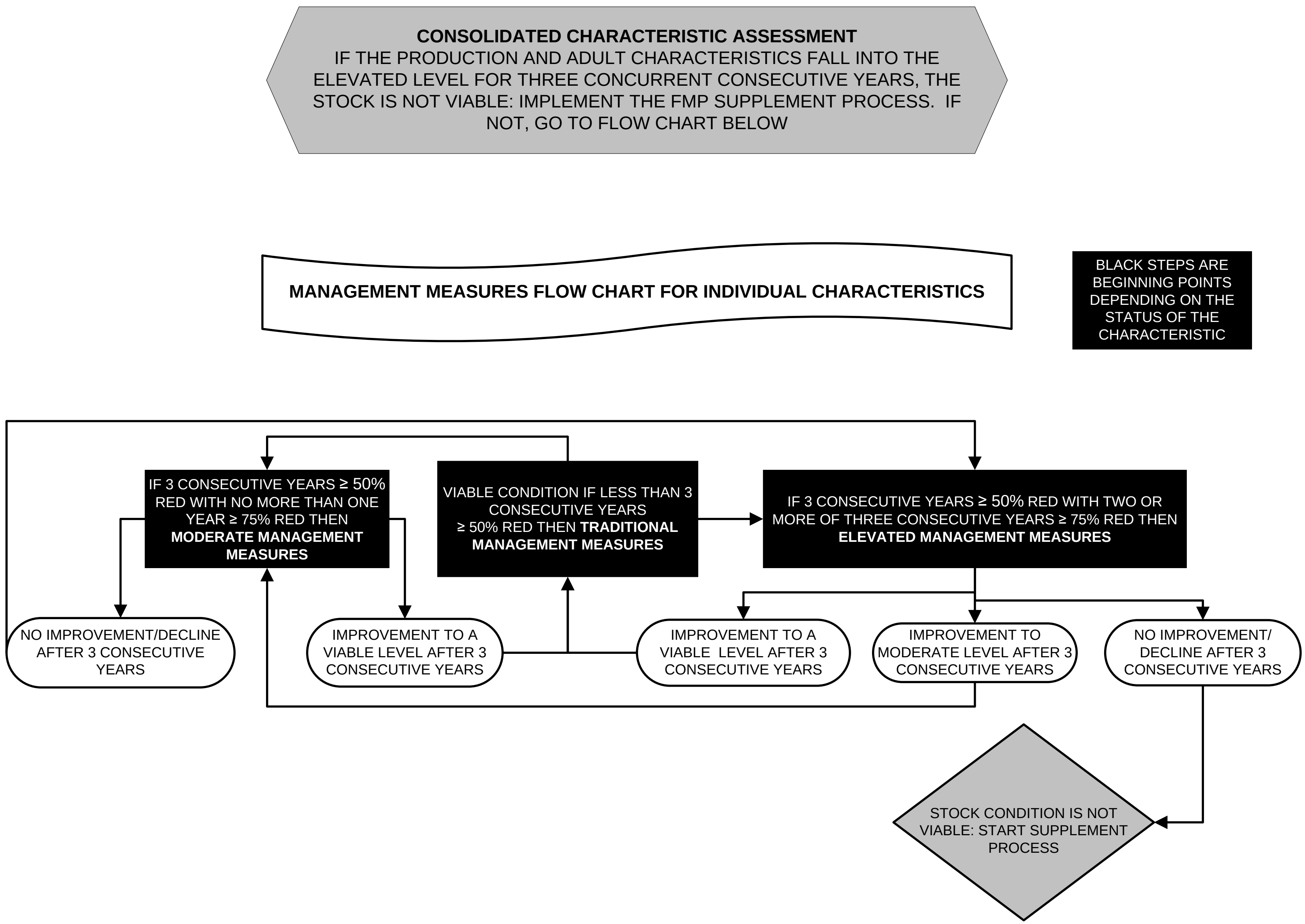

Figure 11.1.3 The blue crab adaptive management framework decision making process for each management level.

IV. AUTHORITY

G.S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

15A NCAC 03J .0301 POTS
15A NCAC 03J .0302 RECREATIONAL USE OF POTS
15A NCAC 03L .0201 SIZE LIMIT AND CULLING TOLERANCE
15A NCAC 03L .0202 CRAB TRAWLING
15A NCAC 03L .0203 CRAB DREDGING
15A NCAC 03L .0204 CRAB POTS
15A NCAC 03L .0205 CRAB SPAWNING SANCTUARIES
15A NCAC 03L .0206 PEELER CRABS
15A NCAC 03L .0209 RECREATIONAL HARVEST OR CRABS
15A NCAC 03R .0109 TAKING CRABS WITH DREDGES
15A NCAC 03R .0110 CRAB SPAWNING SANCTUARIES

V. DISCUSSION

With increasing concerns over fluctuating and declining blue crab landings, changes to the current management approach are necessary. Blue crab recruits in any given year rely, in part, on the size of the spawning stock from which the young originated (Chesapeake Bay Program 1997). Thus, declines in adult abundance could lead to reduced recruitment in subsequent seasons or years. To effectively manage the blue crab stock, information on the size structure of the stock, recruitment relationships, abundance, and movements of the spawning stock must be examined.

Environmental conditions (i.e., winter mortality, drought, hypoxia, hurricanes, and human development effects), diseases, predation, and cannibalism can contribute to population decline. Investigators often state that annual fluctuations in blue crab populations are the result of environmentally-induced variations in recruitment. As noted in Section 10 of this amendment "Maintenance and improvement of suitable estuarine habitat and water quality are probably the most important factors in providing a sustainable blue crab stock". Section 10 provides a litany of environmental and water quality impacts and a series of recommendations specific to blue crab. However, the MFC only has jurisdiction over and the management tools to respond to situations where populations are being impacted by harvest activities (fishing mortality). Non-fishing activities and impacts are under the jurisdiction of other government agencies and natural climate conditions and other environmental factors. Recognizing the critical importance of healthy and productive habitats to produce fish for human benefits, the North Carolina General Assembly included a provision in the Fisheries Reform Act of 1997 instructing the Department of Environment and Natural Resources (DENR) to prepare Coastal Habitat Protection Plans (CHPPs). The legislative goal of the plans is long-term enhancement of coastal fisheries associated with each habitat. The CHPP compiles the latest scientific information on each habitat so that management needs can be identified to protect, enhance, and restore associated fish populations. Each designated division within the DENR compiles a bi-annual implementation plan to accomplish recommendations within their authority. The influence of the habitat and environmental factors need to be considered in order to maintain a sustainable fishery. At a minimum, formal communication with the CHPP steering committee about blue crab habitat issues and recommendations should commence when the recruitment traffic light characteristic achieves a designated management level.

Conflicting views exist regarding the existence or absence of a spawning stock-recruitment relationship for the blue crab (Lipcius and Van Engle 1990; Lipcius and Stockhausen 2002; Eggleston et al. 2004; Pearson 1948; Sulkin et al.1983; Van Engel 1987). Although a definitive stock-recruitment relationship has not been identified for blue crabs, this does not mean that recruitment is independent of the size of the spawning stock. To manage a fishery based on the assumption that recruitment is independent of spawning stock size when this is not the case could lead to the decline of the population. In cases like this, the most appropriate management approach would be to provide some protection for spawners until the dynamics of the population are better understood.

As noted previously the main assumptions of the Traffic Light method are that the indicators reflect the characteristic to which they are assigned and that the characteristics adequately reflect the feature of the stock they represent. During the AC deliberations on the Traffic Light assessment, they raised a number of concerns on the adequacy of the Traffic Light to represent the condition of the stock, particularly by its not including fishery dependent data and the use of trawl gear as the principle survey gear as well as some other survey design concerns. Please refer to Attachment A to this paper for a more in-depth discussion of these topics.

Potential Management Measures

Many management tools are available; some are more restrictive to the fisheries than others and need to be categorized within the moderate and elevated management levels accordingly. Within each stock characteristic (adult abundance, recruit abundance and production), specific management measures should be pre-determined for each management level. The various management tools considered are described below.

<u>Effort control</u>

Limited entry is one type of effort control tool for consideration. The MFC has no authority to limit entry in a fishery and can only recommend that the General Assembly limit participation in the fishery, if it is determined that sustainable harvest cannot otherwise be achieved. The North Carolina General Assembly would have to enact legislation approving any further limited entry in the fisheries or delegate this authority to the MFC (NCDMF 1998). Sustainable harvest for the blue crab stock cannot be determined at this time and there are other management options available that can be used to attain a viable stock condition. Therefore, limited entry is not a viable option for consideration at this time.

Managing fisheries with a quota, or a specified amount of harvest, is usually used to prevent over-expansion of the fishery. Quotas must be monitored closely to avoid overage. The blue crab fishery is the largest fishery in terms of the number of dealers and participants, and landings in North Carolina. Monitoring this fishery would be extremely difficult due to the high variability in daily landings and the large number of dealers and participants involved. The NCDMF would need to implement a monitoring system that can effectively track the volume of landings on a much shorter time scale than what is already in place. It is unlikely the NCDMF could immediately implement a quota tracking system for such a large fishery.

Pot limits are another method for managing effort and improving economic efficiency in the crab pot fishery. The only existing crab pot limit in North Carolina is a 150 pot per vessel limit in Newport River, Carteret County. This limit was requested by the Newport River crab potters and has been in existence since 1985. This pot limit is self-enforced by the local potters. If a new operation shows up and deploys over 150 pots, Marine Patrol is called immediately by the potters who work the river.

After the Blue Crab FMP was adopted in 1998, the MFC convened a Regional Stakeholder Advisory Committee to draft an open access plan for the crab pot fishery with discussions including pot limits (NCDMF 2004). A considerable amount of time and effort was spent in developing a permit, regional pot limit criteria, and a pot tagging system for enforcement. Consensus could not be reached on an appropriate effort management plan for the blue crab fishery. The MFC in 2000 did not implement any aspect of the proposed regional effort management strategy for the crab pot fishery (NCDMF 2004).

Restricting pot fishing time to a certain time frame (e.g., 6 am until 2 pm) could potentially reduce the overall amount of gear used and harvest. However, time limits may push crabbers to utilize areas where catch rates are higher. Time restrictions would significantly impact or eliminate those fishermen that work at other jobs and fish pots after work. Also, problems would be encountered by full-time fishermen working in tidal areas, generally in the more southern areas of the state. The latter problem could potentially be addressed through regional management.

<u>Catch limits</u>

Catch limits attempt to reduce effort, and/or fishing mortality by limiting harvest. The basic assumption of this management strategy is that restricting catch allows more blue crabs to be available to perpetuate the stock.

One type of catch limit is trip limits. The assumption with a trip limit is that fishermen would likely limit the amount of gear needed to catch the trip limit, or adjust their effort to maximize economic efficiency. However, this effort adjustment would vary from year to year depending on resource availability. In years of low crab abundance or limited size availability, fishermen might put out more pots to compensate for loss in harvest.

Increasing the minimum or establishing a maximum size limit is a common management tool used to rebuild the spawning stock. Mature females and peeler/soft crabs are exempt from the 5 inch minimum size limit (Rule 15A NCAC 03L .0201). The short term effects of an increased minimum size limit would diminish the pool of younger, smaller crabs immediately available for harvest, which in turn would produce a short term decrease in the overall catch. Decreasing the harvest of smaller crabs may not have an immediate effect on reducing the fishing mortality on older, larger crabs. The benefit to the fishery of an increase in minimum size would not be realized until the survival of the smaller crabs contributes more to the pool of older individuals. One of the major benefits to increasing the minimum size limit is that it would allow a larger number of younger crabs the opportunity to mate prior to harvest. The major benefit to establishing a female maximum size limit is that it would allow a greater portion of the stock the opportunity to spawn before harvest. Additionally, catch limits, in the context of minimum size limits could have a negative impact on the crab market, by creating uncertainty in product availability.

Increased effort and harvest in the peeler/soft blue crab fishery and reduced adult harvest has prompted concern about the impacts of peeler/soft crab harvest on the overall health of the fishery. Establishing a minimum size limit for peeler crabs would reduce fishing mortality on the smallest crabs currently allowed for harvest. Effects and benefits would be the same as those described above for minimum size limits. In addition, current peeler fishing practices, employing live male crabs as an attractant or bait, target immature female peelers. Therefore, the vast majority of the peelers harvested are immature females that are approaching their terminal molt. Reducing fishing mortality on this segment of the population would contribute to efforts to protect the stock. Natural mortality of sublegal crabs (less than five inches) is in the range of 26% to 32% per year in Chesapeake Bay (Casey et al. 1992). Eggleston (1998) estimated an annual mortality rate of 50% for sub-adult and adult blue crabs in North Carolina. Several other states have minimum size limit restrictions for peeler and/or soft crab harvest. A Maryland report noted that raising the peeler size limit would potentially provide an increase in spawning stock biomass by allowing more females to enter the spawning population (Uphoff et al. 1993). Raising the size limit should also increase yield to the fishery (Uphoff et al. 1993). Peeler size limits could possibly improve recruit abundance.

As the time between sheds increases with increasing size, the probability of capture of larger crabs at the peeler stage decreases. The time interval between sheds of 3.0 or 3.5 inch crabs will generally be one to three months (Rothschild et al. 1992). The increase in yield from an increased peeler size limit would not be totally lost to natural mortality. The overall value of the peeler/soft crab fishery might be enhanced by a size limit as larger soft crabs generally bring a higher price. A potential adverse impact on the soft crab fishery would be a decrease in market flexibility, particularly during the early spring when product availability is low and small peeler/soft crabs are in demand, bringing very high prices to fishermen. Implementing a peeler size limit might increase handling mortality and waste in the fishery. Peeler/soft crab size limits could allow more effective and efficient enforcement of size limits, both in state and out of state as crabs are shipped to states with existing size limits. Therefore, adopting a peeler minimum size limit of 3 or 3.25 inches would address regulatory consistency among the Atlantic Coast States and foster interstate trade.

The underlying hypothesis of limiting sponge crab harvest is that by protecting the spawning stock (defined here as egg-bearing females), the fishery would benefit with more recruits to the fishery. Concerns with protecting egg-bearing female blue crabs (sponge crabs) are complex, consisting of: economic factors (fewer pounds of meat can be picked from a given weight of sponge crabs than from the same weight of non-sponge crabs); biological considerations (recruitment overfishing); and personal opinions regarding “motherhood”. Currently, there are a number of states that prohibit the sale or possession of egg-bearing females (Table 11.1.1). Without exception, these states experience the same fluctuations in blue crab landings as seen in states that do not protect egg-bearing females. From the early 1920s until 1964, it was unlawful to harvest sponge crabs in North Carolina. When the sponge crab law was repealed in 1964, it was replaced with the establishment of Crab Spawning Sanctuaries [MFC (2011) rules 15A NCAC 03L .0205 and 03R .0110]. During the time frame that the North Carolina sponge crab law was in effect, reported hard crab landings showed the same patterns in fluctuations as were observed after its repeal. However, reducing or prohibiting sponge crab harvest would provide additional protection to those crabs that will be spawning in a very short time (i.e., 14 days or less depending on sponge stage/color). Limiting harvest would protect sponge crabs where sanctuaries do not exist. Eggleston (2003) found no significant difference between mature female catches within the sanctuaries versus an area five kilometers outside of the sanctuaries. Depending on the level of concern, catch limits on sponge crab harvest could be seasonal, regional, and/or by sponge stage/color. Limiting the harvest of sponge crabs would have an economic impact on the crab fisheries in some areas during certain periods (e.g., Outer Banks during spring).

Table 11.1.1 Summary of blue crab sponge and spawning sanctuary regulations (New Jersey to Texas).

State	Prohibit the sale or possession of sponge crabs	Have established crab spawning sanctuaries
New Jersey	Yes	No
Delaware	Yes	No
Maryland	Yes	No
Virginia	Yes [1]	Yes
North Carolina	No	Yes
South Carolina	Yes	No
Georgia	Yes	No
Florida	Yes	No
Alabama	No	No
Mississippi	Yes	No
Louisiana	Yes	No
Texas	Yes	No

[1] Prohibit brown and black sponge crabs with tolerance

<u>Closures</u>

Closures to the fishery could include: season, area, and gear. The premise behind this management tool is to restrict harvest, whether by time, location, fishery, or to provide protection to a species that is vulnerable to harvest in a particular place and time due to some stage in their life history.

A seasonal closure can be used to restrict harvest during certain times of the year and to reduce removals from the stock. Since effort can be increased during the open periods of the fishery to offset losses during the closed season, it is best to have seasonal closures that are a minimum of two weeks, but preferably longer. The timing of harvest from the different crab fisheries should also be considered.

Season closures during peak harvest periods tend to be more effective than season closures when harvest is minimal because closures at peak harvest leave less opportunity for recoupment by the fisheries. However, a possible result of overall season closures would be an increase in discards, particularly in fisheries that land, but do not target blue crabs. Discards from the target fisheries could be minimized during closed seasons by removing the gear from the water.

North Carolina has five locations designated as crab spawning sanctuaries north of Cape Lookout which cover approximately 28,975 acres**.** The spawning sanctuaries are already closed from March 1 through August 31 by Rule 03L .0205. Existing proclamation authority in Rule 03L .0205 also provides that these crab spawning sanctuaries can be closed or restricted further outside of the closed period (September 1 through February 28) to protect spawners.

The purpose of these sanctuaries is to protect mature females that inhabit these areas prior to and during the sponge stage and spawning season. Recent tagging data suggest this is not the case in all areas. In Core Sound most tagged crabs migrate toward the inlets and many will release their first clutch of eggs prior to reaching the spawning grounds (Rittschof 2003). Some female crabs remain within the sounds and some go out the inlet and move with currents up and down the coast. In Pamlico Sound, sponge crabs are present on the spawning grounds from spring to fall, and mature females year round (Ballance and Ballance 2002; NCDMF 2008). Tag return data suggest that females tagged on the sanctuaries in Pamlico Sound are consistently caught in areas up to four kilometers surrounding the sanctuaries (Ballance and Ballance 2002; NCDMF 2008).

Crab spawning sanctuaries have not been designated south of Cape Lookout, NC due to the small inlets and relatively small estuarine waters near most of the southern coastal inlets. Spawning sanctuaries around the southern inlets would prohibit commercial gears currently in use, forcing commercial harvesters into other areas; thereby, increasing conflicts among all user groups. Local crabbers suggest that the deep fast flowing waters of the lower Cape Fear River ship channel provide a natural barrier to some crab harvesting practices. Thus, this area serves as a sanctuary for all crabs.

Gear modifications

Modifications to harvest gear can be used to reduce catch and mortality of the sublegal bycatch of target or non-target species. Increasing size limits often go in hand with gear modifications to eliminate sublegal bycatch. Cull (escape) rings are one such device used in crab pots to reduce bycatch. Current restrictions require two cull rings per pot of 2 5/16-inch minimum inside diameter. The cull rings expand with use and are likely not an efficient culling device to the current minimum size limit. The cost and effort to change the cull ring size must also be considered.

Existing rule authority requires a minimum stretched mesh of 3 inches for crab trawls for taking hard crabs, except that the Fisheries Director may, by proclamation, increase the minimum mesh length to no more than 4 inches [15A NCAC 03L .0202 (b)]. Increasing the minimum mesh length of crab trawls in areas not currently under proclamation authority would further reduce catch and mortality of sublegal crab bycatch. In 1992, the NCDMF conducted a study to examine the culling ability of larger crab trawl tailbag sizes, the number of sublegal blue crabs was reduced by 13% in the 4 inch tailbag and the number of legal crabs was reduced by 7%, as compared to catches in a 3 inch tailbag (McKenna and Clark 1993). Overall survival rates were documented for trawl-caught crabs at 64%, while 93% of the crab pot caught crabs survived (McKenna and Camp 1992). During a trip in June, a large number of paper shell and soft crabs were killed in the trawling process. Given the high percentage of sublegal blue crabs currently being captured by the crab trawl fishery, it was recommended that an increase in the minimum tailbag mesh size should be implemented to reduce fishing mortality on this species (McKenna and Clark 1993). A reduction of fishing mortality on sublegal crabs should make more legal size individuals available for harvest at a future date.

Reductions in trawl headrope length would reduce bycatch CPUE (catch per standardized trawl tow time) and could potentially reduce overall effort.

Some researchers have documented sponge mutilation (scrubbing) by pot caught crabs (Rittschof 2004). Even when sponge crabs are returned to the water, egg mass destruction and reduced viability of the eggs may occur during the pot harvesting and handling process. Other research has indicated that sponge crab excluders can be effective in reducing the harvest of egg bearing crabs. Research comparing control crab pots and pots equipped with sponge crab excluders was conducted in the high salinity waters of Core Sound, NC near crab spawning sanctuaries (Rudershausen and Turano 2006). They concluded that in areas where mature females dominate the crab pot catch, the benefit of using excluders to reduce entry of sponge crabs may outweigh a potentially modest decrease in catch of non-sponged females.

Discard reductions in the shrimp trawl fishery

There is some concern for blue crab discards in the shrimp trawl fishery. Discard reductions of blue crabs in non-target fisheries were reviewed in Amendment 1 of the Blue Crab FMP and only one more recent study has further information specific to the commercial shrimp trawl fishery (NCDMF 2004). An at-sea sampling study was conducted from July 1 through December 31, 2009 in the commercial shrimp trawl fishery in Pamlico Sound and its tributaries (Brown 2010). A total of 66 observed trips during the study achieved 1.21% coverage of the commercial shrimp trawl fishery for that time and area. Observers sampled commercial shrimp trawls consisting of three different net types: double seamed, four seamed, and tongue nets. Varying trends were observed in the three gears. Blue crabs accounted for between 0.31% and 1.29% of the total weight of the catch within the three net types. All blue crabs were discarded, and observed mortality was minimal (K. Brown, personal communication 8/12/11). Tow times ranged from 50 to 275 minutes. Limiting maximum tow times would help to reduce mortality of sublegal crab bycatch. More research would be helpful to determine the extent of delayed mortality of blue crabs in the shrimp trawl fishery.

Proposed Management Strategy

Other states have implemented multiple management criteria to manage their blue crab stock (see Appendix 14.3 and 14.4 for management measures used in other states). The Chesapeake Bay jurisdictions (Maryland and Virginia) have complementary blue crab management programs, but implementation differs slightly to achieve the management benchmarks. Both have: limits on licenses and pot effort; minimum size limit on hard, soft, and peeler crabs, except mature females; time limits; and seasonal daily catch limits. Maryland prohibits the harvest of sponge crabs, and Virginia employs sanctuaries and prohibits harvest of brown/black sponge crabs. Georgia manages the commercial fishery under a controlled access system, including a limited number of licenses issued in a year and pot limits; a minimum size limit for both hard and peeler crabs, except mature females; and prohibits the harvest of sponge crabs (Sartwell 2009). Georgia implemented no harvest of females in the month of March beginning in 2011 to allow more eggs to be released by females (http://savannahnow.com/stories/012704/LOC_crabdecision.shtml).

After much deliberation over the various management options that could be implemented within the moderate and elevated management levels, the FMP Plan Development Team proposes management measures within each stock characteristic to be implemented by proclamation authority when a characteristic achieves the designated management level (Table 11.1.2). Some or all of the measures could be implemented in either of the characteristics following the adaptive management framework (Table 11.1.2). Both the adult abundance and production characteristics have shown at least one instance below the 50% threshold for the last three consecutive years. Therefore, no management measures for these two characteristics would be required at this time. Since management measures for the recruit abundance characteristic cannot be considered until after either the production or adult abundance characteristic reach their thresholds for three consecutive years, no management measures are warranted at this time for the recruit abundance characteristic.

The following scenario is presented for illustrative purposes to show how management measures could be implemented. If the adult abundance levels were above 50% but less than 75% red for all of the last three years, the preferred management measures within the adult abundance moderate management level (Table 11.1.2) that could be initiated by proclamation include:

1. Increase in minimum size limit for male and immature female crabs.
2. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 5%) and/or implement gear modifications to reduce sublegal catch.
3. Eliminate harvest of v-apron immature hard crab females.

Also, when management is triggered for either the adult abundance or production characteristics, then the level of red in the Traffic Light for the recruit abundance characteristic will be evaluated and appropriate recruit abundance management measures (Table 11.1.2) may be implemented in combination with management actions for the adult abundance or production characteristics.

Table 11.1.2 Fishery management measures proposed to be implemented by proclamation authority in the blue crab adaptive management framework when a stock characteristic achieves a designated management level.

Characteristic	Moderate management level	Elevated management level
Adult abundance	A1. Increase in minimum size limit for male and immature female crabs	A4. Closure of the fishery (season and/or gear)
	A2. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 5%) and/or implement gear modifications to reduce sublegal catch	A5. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 1%) and/or implement gear modifications to reduce sublegal catch
	A3. Eliminate harvest of v-apron immature hard crab females	A6. Time restrictions
Recruit abundance	R1. Establish a seasonal size limit on peeler crabs	R4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots in specific areas
	R2. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	R5. Expand existing and/or designate new crab spawning sanctuaries
	R3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	R6. Closure of the fishery (season and/or gear)
		R7. Gear modifications in the crab trawl fishery
Production	P1. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	P4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots for specific areas
	P2. Minimum and/or maximum size limit for mature female crabs	P5. Reduce peeler harvest (no white line peelers and/or peeler size limit)
	P3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	P6. Expand existing and/or designate new crab spawning sanctuaries
		P7. Closure of the fishery (season and/or gear)

These management measures went through further refinement after input was gathered from the AC on 8/22/11 and 9/19/11. The AC recommendations on 9/19/11 supported the principle behind the adaptive management system as opposed to the system that is currently in place, but the AC wanted to improve the data collection methods and consider commercial landings as part of the Traffic Light method. Instead of endorsing particular items within the framework at the different management levels, the AC suggested eliminating sponge females and immature (v-apron) crabs from the harvest to promote recruitment and increase survival of recruits into adults.

Reductions in the crab pot fishery from the elimination of sponge and immature female harvest and a minimum size limit on peeler crabs can be estimated from samples collected from the NCDMF commercial blue crab sampling program. The sampling program determines size, sex and maturity (female) for blue crabs harvested in the crab pot commercial fisheries by market category and area as the catch is brought into the dealer to be sold. However, sampling intensity is not evenly distributed to the catches seasonally or by area and market grades. Therefore, these estimates may not be a true reflection of what is harvested in the fishery. Using this information provides broad estimates of harvest reductions from potential regulatory changes and must be used with caution.

Elimination of female sponge crab harvest is considered to improve recruitment into the population by giving the eggs the opportunity to grow and become adults, and an additional benefit would be to allow the sponge females to survive for multiple clutches in a season. North Carolina is one of only two states in the US that have no restrictions on sponge crab harvest (Table 11.1.1).

To provide an estimate of the impacts of prohibiting sponge crab harvest, the number of sponge crabs harvested was divided by the total number of crabs measured in the straight and cull market categories collected in the sampling program to estimate the percent by number. In order to apply the estimate to trip ticket information, the numbers must be converted to weight in pounds for a direct comparison, using three crabs per pound. Once the percentage by weight is completed within the commercial sampling program, then the weight estimates are applied to the trip ticket landings for just the straight and cull market grades to determine the statewide percent reduction for the elimination of sponge crabs in the harvest.

The average annual reduction for sponge crabs estimated from commercial sampling applied to the total commercial landings statewide for 2001 to 2009 was 3.78 percent and 726,470 pounds of the average annual catch (Table 11.1.3). We know that the Pamlico Sound along the Outer Banks would be impacted the greatest by prohibiting sponge crab harvest since a large number of the sponge females are caught near the inlets. Reduction estimates could not be derived specifically for the Pamlico Sound area, the percentages were inflated because commercial sampling occurs more near the inlets than in all other areas of Pamlico Sound. The estimates are not reasonable for calculating meaningful reductions in the catch at such a fine level and can only be shown statewide. Also, during AC discussions, it was noted by commercial potters that sponge crabs are not usually targeted due to low market value; but, sponge crabs will be harvested when other more valuable crabs are not available. The Pamlico Sound and statewide commercial sampling showed in more recent years the catch of sponge crabs has declined, which may also be a result of fishing behavior shifting away from these less valuable sponge crabs. Therefore, eliminating sponge harvest will only have minimal impacts to the overall harvest.

Immature (v-apron) females are also encountered in the commercial sampling program across six market categories (Straight, Jimmies (No. 1), No. 2, No. 3, Culls, and Mixed). Reduction estimates to the total harvest were also calculated for immature females exactly as they were for sponge crabs and applied to harvest in pounds and percent statewide. The average annual reduction estimated for immature females from 2001-2009 in the total harvest was estimated at 1.05 percent and 307,087 pounds (Table 11.1.4). Members of the AC determined that immature females are not wanted in the catch by dealers. Even with a culling tolerance, prohibiting harvest of immature hard crabs of 5 inches and larger would allow some of the immature females to become spawning adults.

Table 11.1.3 Female sponge crab harvest (pounds) statewide and the percent reduction of female sponge crab harvest statewide in the straight and cull market categories, 2001-2009.

Estimated female sponge crab landings	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average 2001-2009
Statewide, Straights (pounds)	600,543	1,142,377	1,840,681	675,236	873,788	653,388	157,016	3,576,836	3,793	12,357	459,656
Statewide, Culls (pounds)	749,380	142,788	90,377	644,902	765,951	436,083	154	262,138	103,511	172,505	266,814
Reduction statewide Straight and Cull Markets (percent)	7.63	10.48	12.05	6.92	10.84	9.07	1.40	56.13	1.08	2.29	5.67
Reduction Statewide all Markets (percent)	3.59	4.51	5.52	3.30	5.21	4.72	0.65	18.79	0.35	0.66	3.78

Table 11.1.4 Pounds and percent immature females removed from the total catch, 2001-2009.

Selection	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average 2001-2009
Immature female total landings (pounds)	468,629	406,990	307,839	356,100	342,412	214,082	253,522	372,539	84,949	191,662	307,087
Percent immature females to the total landings	1.25	1.44	0.89	0.91	1.10	0.94	1.06	1.87	0.29	0.71	1.05

Currently, there are no minimum size limits in place for peeler crabs. Options within the adaptive management framework propose peeler size limits. NCDMF collects size, sex and maturity (female) information on peeler crabs harvested for commercial shedding operations. Sampling is limited and can only be summarized by region (Albemarle – all areas north of Roanoke and Croatan sounds; Pamlico – Pamlico, Roanoke, Croatan and Core sounds, Neuse and Pamlico rivers; Southern - From Back Sound and all areas south to the South Carolina line). Sample sizes decline considerably when summarized at a waterbody level; and thus, only statewide estimates are provided.

The cumulative percent reduction that could occur for various size limits for each ¼-inch length of peeler crabs by region from 2005 to June 2010 is shown in Table 11.1.5. As an example, if a 3 ¼-inch minimum size limit was imposed on peeler crab harvest, 4.50 percent of peeler crabs statewide fell into the size classes below this minimum size. The Pamlico region would be the most impacted by the minimum 3 ¼-inch size limit at 8.26 percent, followed by the Albemarle region at 2.03 percent and Southern region at 1.25 percent.

Table 11.1.5 Peeler crab size limit percent reduction (cumulative percent) estimates based on sampling at shedder operations by region, 2005 to June 2010 combined.

	Peeler size limit percent reduction			
Size bins (1/4 inch)	Albemarle	Pamlico	Southern	State
2 to 2.249				
2.25 to 2.499	0.01	0.09	0.00	0.04
2.5 to 2.749	0.10	0.55	0.00	0.28
2.75 to 2.999	0.75	3.18	0.00	1.71
3 to 3.249	2.03	8.26	1.25	4.50
3.25 to 3.499	3.95	16.79	3.33	9.06
3.5 to 3.749	8.69	31.24	12.08	17.72
3.75 to 3.999	17.50	45.82	19.17	28.81
4 to 4.249	32.29	59.89	35.83	43.33
4.25 to 4.499	50.95	76.33	54.17	61.11
4.5 to 4.749	67.69	87.67	69.17	75.67
4.75 to 4.999	81.82	94.98	81.67	87.07
5 to 5.249	92.35	98.31	92.50	94.73
5.25 to 5.499	96.54	99.40	95.42	97.66
5.5 to 5.749	98.96	99.81	98.75	99.30
5.75 to 5.999	99.61	99.89	100.00	99.73
6 to 6.249	99.85	99.91	100.00	99.88
6.25 to 6.499	99.96	99.95	100.00	99.95
6.5 to 6.749	99.97	99.95	100.00	99.96
6.75 to 6.999	99.97	99.95	100.00	99.96
7 to 7.249	99.97	99.97	100.00	99.97
7.25 to 7.499	99.99	99.99	100.00	99.99
7.5 to 7.749	100.00	100.00	100.00	100.00

The traffic light assessment tool and proposed adaptive management framework is intended to help frame the condition of blue crabs and to facilitate a flexible decision making process. The information that has been provided herein is the best available data the NCDMF has to offer for deciding on the relative merits of the approach and the various management options presented. With this information, as noted in a recent article, we should strive to “do what is for best for the crab stocks and be fair to all parties” (ASMFC 2007a).

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo [Continue with the current female stock conservation management trigger as outlined in Rule 15A NCAC 03L .0201 SIZE LIMIT AND CULLING TOLERANCE (c) (1) (2)]
   - \+ No rule change required
   - \+ Keeping the only conservation measure in place for stock protection
   - \- Management based on only one component of the stock in one region of the state
   - \- Has not shown to have improved the blue crab stock

2. Implement some measure of effort control
   - \+ Known universe of participants and/or gear
   - \- Limited entry constrained by statute
   - \- Difficulty implementing a monitoring system for both pot limits or quota
   - \- Pot limits would be cumbersome and costly to administer
   - \- Pot limits difficult to enforce
   - \- Previous efforts to establish pot limits were unsuccessful

3. Repeal the current female stock conservation management trigger as outlined in Rule 15A NCAC 03L .0201 SIZE LIMIT AND CULLING TOLERANCE (c) (1) (2)
   - \+ Compliance with the female seasonal maximum size limits has been marginal and largely ineffective at protecting these large mature females
   - \+ Even with release, the large females may be captured multiple times and injured or ultimately harvested by another crabber during their migration to the lower estuaries
   - \- Rule change required
   - \- Eliminating the only conservation measure in place for stock protection

4. Adopt adaptive management framework based on the Traffic Light Stock Assessment and the proposed moderate and elevated management levels for recruit, adult, and production stock characteristics
   - \+ Management is based on multiple components of the stock in all regions of the state
   - \+ Provides some measure of stock condition
   - \+ Provides multiple options to address stock management
   - \+ Provides for elevation or relaxation of management measures based on stock condition
   - \- Rule changes required
   - \- No measure of how proposed management measures will affect the stock

VIII. RECOMMENDATIONS

MFC selected management strategy

- Repeal the current female stock conservation management trigger.
- Continue existing sampling programs to maintain baseline information for the Traffic Light method.
- Adopt the adaptive management framework based on the Traffic Light Stock Assessment and the proposed moderate and elevated management levels for recruit abundance, adult abundance, and production characteristics. Initial management actions will only be implemented when either the adult abundance or production characteristics reach the management trigger of 50% red or greater for three consecutive years. The recruit abundance characteristic will be used as a supplement to further direct conservation management actions, if deemed necessary.

Note: All management measures would be implemented through proclamation authority. The table below shows the proposed moderate and elevated management levels for the management framework and is the same as Table 11.1.2.

Characteristic	Moderate management level	Elevated management level
Adult abundance	A1. Increase in minimum size limit for male and immature female crabs	A4. Closure of the fishery (season and/or gear)
	A2. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 5%) and/or implement gear modifications to reduce sublegal catch	A5. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 1%) and/or implement gear modifications to reduce sublegal catch
	A3. Eliminate harvest of v-apron immature hard crab females	A6. Time restrictions
Recruit abundance	R1. Establish a seasonal size limit on peeler crabs	R4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots in specific areas
	R2. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	R5. Expand existing and/or designate new crab spawning sanctuaries
	R3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	R6. Closure of the fishery (season and/or gear)
		R7. Gear modifications in the crab trawl fishery
Production	P1. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	P4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots for specific areas
	P2. Minimum and/or maximum size limit for mature female crabs	P5. Reduce peeler harvest (no white line peelers and/or peeler size limit)
	P3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	P6. Expand existing and/or designate new crab spawning sanctuaries
		P7. Closure of the fishery (season and/or gear)

History Note:

The NCDMF and AC evaluated and modified their recommendations after the public comment meetings in December 2011. The NCDMF revised the adaptive management framework to use only the adult abundance and production characteristics as the trigger mechanisms for management options and incorporated some AC management recommendations. The AC ultimately supported the adaptive management framework, but with more specific moderate and elevated management measures ranked by priority. Specifics of these NCDMF and AC recommendations are outlined below.

NCDMF - Repeal the current female stock conservation management trigger.
- Continue existing sampling programs to maintain baseline information for the Traffic Light method.
- Adopt the adaptive management framework based on the Traffic Light Stock Assessment and the proposed moderate and elevated management levels for recruit

abundance, adult abundance, and production characteristics. Initial management actions will only be implemented when either the adult abundance or production characteristics reach the management trigger of 50% red or greater for three consecutive years. The recruit abundance characteristic will be used as a supplement to further direct conservation management actions, if deemed necessary.

Note: All management measures would be implemented through proclamation authority. The table below shows the proposed moderate and elevated management levels for the management framework and is the same as Table 11.1.2.

Characteristic	Moderate management level	Elevated management level
Adult abundance	A1. Increase in minimum size limit for male and immature female crabs	A4. Closure of the fishery (season and/or gear)
	A2. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 5%) and/or implement gear modifications to reduce sublegal catch	A5. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 1%) and/or implement gear modifications to reduce sublegal catch
	A3. Eliminate harvest of v-apron immature hard crab females	A6. Time restrictions
Recruit abundance	R1. Establish a seasonal size limit on peeler crabs	R4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots in specific areas
	R2. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	R5. Expand existing and/or designate new crab spawning sanctuaries
	R3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	R6. Closure of the fishery (season and/or gear)
		R7. Gear modifications in the crab trawl fishery
Production	P1. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	P4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots for specific areas
	P2. Minimum and/or maximum size limit for mature female crabs	P5. Reduce peeler harvest (no white line peelers and/or peeler size limit)
	P3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	P6. Expand existing and/or designate new crab spawning sanctuaries
		P7. Closure of the fishery (season and/or gear)

AC - Repeal the current female stock conservation management trigger.
- Improve data collection and consider fishery dependent and independent data to apply to the stoplight method.

- Support the NCDMF adaptive management framework with more specific moderate and elevated management measures ranked by priority for the adult abundance and production characteristics.

Note: All management measures would be implemented through proclamation authority. The specific management measures for each are ranked in order by level include:

Characteristic	Moderate management level	Elevated management level
Adult abundance	A1. Eliminate harvest of v-apron immature hard crab females	A4. Eliminate crab dredging
	A2. Reduction in tolerance of sub-legal size blue crabs to 7.5%	A5. Reduction in tolerance of sub-legal size blue crabs to 5%
	A3. Require an additional cull ring on all crab pots	A6. Allow no harvest of crabs on either Saturday or Sunday.
Production	P1. Restrict trip level harvest of sponge crabs carrying brown or black eggs	P3. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots for specific areas
	P2. Close the crab spawning sanctuaries during September and October	P4. Expand existing and/or designate new crab spawning sanctuaries

IX. RESEARCH RECOMMENDATIONS

- Develop methods to expand sampling effort to more accurately assess the status of the blue crab stock and its fisheries.
- Continue research on blue crab discards in the shrimp trawl fishery.

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August 15, 2011

Revised: September 24, 2011
September 29, 2011
January 31, 2012
February 27, 2012

ATTACHMENT A. Addendum to address the Blue Crab Advisory Committee concerns on the Traffic Light assessment and adaptive management framework.

During the Blue Crab AC deliberations on the Adaptive Management Issue Paper and Traffic Light Stock Assessment, they raised a number of concerns on the adequacy of the Traffic Light to represent the condition of the stock, particularly by its not including fishery dependent data and the use of trawl gear as the principle survey gear, as well as some other survey design concerns. The following information provides some clarification or additional background rationale and explanation.

CPUE Discrepancy

A discrepancy was noted by the Advisory Committee between commercial CPUE data reported in Table 7.1.27 of the Commercial Section of the draft BCFMP Amendment 2 (Table 11.1.A1) and commercial CPUE data reported in the stock assessment (Figure 11.1.A1). The discrepancy was caused by how the data were selected from the trip ticket database. Commercial CPUE data reported in the stock assessment report were initially summarized by excluding crabbers that had less than 15 years of experience at the time of the assessment. This was done to remove variation in effort from crabbers who enter and leave the fishery based on market value and perceptions of likely income. Other filtering was done to facilitate analytical techniques: (1) trips with zero crabs were determined to be an error in reporting and removed; and (2) trips with less than two pots fished were also removed to facilitate log transformation for analysis. Data reported in Table 7.1.27 of the commercial section of the FMP were selected by removing trips that reported landings of greater than 15 pounds per pot and trips fishing more than 1,200 pots per day or less than 10 pots per day (Table 11.1.A2). These criteria for removing abnormal trips were chosen based on the review of fishery dependent fish house samples that set the range for acceptable values.

Apart from these selection differences, a previously undetected analysis error was discovered just in the stock assessment CPUE. Due to the manner in which the trip ticket database is constructed, the number of pots reported as fished on each trip ticket is recorded for each combination of market type and market grade landed on the trip ticket. When accessed, the number of pots is counted for each market type and grade. The initial analysis inadvertently summed numbers of pots at the market grade level, rather than the trip level, and this inflated the number of pots fished.

To correct the discrepancies, the stock assessment CPUE was recalculated using the same variable (number of pounds reported divided by reported number of pots fished for crabbers with 15 years experience) and selecting the data in with the same criteria as the commercial section CPUE (pots fished limited to between 10 and 1200 and trips limited to those between zero pounds and 15 pounds per pot). Appropriate tables in the Traffic Light Stock Assessment paper have been corrected.

One other confounding factor, for either of the CPUE analyses, deals with how the trip ticket program records data for catch from a single trip that is split and sold at more than one fish house. When catch is sold, the sale is marked with a transaction number. Transaction number is important in the blue crab fishery because some crabbers will sell their catch to two different dealers to get a better price by market grade or market type. The transaction number should increase with the number of sales made (e.g., the first dealer records a transaction number of one and the second a two). The number of pots fished would be accessed under each transaction as a separate trip in the trip ticket database, which could artificially inflate the number of pots fished in a given year. It is suspected there is error by the dealers in reporting transactions as intended. Crabbers may not know that they are meant to clarify transaction numbers when visiting multiple dealers. In the CPUE analysis, trip tickets with transaction numbers greater than one were not included. This reduces the overall landings total, but reduces reporting duplicate pots by a larger amount, resulting in a more accurate CPUE estimate.

CPUE recalculations resulted in some changes from what was reported previously; the biggest difference was that CPUE was much higher than before [compare 11.1.A1 (in error) and Figure 11.1.A2]. Aside from being higher, data from the Albemarle Region showed a similar pattern to that from the previous summary; CPUE in recent years was higher than years prior to 2001. This pattern resulted in a significant increasing trend in the last summarization; however, this trend was no longer significant for CPUE (Table 11.1.A3; Figure 11.1.A2), nor was it significant for landings, number of trips reported, or number of pots fished (Table 11.1.A3; Figure 11.1.A3). The negative trend in CPUE is no longer significant in the Pamlico Region (Table 11.1.A3; Figure 11.1.A2). Significant negative trends in landings, reported trips, and reported numbers of pots fished were observed for the Pamlico Region (Table 11.1.A3; Figure 11.1.A3). The Southern Region also showed higher CPUE prior to 2001 (Figure 11.1.A2), before dropping and remaining relatively constant in recent years. There were no significant trends in the CPUE data from the previous or current summarization for the Southern Region. A significant declining trend was observed in the number of trips taken by crabbers in the Southern Region (Table 11.1.A3; Figure 11.1.A3).

Trends in Landings and Effort

At their September 19, 2011 meeting, the Blue Crab Advisory Committee stated that reduction in effort and maintained landings proved to them the stock is healthy. If effort has been reduced and landings have remained relatively the same, one would expect that effort and landings are not correlated. A simple correlation analysis (Table 11.1.A 4) was performed to investigate the relation between effort and landings in the blue crab fishery during 1997–2009 for the Albemarle, Pamlico, and Southern regions. Effort was defined as both the number of pots fished and the number of trips taken. The analysis (Table 11.1.A 4) found highly significant ($P < 0.01$) positive correlations between effort and landings in all three areas, regardless of whether effort was expressed as the number of pots or the number of trips. Note that correlation analysis is used to measure how two variables vary in relation to each other. Correlation does not imply causation; that is, the results do not imply that changes in one variable cause or are responsible for changes in the other variable. In the analysis here, the results simply indicate that effort and landings show a similar pattern over time; no inference can be made about stock health from this analysis. In the Pamlico and Southern regions (Figure 11.1.A3), both effort and landings have shown a decrease since about 2000. In the Albemarle Region (Figure 11.1.A3), effort and landings have generally increased since 2005; between 2008 and 2009, effort increased slightly while landings showed a small decrease. The analysis does not support the statement that effort has reduced while landings have remained unchanged.

Omission of Fishery Dependent CPUE in Traffic Light

The blue crab assessment working group determined that the data needed to conduct a traditional assessment model for the current assessment were limited or unavailable (see Section 3.1.2 of stock assessment report). As such, the blue crab stock assessment was comprised of a trend analysis and the Traffic Light approach. Commercial landings and CPUE indices were included in the stock assessment as part of the analysis of trends in order to understand changes in landings over time and patterns in nominal catch rates.

The Traffic Light approach was selected to synthesize the various sources of available data to characterize trends in stock size over time. A number of fishery independent and fishery dependent data sources were reviewed to identify data that were considered reliable indicators of stock trends. Fishery dependent CPUE data were eliminated from consideration because these data are inherently biased and thereby unsuitable for providing a reliable index of population trends. While fishery dependent CPUE indices, or catch rates, may be indicative of major fluctuations in population size, they are generally not considered proportional to abundance. In order for fishery dependent CPUE to be proportional to abundance, fishing effort must be random with respect to the distribution of the population and catchability must be constant over space and time (Clark and Mangel 1979; Hilborn and Walters 1987, 1992; Dunn and Doonan 1997; Dunn et al. 2000). This is one of the draws of fishery independent surveys for use as indices of abundance—they are designed to provide unbiased estimators and employ a standard methodology over time and space. Fishery dependent CPUE indices are, at most, only reflective of trends in harvestable size individuals and in fished areas. It is not advisable to assume fishery dependent catch rates are applicable to individuals smaller or larger than harvestable size and to unfished areas.

Evidence against the assumption of proportionality between fishery dependent CPUE and population size has been well documented in the literature (e.g., Beverton and Holt 1957; Gulland 1974; MacCall 1976; Clark and Mangel 1979; Roff 1983; Cooke and Beddington 1984; Winters and Wheeler 1985; Crecco and Overholtz 1990; Hilborn and Walters 1992; Dunn and Doonan 1997; NRC 1998, 2000; Dunn et al. 2000; Harley et al. 2001; Walters 2003; Maunder et al. 2006; Cotter and Pilling 2007; Kleiber and Maunder 2008; Ye and Dennis 2009; Carruthers et al. 2010; Sturdivant and Clark 2011). Some of the factors that affect the proportionality between fishery dependent CPUE and abundance include changes in fishing power, gear selectivity, gear saturation and handling time, fishery regulations, gear configuration, fishermen skill, market prices, discarding, vulnerability and availability to the gear, distribution of fishing activity, seasonal and spatial patterns of stock distribution, changes in stock abundance, and environmental variables (Gulland 1964; Clark and Mangel 1979; Hilborn and Walters 1987, 1992; Dunn and Doonan 1997; Dunn et al. 2000; Walters 2003; Maunder et al. 2006; Cotter and Pilling 2007; Ye and Dennis 2009). The non-random distribution of fishing effort—characteristic of many fisheries—is another important bias to consider when interpreting fisheries dependent CPUE (Swain and Sinclair 1994; NRC 2000; Ye and Dennis 2009). Many agencies, including the NCDMF, don't require fishermen to report records of positive effort with zero catch; lack of these "zero catch" records in the calculation of CPUE can bias CPUE estimators (Cotter and Pilling 2007). Soak time (Miller 1979; Smith and Jamieson 1989), freshness of bait (Smith and Jamieson 1989), temperature (Sharov et al. 2003; Murray and Seed 2010), pot design (Miller 1979; Smith and Jamieson 1989), and escape rates (Sturdivant and Clark 2011) have all been found to bias CPUE for crustaceans in particular.

Some methods do exist that can correct for some of these biases (e.g., NRC 1998; Walters 2003; Campbell 2004; Hinton and Maunder 2004; Maunder and Punt 2004). However, the data required to apply these methods (e.g., harvest area on fine spatial scale, more detailed effort information) are not currently collected through the NCDMF Trip Ticket Program. Even if the fishery dependent CPUE index were corrected for all possible factors, there is no guarantee that the corrected CPUE index will be proportional to abundance (Campbell 2004; Maunder and Punt 2004).

Most of the commercial blue crab landings are taken with pots, and there is a high degree of variation in pot use that is unaccounted for in NCMDF trip ticket data. This creates an inability to define a standard unit of effort that is comparable among all landings records, preventing application of some of the methods for bias-correcting CPUE. It also prevents calculation of even a basic, or nominal, CPUE index. The NCDMF Trip Ticket Program currently requires blue crab fishermen to report the number of pots (presumably) fished. Defining effort in terms of pots is likely not adequate given that soak times, bait type and age, and number of pots actually handled can be widely variable. The use of NCDMF Trip Ticket Data for calculation of CPUE indices should be revisited when more data become available to address the numerous associated biases.

Considering these caveats, the fishery dependent pot landings data are compared to the Traffic Light characteristics for general examination (Figure 11.1.A4A and B). Further, a comparison of commercial pot landings and the Traffic Light adult abundance characteristic (Figure 11.1.A5A and B) with yellow and green bars combined (uncertain and favorable conditions) is shown to provide a visual comparison between landings and the Traffic Light results. It should be noted that there has been no correction for variation in landings that comes from differing effort, fishing efficiency, crabber choice, differences in landings collection methods over the years, or any commonly used standardization techniques for comparison of these data. Also note that the collection of commercial landings data changed considerably in 1994. Prior to 1994, commercial landings data were provided on a voluntary basis. As of January 1994, dealers have been required to report trip-level commercial fisheries landings using trip tickets. This change in reporting should be considered when comparing commercial landings before and after 1994.

Survey Design Issues

Another concern raised was whether sampling is adequate for analysis. There is often a difference between fishery dependent data and fishery independent data, and trend analyses show no significant increase in any commercial fishing variable in the time series analyzed (Table 11.1.A3). One concern was that the difference could be due to inappropriate sampling. Comparison of the commercial CPUE and fishery independent catch per tow show some similar patterns. For example, the Albemarle Region has a similar peak in CPUE and catch per tow in 2008 (Figure 11.1.A6). In the Pamlico Region, the Estuarine Trawl Survey is rather low and trendless compared to the other two, but the Fall data for the Pamlico Sound Survey follow the same similar pattern of declining abundance as the declining CPUE beginning around 2000 (Figure 11.1.A7). However, the Southern Region does not show many similarities (Figure 11.1.A8).

A likely cause of this perceived difference is that fishery independent surveys are designed to sample available habitat consistently. This is done so that potential habitat has an equal chance of being sampled regardless of habitat quality, environmental variables and historical abundance. This results in both "good" and "bad" areas being sampled. Due to the consistent nature of selection, the sampling will result in a characterization of the area or habitat types as a whole, taking an average of these "good" and "bad" areas to arrive at a meaningful estimate of a variable within the entire area. During sampling, environmental data are collected at the time of sampling in an attempt to assess the impacts of these variables. Additionally, the effort and gears used for the independent surveys are consistent to minimize bias. The catch and effort data that were used for the Traffic Light were all from trawl surveys. Trawls, when appropriately sized, are considered unbiased because they are neither attractive nor repellant to the crabs. If crabs in the swept area do not fit through the net and cannot swim faster than the boat, they are captured for sampling. The trawls used for the Albemarle survey (P100, 0.25 inch bar mesh bag), the Pamlico Sound Survey (P195, 1.5 inch stretch mesh codend) and the Estuarine Juvenile Trawl Survey (P120, 0.125 inch bar tailbag mesh), were all considered adequate by the PDT for sampling the various life stages and habitats targeted. The frequency of capture of crabs using the three trawl surveys is displayed in Figure 11.1.A9. The majority (65%) of trawls for the Estuarine Trawl Survey captured less than two crabs per one-minute tow. A majority of tows (54%), in the Pamlico Sound Survey (P195), caught up to 16 crabs per 20-minute tow. Because of differing tow times, the trawls in Albemarle Sound were standardized to one-minute tows, with a majority of tows (79%) capturing 0.33 crabs/minute or less.

Sampling with passive and baited gear introduces bias that cannot be readily measured or corrected for. Crab pots, even when variables such as soak time are corrected, are attractive even when they are unbaited. Also, variables such as the quantity, type and freshness of bait as well as the number, size and sex of crabs in the pot can introduce bias that cannot be corrected for. Similarly, gill nets have been found to catch considerable numbers of crabs. Although, depth, length of the net and time in the water can be standardized, the crab bait (finfish caught in the net) is not, nor can it be corrected for because it is impossible to know when the fish are caught in the net.

Environmental data and habitat quality were other concerns brought up by the Advisory Committee. As mentioned in previous fishery management plans, environmental parameters can have a significant impact on blue crab stocks. Including environmental data such as temperature, rainfall, dissolved oxygen concentration, and salinity were considered for inclusion in the Traffic Light. They were ultimately omitted because of their highly variable nature, quality, and sometimes inconsistent and limited availability over broad areas. Highly variable data require more intense sampling for statistical analyses than less variable data. For environmental variables such as those mentioned, sampling is usually conducted with data collectors that remain in place with monitoring occurring multiple times a day. The desire to include these in the Traffic Light remains, and these variables are being investigated for subsequent updates to this FMP.

A second concern about independent monitoring surveys is that they might be disproportionately sampling unsuitable water for crabs due to low dissolved oxygen concentrations. The trawl surveys, the Estuarine Trawl Survey (P120), the Pamlico Sound Survey (P195), and the Albemarle Sound Survey (P100) were examined to determine the proportion of tows that were conducted in hypoxic (<2mg/L of dissolved oxygen) conditions (Figure 11.1.A10). At times, the dissolved oxygen reading may not be taken, and is therefore not reported. The percentage of trawls conducted in hypoxic conditions when dissolved oxygen was recorded was less than five percent in all surveys.

Lagged Traffic Light Characteristics

A request was made to conduct a correlation analysis of different characteristics of the Traffic Light with each other. Unfortunately, the Traffic Light does not lend itself readily to a correlation analysis. The proportions of red, yellow and green are not independent, so the variation in one color would be affected by the remaining colors, and removing colors from the Traffic Light reduces its utility. To address this question as well as possible, the Traffic Light data with appropriate lags are displayed in Figure 11.1.A11. It was requested by the Advisory Committee to lag the data one year between the production and recruit characteristics and two years between production and adult characteristics. Lagging the data should make it less difficult to follow cohorts. As an example, the 2000 cohort will be referred to as the production characteristic in 2000, which turns into the 2001 recruit abundance characteristic and the 2002 adult abundance characteristic. The peaks in proportion of red align in several years (e.g., the 1991, 2000, and 2002 cohorts) as well as the peaks in proportion of green (e.g., the 1996 and 2007 cohorts).

The Advisory Committee also raised concerns as to whether the scale and intensity of sampling are adequate for use in making management decisions. As with all things, there is room for improvement. It would be desirable if sampling was more frequent and more intense. This is a fair criticism, and part of the reason that a more traditional stock assessment has not been conducted. The data requirements to calculate estimates of abundance are great, and our data limitations have not allowed them to be calculated with confidence in the past. The strength of the Traffic Light is that it allows us to examine the relative changes in the indices and characteristics without the need to calculate absolute abundance and mortality. While we cannot calculate that the stock is, for example 20% larger or smaller now than in previous times, we are able to determine whether the indices are relatively more or less favorable. This makes the data inputs less rigorous along with the assumptions needed for calculating those variables. While imperfect, the data that were selected for use in the Traffic Light were the best data sources available.

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Table 11.1.A1 Annual CPUE (pounds/pots fished) estimates from filtered crab pot* data by area in North Carolina, 1997–2009 (Table 7.1.27 in the commercial section, reproduced).

	Year													
Region**	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Ocean	N/R	***	***	***	***	***	2.23	1.88	1.48	2.69	2.85	***	2.98	2.40
Southern	2.12	2.19	2.15	1.91	1.61	1.78	1.93	1.78	1.99	1.99	1.92	2.03	2.05	1.94
Albemarle	1.64	1.92	1.74	1.53	1.14	1.65	1.69	1.64	1.60	2.14	1.95	2.93	2.11	1.77
Pamlico	1.67	1.62	1.70	1.23	0.95	1.15	1.54	1.39	1.30	1.41	1.13	1.54	1.35	1.41
Grand Total	1.68	1.72	1.73	1.38	1.06	1.43	1.62	1.50	1.45	1.76	1.60	2.31	1.86	1.58

1. *Crab pots include both hard and peeler pots, data summarization criteria provided in Table 2.
2. **See Table 7.1.9 (Commercial Section) for area description; N/R=No landings reported.

Table 11.1.A2 Total trips with effort data and filtered trips by type for the crab pot fishery in North Carolina, 1997–2009 (Table 7.1.24 in the commercial section, reproduced).

	Filtered data						
Waterbody	Total crab pot trips with effort data	≥1,200 pots fished	<10 pots fished	lbs/pot ≥15*	Total unusable trips	Percent of total trips	Total usable trips
Albemarle Sound	237,895	38	175	30	243	0.10%	237,652
Pamlico Sound	178,548	75	352	11	438	0.25%	178,110
Pamlico River	119,881	90	89	12	191	0.16%	119,690
Neuse River	63,238	39	40	7	86	0.14%	63,152
Pungo River	53,994	0	29	5	34	0.06%	53,960
Roanoke Sound	46,630	8	492	16	516	1.11%	46,114
Currituck Sound	45,149	0	45	17	62	0.14%	45,087
Croatan Sound	33,840	9	23	23	55	0.16%	33,785
Alligator River	21,802	3	23	11	37	0.17%	21,765
Bay River	20,704	8	37	2	47	0.23%	20,657
Cape Fear River	18,547	0	31	3	34	0.18%	18,513
Core Sound	18,314	8	14	20	42	0.23%	18,272
New River	11,540	0	109	4	113	0.98%	11,427
Inland Waterway	15,190	0	145	9	154	1.01%	15,036
Masonboro Sound	8,554	1	31	2	34	0.40%	8,520
Newport River	8,417	0	10	1	11	0.13%	8,406
Bogue Sound	6,036	0	26	0	26	0.43%	6,010
Topsail Sound	5,983	0	28	7	35	0.58%	5,948
White Oak River	5,194	2	109	2	113	2.18%	5,081
Stump Sound	4,260	0	1	9	10	0.23%	4,250
Shallotte River	3,267	0	8	1	9	0.28%	3,258
North River/Back Sound	2,329	0	20	1	21	0.90%	2,308
Lockwood Folly	1,604	0	44	6	50	3.12%	1,554
Pasquotank River	969	0	9	0	9	0.93%	960
Chowan River	368	0	3	0	3	0.82%	365
Ocean less than 3 miles	746	0	6	0	6	0.80%	740
Perquimans River	238	0	0	0	0	0.00%	238
Back Bay (VA)	23	0	0	0	0	0.00%	23
Ocean more than 3 miles	2	0	0	0	0	0.00%	2
Roanoke River	1	0	0	0	0	0.00%	1
Unknown	76	0	0	0	0	0.00%	76
Total	933,339	281	1,899	199	2,379	0.25%	930,960

Table 11.1.A3 Mann-Kendall non-parametric trend analysis of fishery dependent data (1997-2009) separated by regions and compiled statewide. Values of P less than 0.025 indicate a significant trend.

	Number of years	S	*P*	Significant trend
Albemarle pounds landed	13	25	0.063602	
Albemarle pots fished	13	11	0.251079	
Albemarle trips	13	19	0.123194	
Albemarle CPUE	13	19	0.123194	
Pamlico pounds landed	13	-45	0.003022	Negative trend
Pamlico pots fished	13	-45	0.003022	Negative trend
Pamlico trips	13	-37	0.011994	Negative trend
Pamlico CPUE	13	-19	0.123194	
Southern pounds landed	13	-25	0.063602	
Southern pots fished	13	-31	0.029294	
Southern trips	13	-39	0.008672	Negative trend
Southern CPUE	13	-29	0.038425	
Statewide pounds landed	13	-13	0.213855	
Statewide pots fished	13	-31	0.029294	
Statewide trips	13	-31	0.029294	
Statewide CPUE	13	3	0.427389	

Table 11.1.A4 Correlation analyses of fishery dependent data (1997-2009) using Spearman's Rank-Sum analysis. Values of P > |ρ| less than 0.05 are significant.

Region	Variable	Compared to	ρ	*P*>| ρ |
Albemarle	Pounds landed	N pots	0.7198	0.0055
	Pounds landed	N trips	0.7692	0.0021
Pamlico	Pounds landed	N pots	0.8297	0.0005
	Pounds landed	N trips	0.7033	0.0073
Southern	Pounds landed	N pots	0.8022	0.0010
	Pounds landed	N trips	0.8242	0.0005

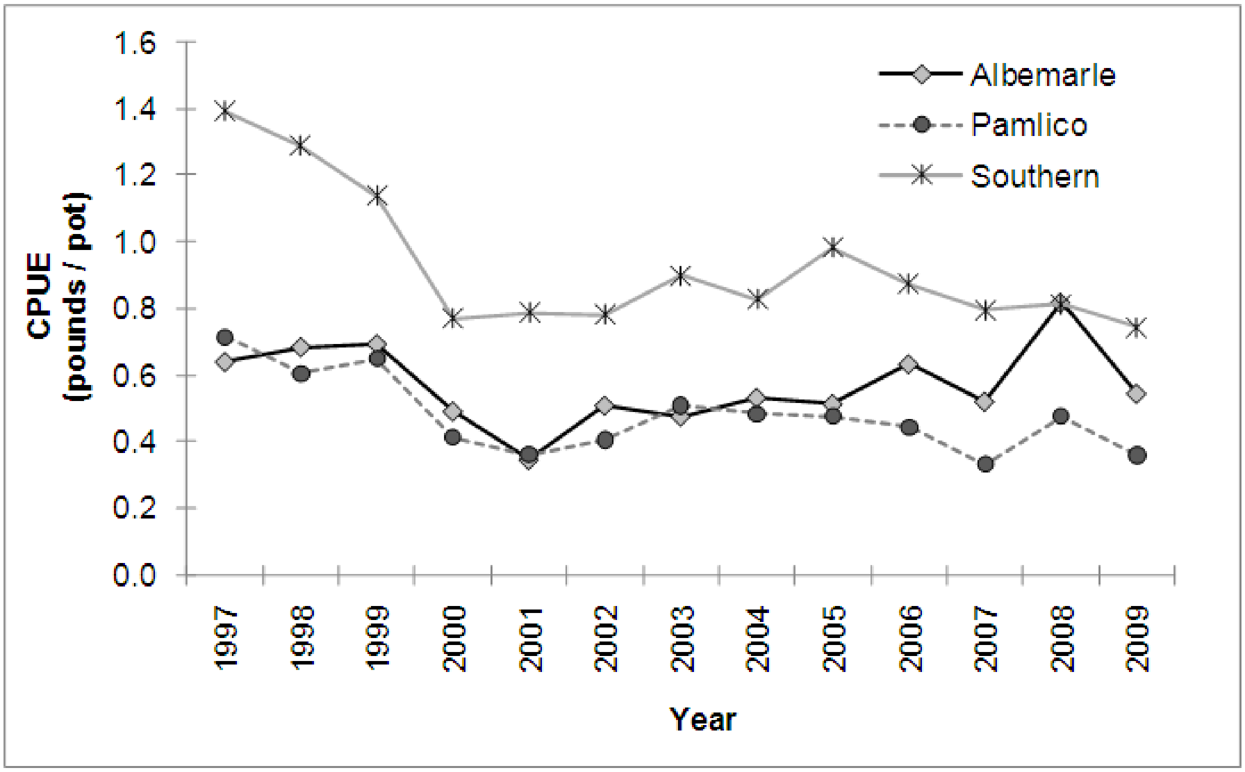


Figure 11.1.A1 Annual index of commercial fishery catch-per-unit-effort (CPUE) for blue crabs landed in North Carolina, by harvest area, 1997–2009. The CPUE indices are based on pot landings reported by fishermen that have had at least 15 years experience (Original version of Figure 2.2 in the commercial data section of the Traffic Light Stock Assessment report reproduced, later found to be in error).

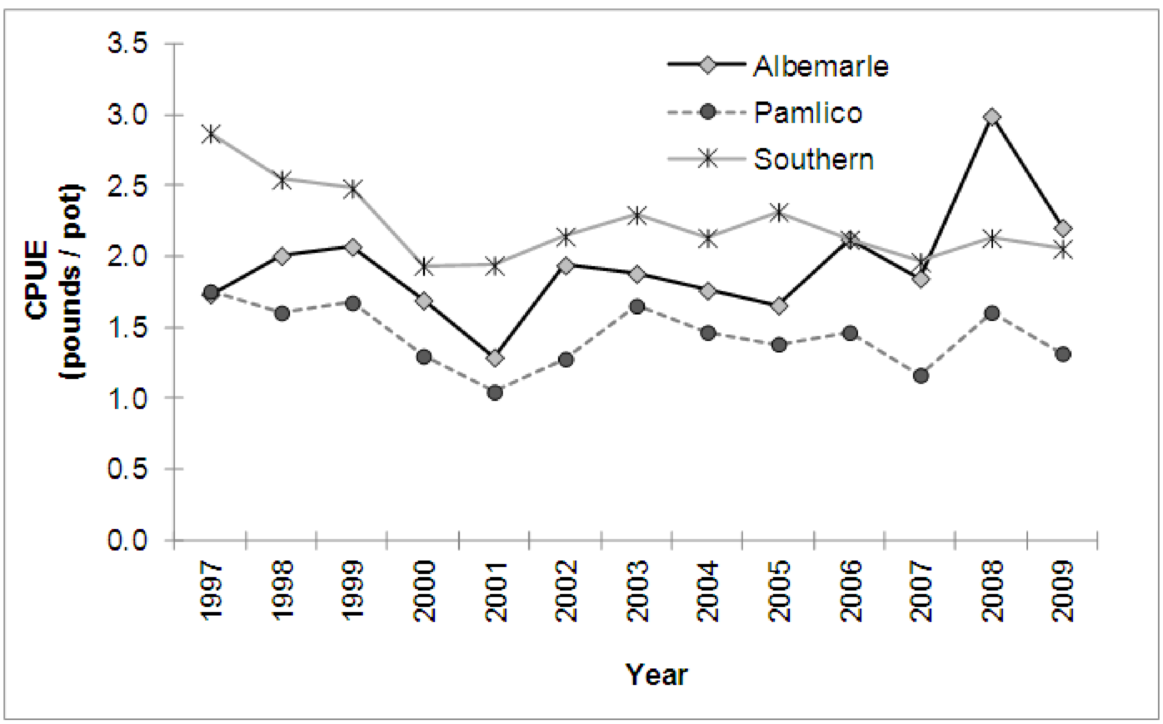


Figure 11.1.A2 Commercial CPUE summarized by removing trips by crabbers with less than 15 years experience and reported landings of either zero or greater than 15 pounds per pot and fishing more than 1,200 pots per day or less than 10 pots per day.

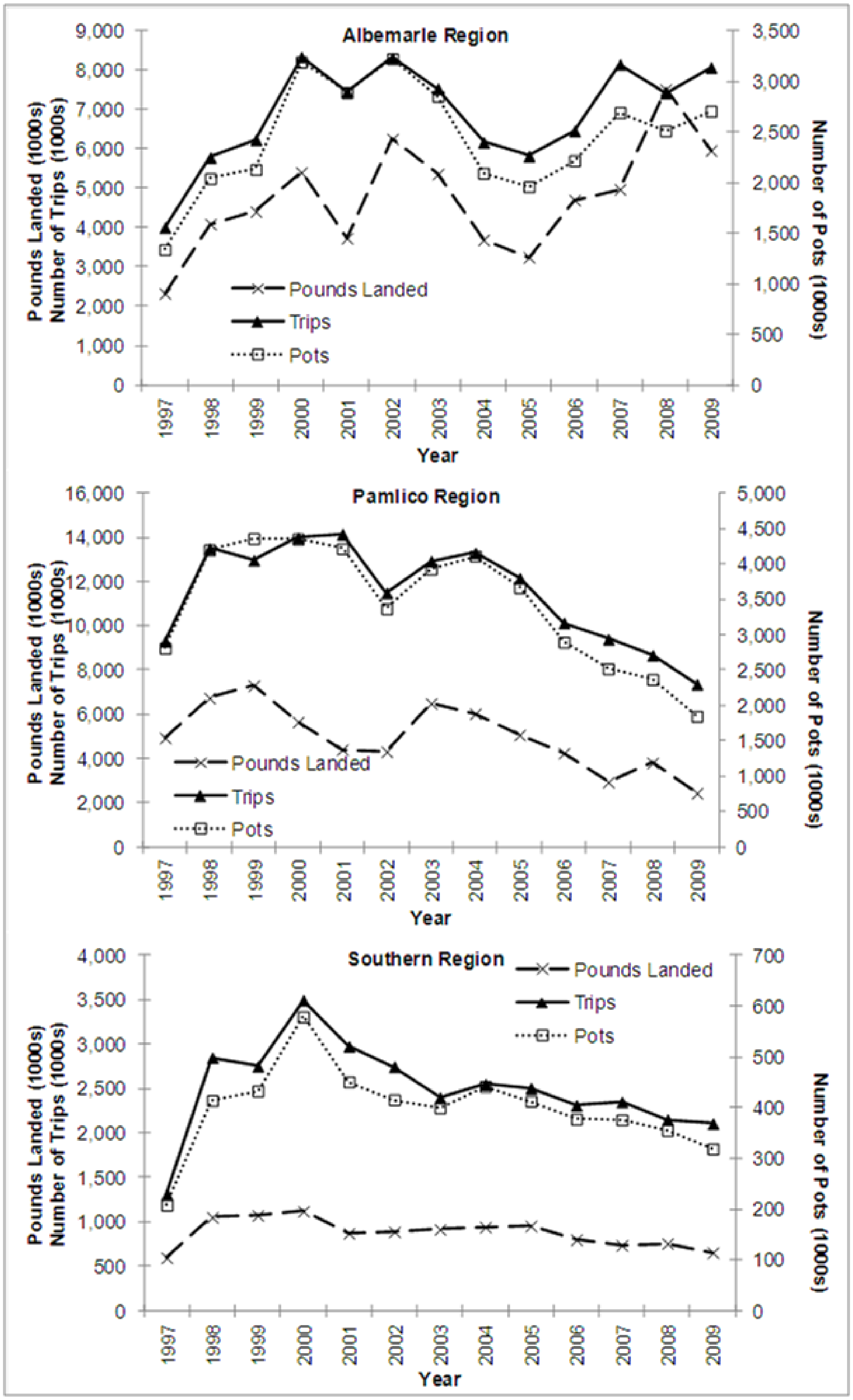


Figure 11.1.A3 Commercial fishery data summarized by removing trips that reported landings of greater than 15 pounds per pot and trips fishing more than 1,200 pots per day or less than 10 pots per day and crabbers with less than 15 years experience.

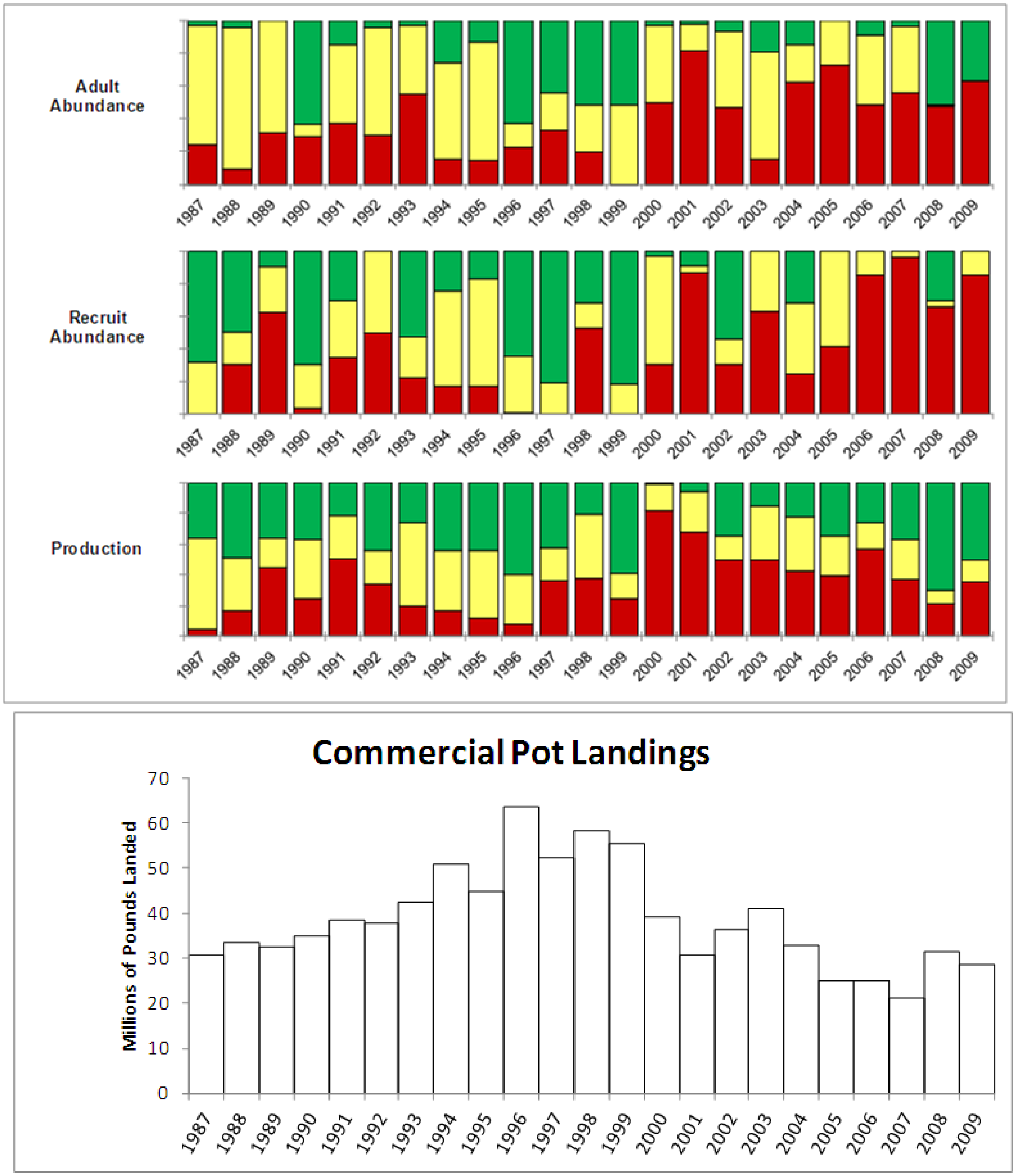
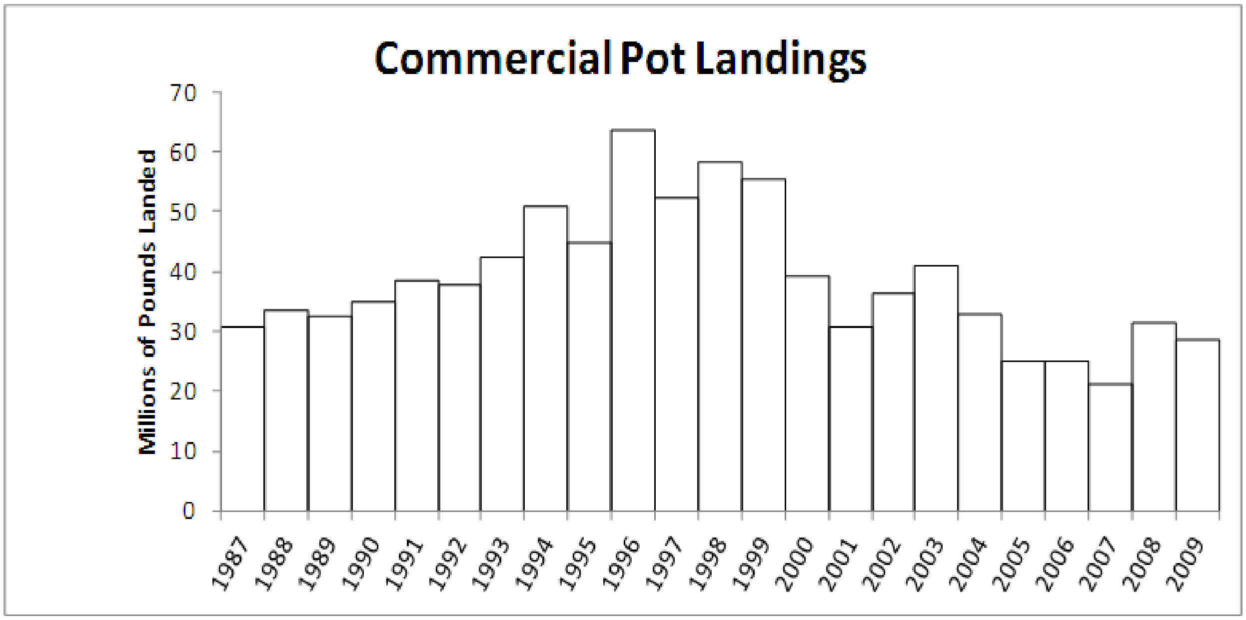


Figure 11.1.A4 A comparison of the Traffic Light results and commercial pot landings (millions of pounds) for illustrative purposes. A. Fishery independent data in the form of the Traffic Light, B. Fishery dependent data in the form of total pot landings (millions of pounds). Note that reporting of commercial landings changed from voluntary to mandatory in 1994.

A.



B.

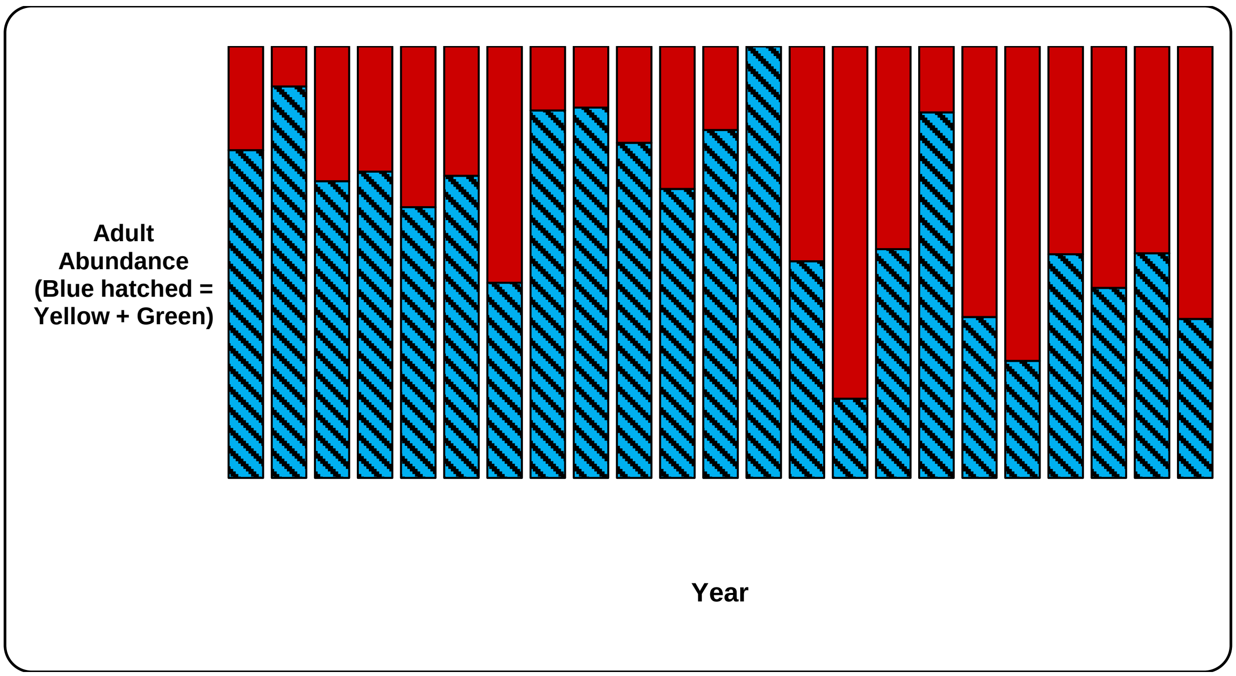


Figure 11.1.A5 A comparison of the Traffic Light results and commercial pot landings (millions of pounds) for illustrative purposes. A. Fishery dependent data in the form of total pot landings (millions of pounds), and B. Inverted adult abundance Traffic Light with yellow and green (uncertain and favorable conditions) bars combined (blue hatched) to provide a visual comparison between landings and the adult abundance characteristic Traffic Light results. Note that reporting of commercial landings changed from voluntary to mandatory in 1994.

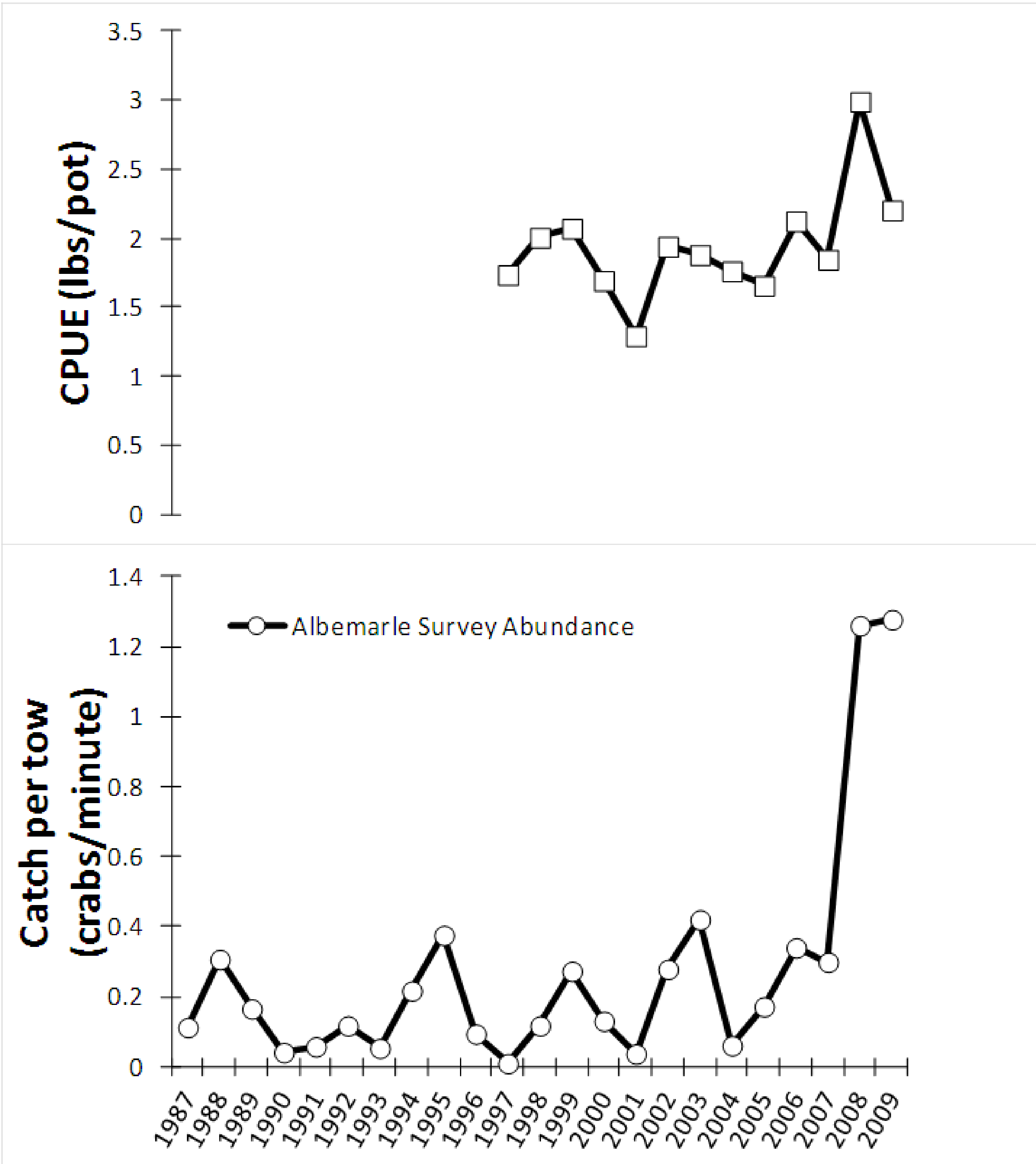


Figure 11.1.A6 Albemarle regional Commercial CPUE compared to fishery independent catch per tow for the Albemarle Sound Survey.

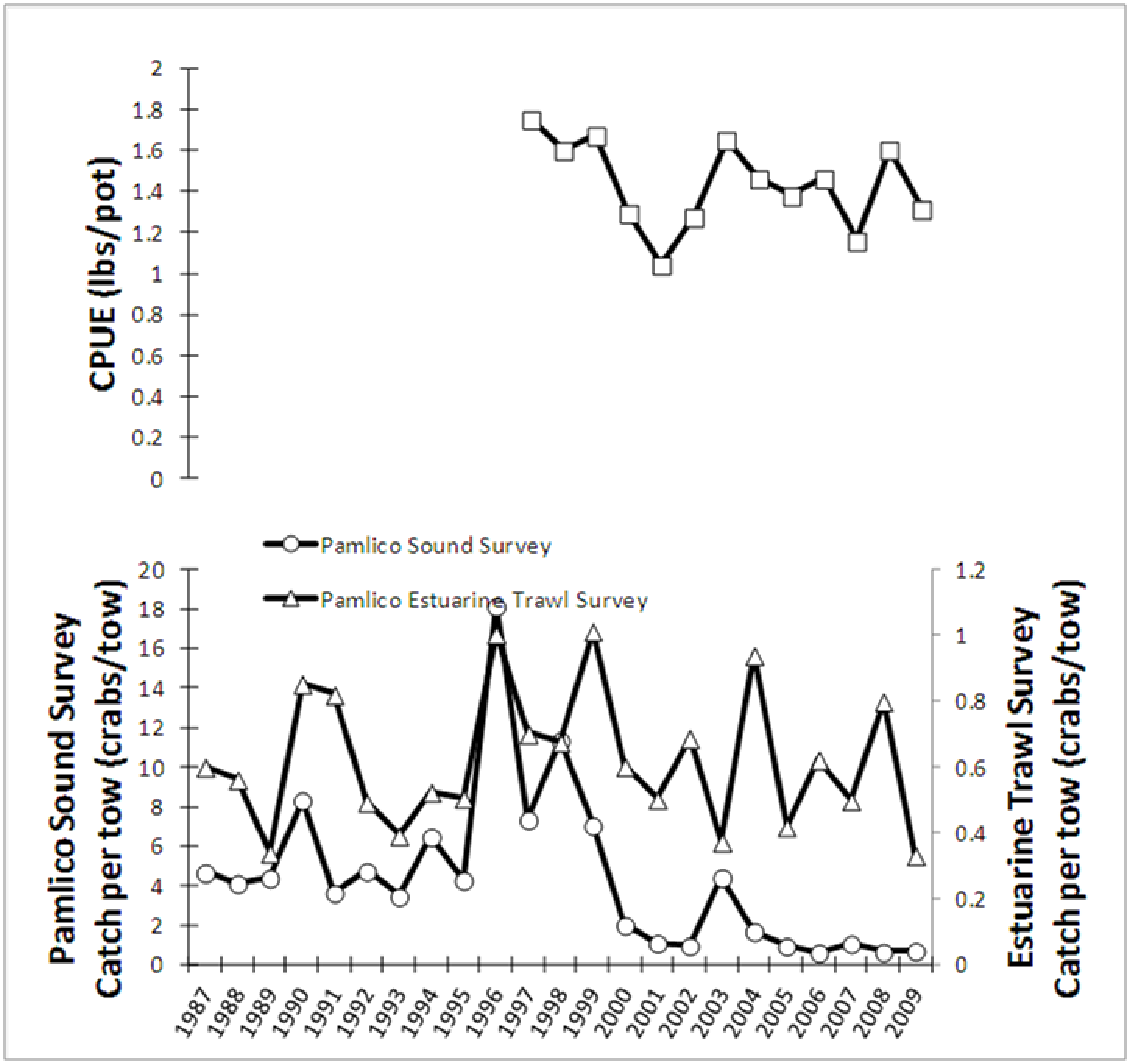


Figure 11.1.A7 Pamlico regional Commercial CPUE compared to fishery independent catch per tow for the Estuarine Sound Survey and Pamlico Sound Survey.

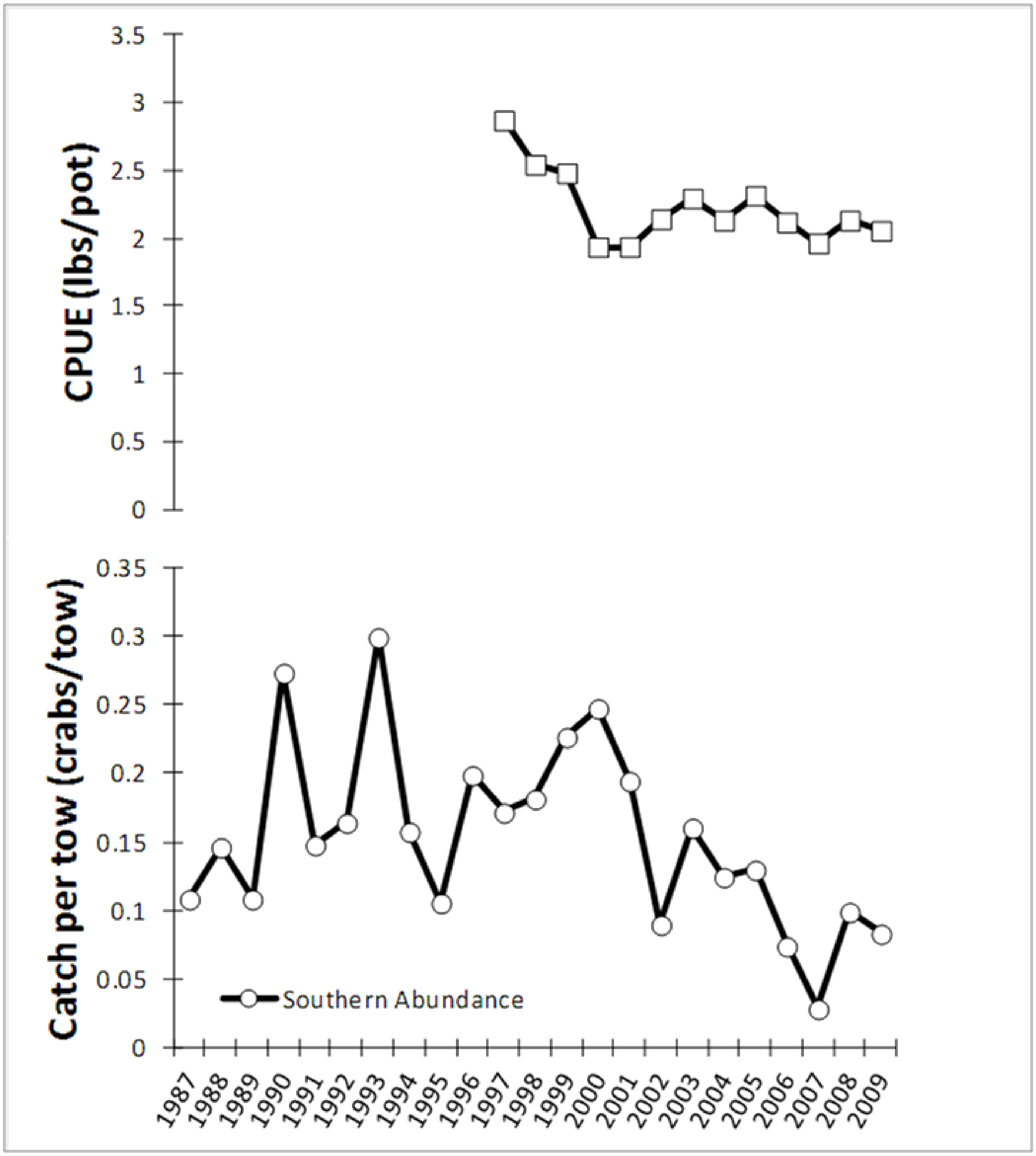
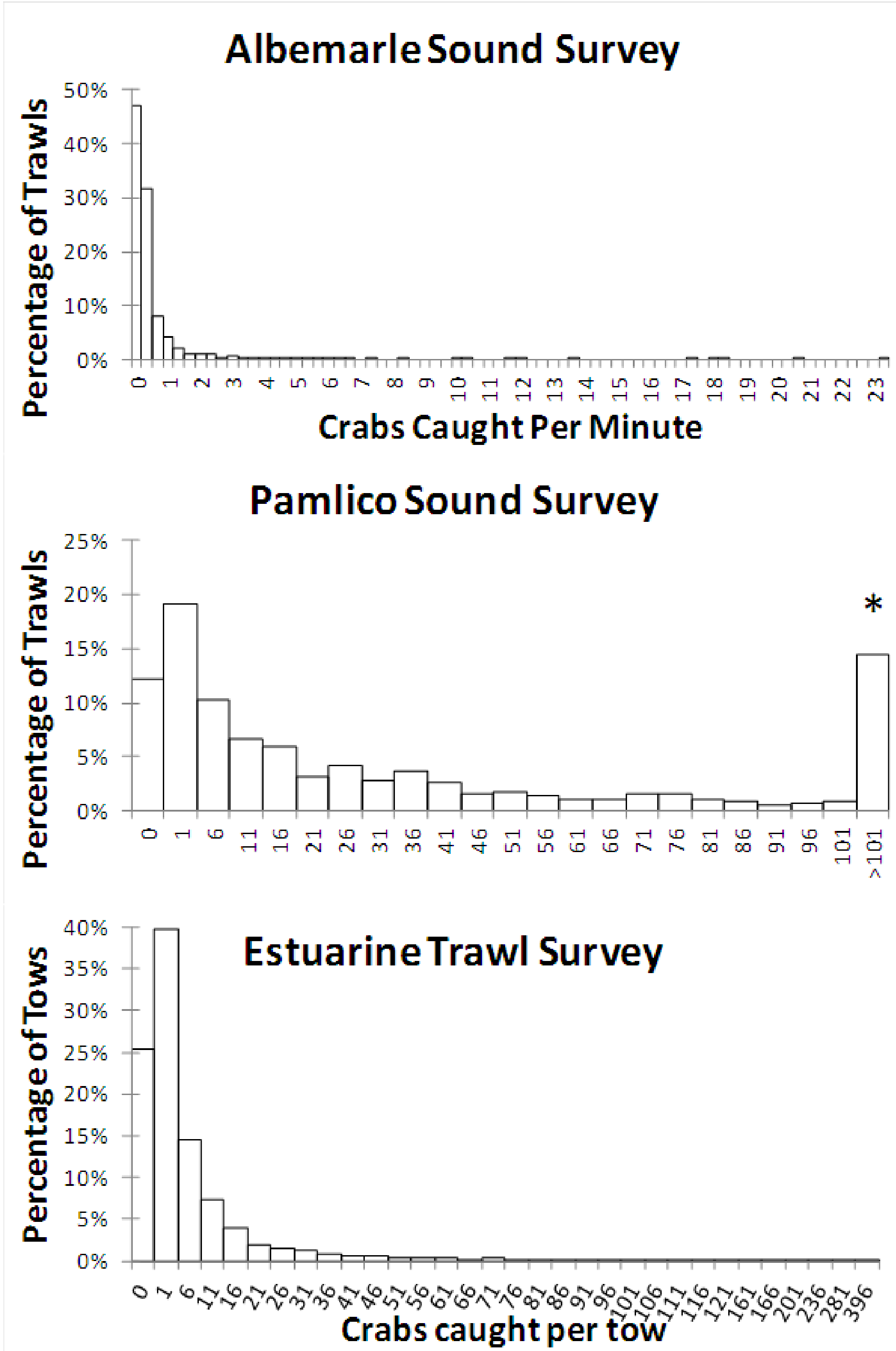


Figure 11.1.A8 Southern regional Commercial CPUE compared to fishery independent catch per tow for the Estuarine Sound Survey.



* Many observations of single trawls capturing large numbers of crabs exist, up to a maximum of 1706 crabs in one tow. This group includes all tows catching more than 100 crabs per tow.

Figure 11.1.A9 Catch frequency for trawl surveys displayed as catch per tow for the Estuarine Trawl Survey (P120), the Pamlico Sound Survey (P195) and catch per minute in the Albemarle Sound Survey (P100).

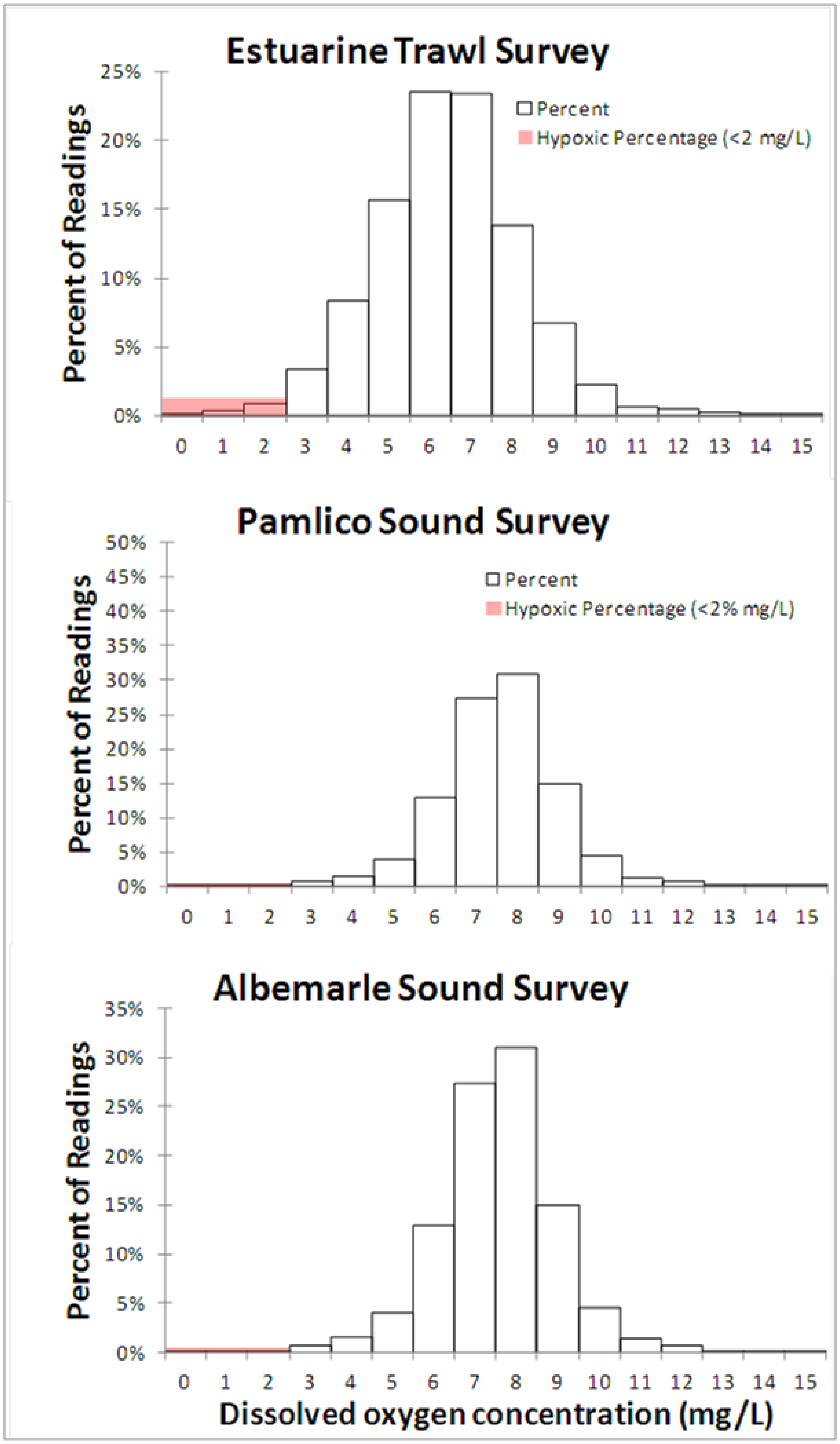


Figure 11.1.A10 Percentage of observations in Pamlico Sound at various levels of dissolved oxygen concentration for the Estuarine Trawl Survey, Pamlico Sound Survey, and Albemarle Sound Survey, 1997 to 2009.

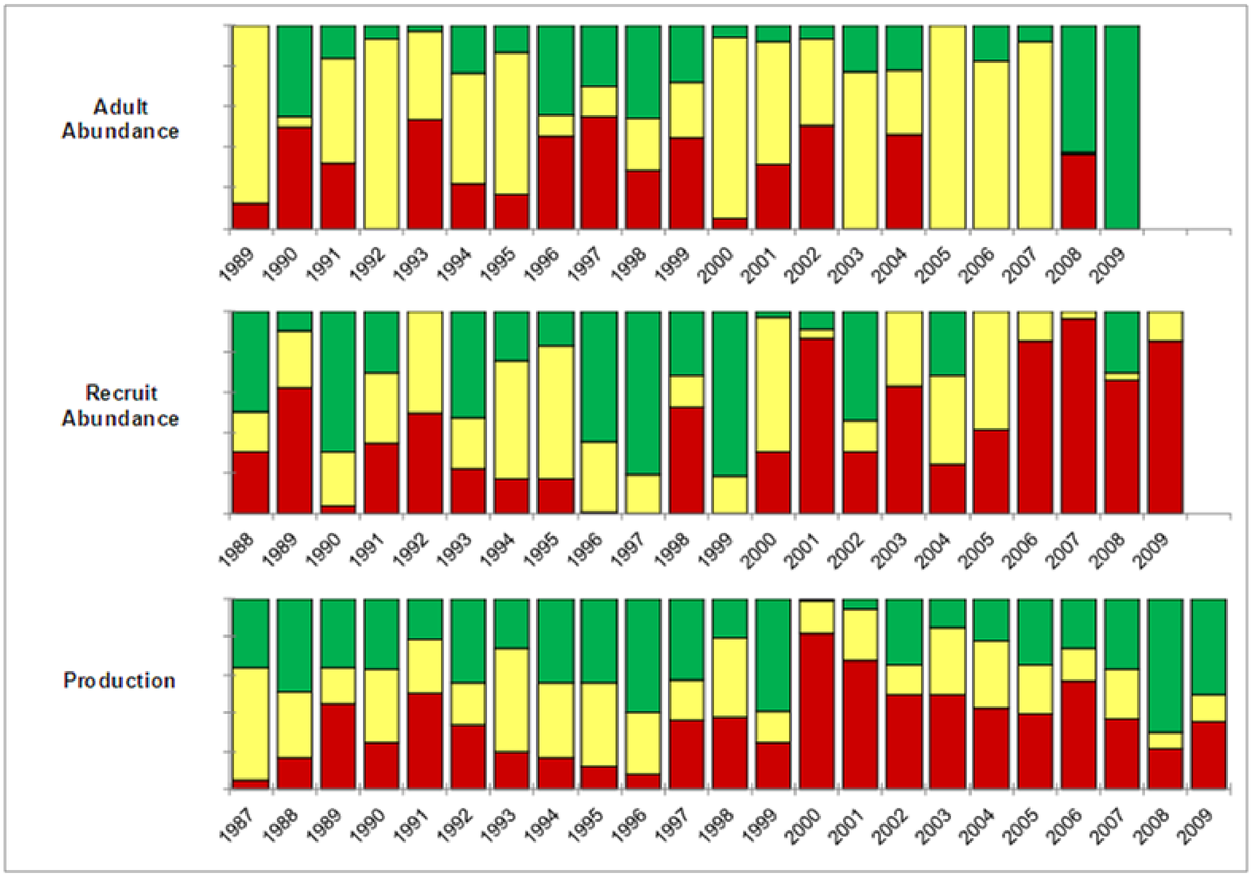


Figure 11.1.A11 Traffic Light with appropriate time lags for comparison of life history stages. Production time series remains unchanged, recruit abundance characteristic is shifted one year to represent time at large from spawning, and adults are shifted two years to account for growth from recruit stage.

ATTACHMENT B. Updated traffic light assessment and adaptive management framework with data from 2010 through 2012. A few charts and tables are attached with the updated data.

In the fall of 2013, NCDMF staff met and discussed the need for updating the present traffic light assessment at the time, which was current with data up to the 2009 harvest year. Since we experienced a significant delay in the final approval of the Amendment 2, it was decided that the data needed to be updated with the latest completed calendar year through 2012. As the expanded yearly data show, not much has changed since 2009. The overall production and adult abundance have remained in the “green” (less than 50% or less than the second quartile relative to the proportion of red), however recruit abundance has remained above the second quartile or between the 50 and 75 percentile in proportion of red (Figure 11.1.B5). Encouraging is that some of the recruitment characteristics have improved slightly to show more of the yellow and green portions since 2009 to 2012. The updated traffic light charts are presented in the next few pages.

The section that pertained to the dependent CPUE data that the Blue Crab Advisory Committee requested to conduct a correlation analysis of different characteristics that they felt were more commercially dependent and thus related more to the traffic light assessment was also updated with data from 2010 through 2012. This filtered data is presented in Table 11.1.B1 and Figure 11.1B6.

Table 11.1.B1. Annual CPUE (pounds/pots fished) estimates from filtered crab pot* data by area in North Carolina, 1997–2012.

*Crab pots include both hard and peeler pots, data summarization criteria provided in Table 2.
**See Table 7.1.9 (Commercial Section) for area description; N/R=No landings reported.

Region	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Total**
Albemarle	1.73	2.01	2.07	1.69	1.29	1.94	1.88	1.76	1.66	2.12	1.85	2.99	2.20	2.47	2.28	2.13	1.99
Pamlico	1.75	1.60	1.67	1.30	1.04	1.28	1.65	1.47	1.38	1.46	1.16	1.61	1.32	1.72	1.90	1.59	1.48
Southern	2.87	2.54	2.48	1.94	1.94	2.14	2.29	2.13	2.31	2.12	1.96	2.13	2.06	2.25	2.39	2.46	2.22
Total	1.80	1.78	1.85	1.50	1.19	1.63	1.78	1.60	1.53	1.60	1.55	2.31	1.86	2.06	2.09	1.93	1.64

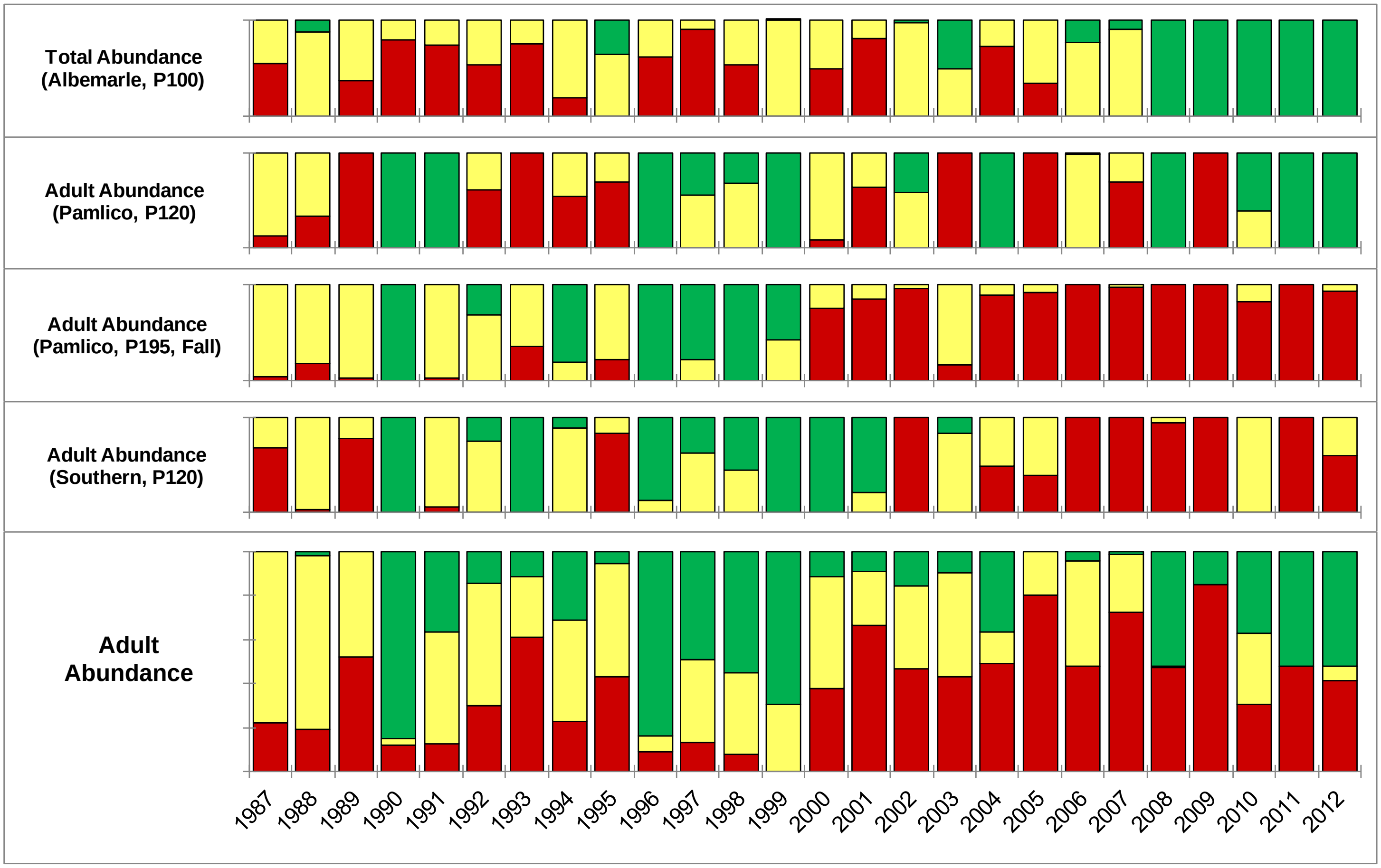


Figure 11.1.B1. Traffic Light representations of individual adult abundance indicators and integrated summary (bottom figure), 1987–2012.

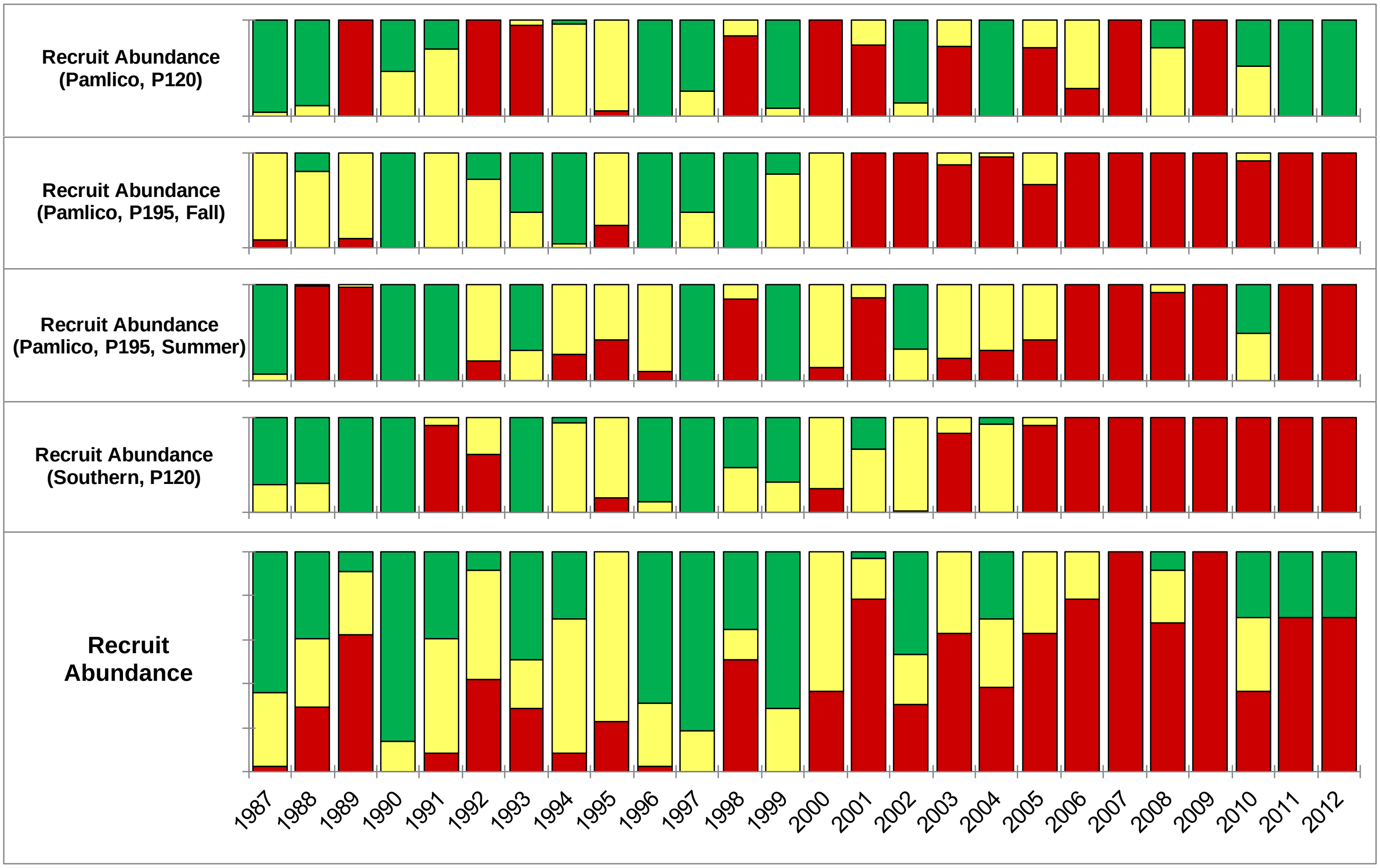


Figure 11.1.B2. Traffic Light representations of individual recruit abundance indicators and integrated summary (bottom figure), 1987**–2012.**

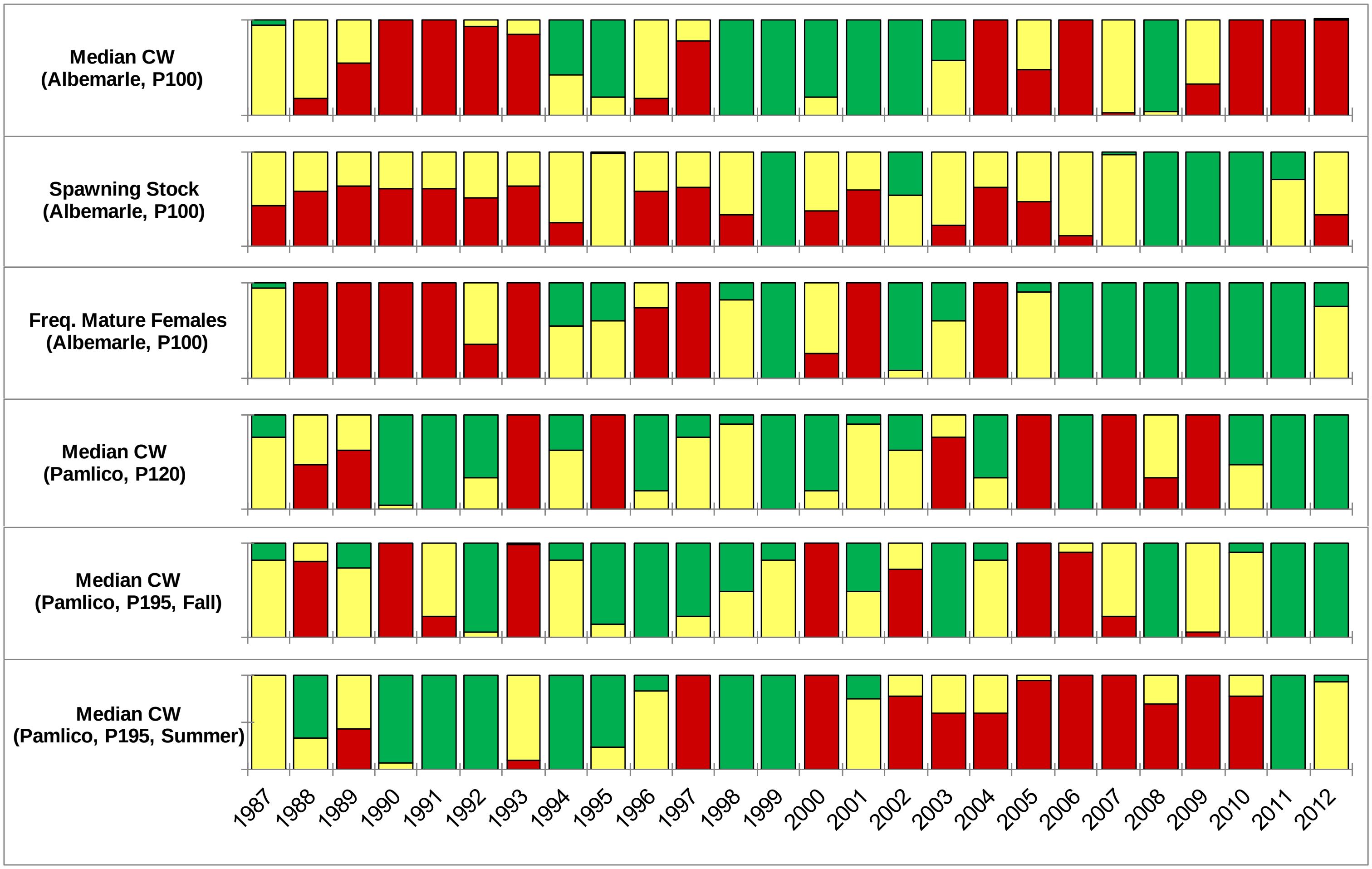


Figure 11.1.B3. Traffic Light representations of individual production indicators and integrated summary (bottom figure), 1987–2012.

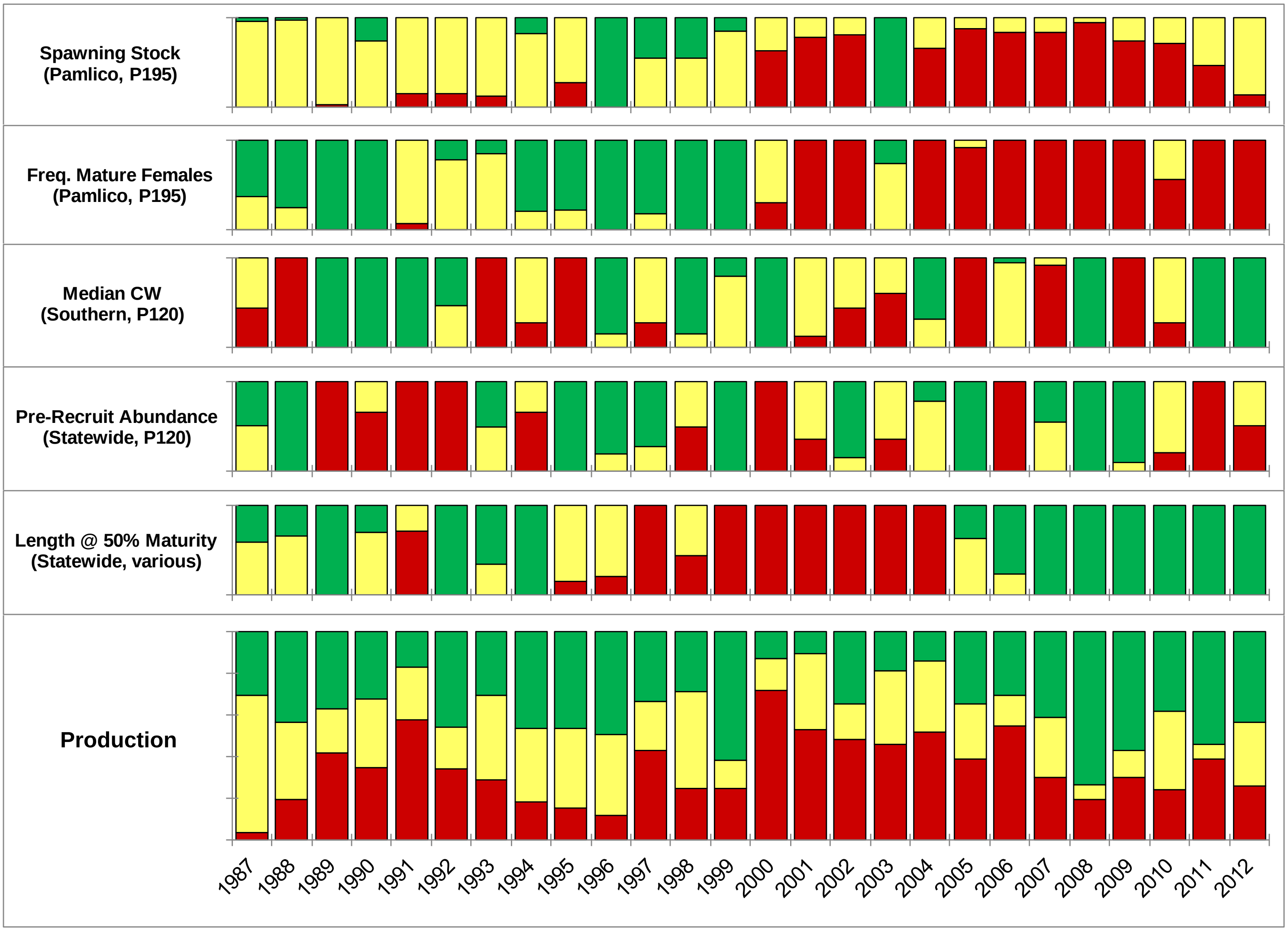


Figure 11.1B3.(*cont.*). Traffic Light representations of individual production indicators and integrated summary (bottom figure), 1987–2012.

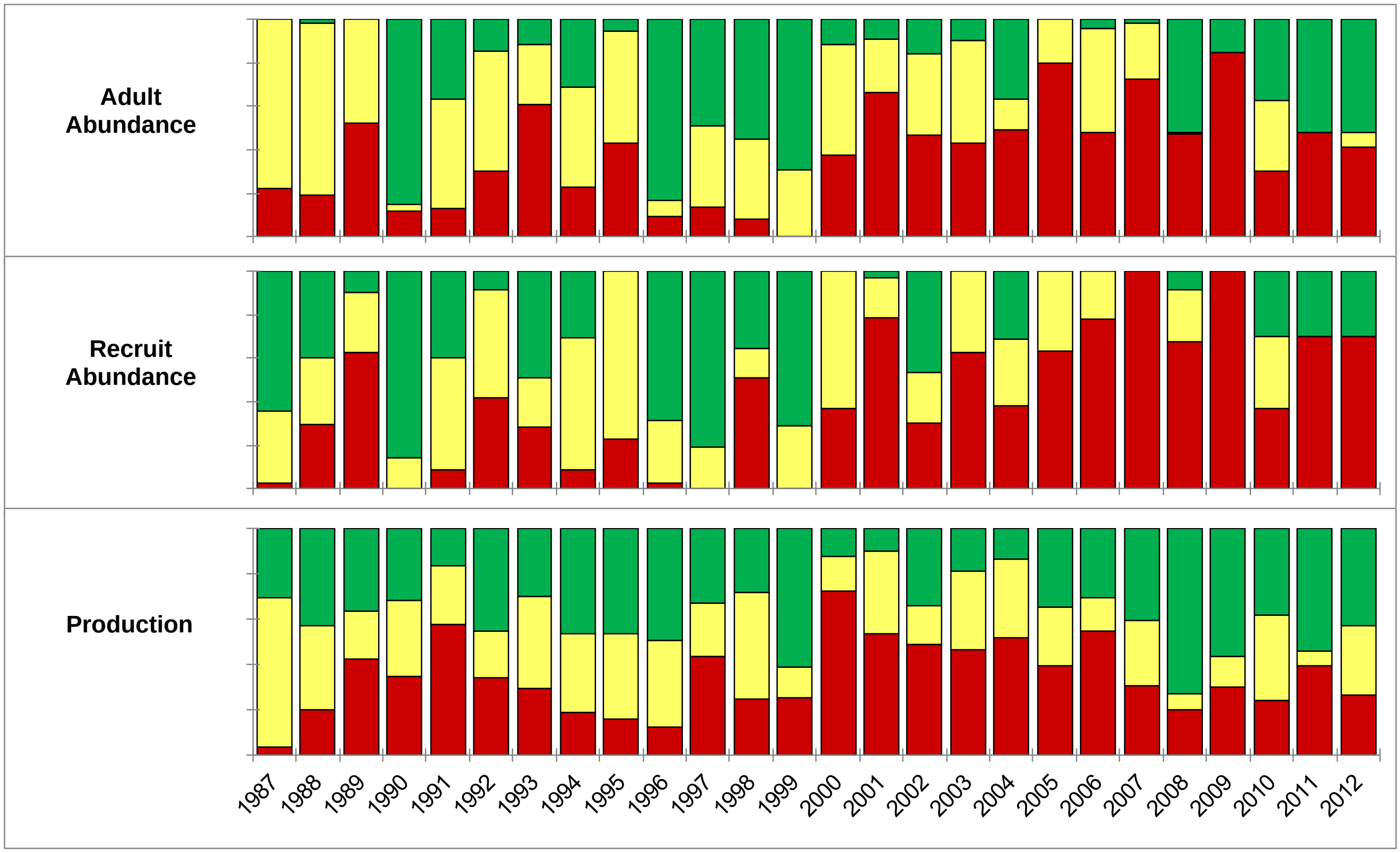


Figure 11.1.B4. Traffic Light representations of adult abundance, recruit abundance, and production characteristics, 1987–2012.

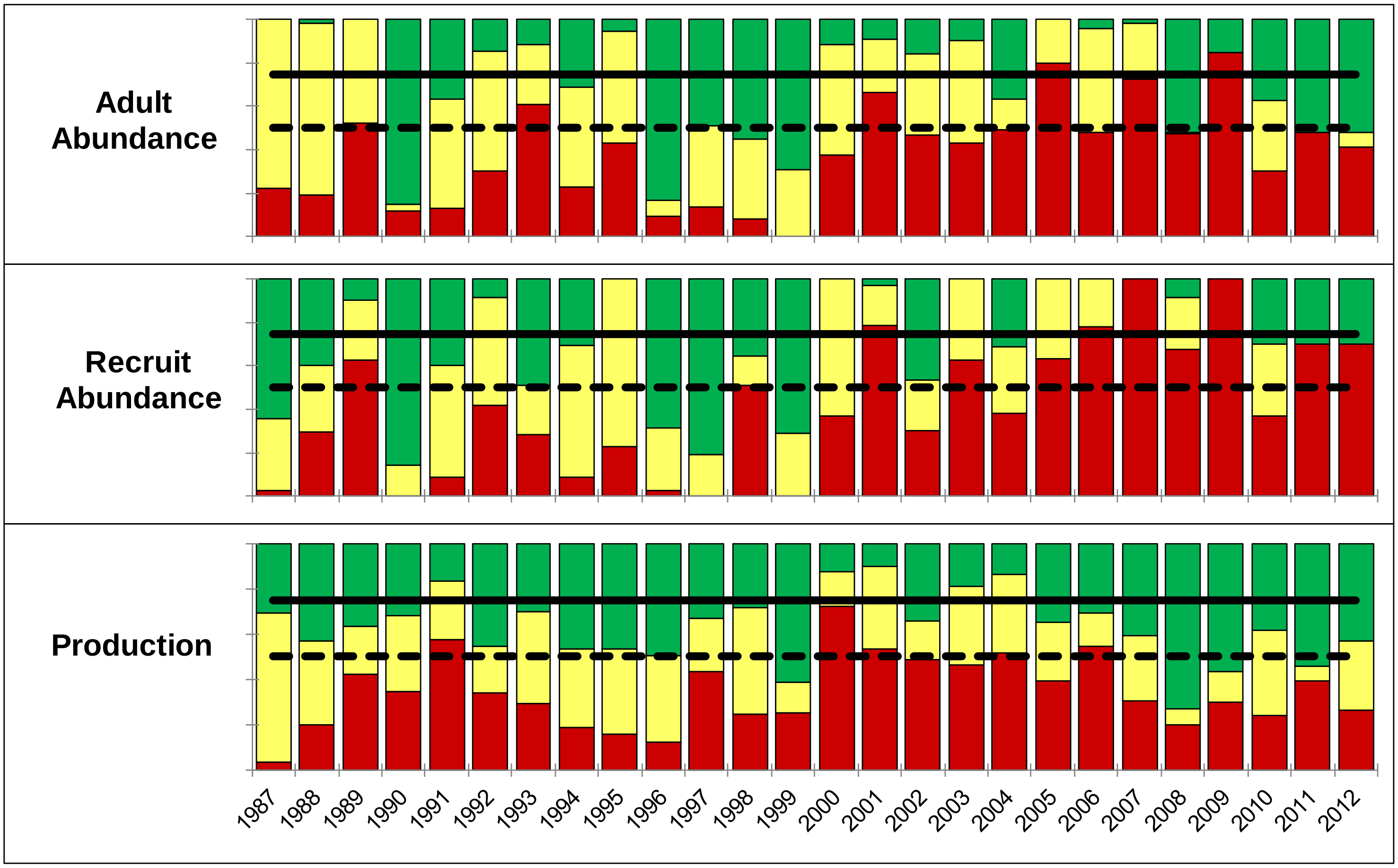


Figure 11.1.B5. Traffic Light representations of adult abundance, recruit abundance, and production characteristics, 1987–2012. The dashed line represents the second quartile and the solid line represents the third quartile relative to the proportion of red.

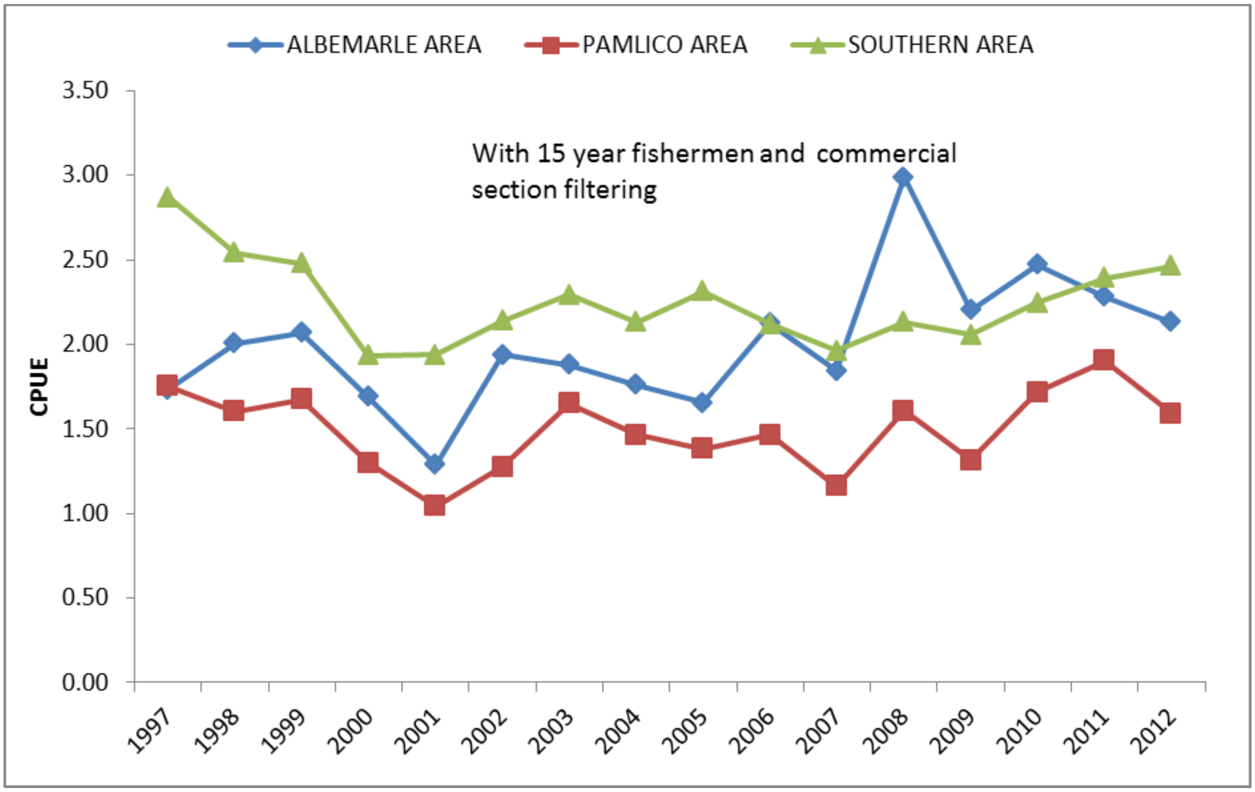


Figure 11.1B6. Annual index of commercial fishery catch-per-unit-effort (CPUE) for blue crabs landed in North Carolina, by harvest area, 1997–2012. The CPUE indices are based on pot landings reported by fishermen that have had at least 15 years experience.

11.2 CRAB POT LIMIT FOR SOUTHERN BOGUE SOUND[5]

I. ISSUE

At the first two meetings of the Blue Crab Fishery Management Plan Advisory Committee, there was a request for a crab pot limit of 75 pots per vessel in southern Bogue Sound.

II. ORIGINATION

The originator of the request was Mr. Ken Seigler.

III. BACKGROUND

Southern Bogue Sound and the Intracoastal Waterway (ICW) between White Oak and New rivers consists of tidal marsh creeks and shallow water bays of limited waterbody depth and size with the ICW running its length. The area under consideration is bound on the north by Highway 58 (Emerald Isle Bridge) and the Highway 24 (Swansboro Bridge, White Oak River) and extends south past the Hurst Beach swing bridge (Onslow Beach Bridge) to Marker #65A (Figure 11.2.1). The area in which the pot limit is requested includes Freeman Creek, Bear Creek, and Queens Creek.

Mr. Seigler stated in his request that increased effort and participation and high demand for local live crabs resulted from a decline in blue crab resources in Chesapeake Bay and the escalation of wholesale crab prices in the mid-1990s. This increased effort has resulted in an apparent lack of large crabs and the presence of a large number of small crabs. Many of these small crabs are fully mature females, having carapace widths of 3" to 4" from tip of spike to tip of spike. Mr. Seigler stated that local crab populations began to expand from 2000 to 2006, with few of the very small mature females and an increasing number of much larger crabs landed in southern Bogue Sound.

In the past four years, however, as the number of overall participants has declined, several crabbing operations have expanded operations into the area of this request with pots now numbering in the hundreds, according to Mr. Seigler. These operations move into the area in the spring and target the crabs which are transiting the area from the ocean to the upper reaches of the lower salinity creeks and rivers. This has resulted in a reduction in the local crab population and the re-emergence of the smaller female crabs. These operations deplete the available crab resources and move on, leaving fewer crabs available for the rest of the summer. Mr. Seigler stated that it takes several shedding cycles (3 to 4 months) for the population to recover to a level at which it is economically feasible for local fishermen to work again.

Larger waterbodies with lower salinities such as the Neuse River are well suited for a large number of crab pots, but Mr. Seigler contends that these small high salinity waters simply cannot sustain the degree of effort being placed on them with the large number of pots. Mr. Seigler contends the local crabbers feel that the small size of the area’s creeks makes it impractical for this large number of pots to fish the area all at once and that the depletion of small crabs early in the spring is harmful to the crab population and the potters’ long term summer employment.

[5] Presented to PDT on 3/24/11 and 1/4/12; Presented to AC on 4/4/11 and 1/10/12; Presented to MRT on 9/28/11 and 1/18/12.

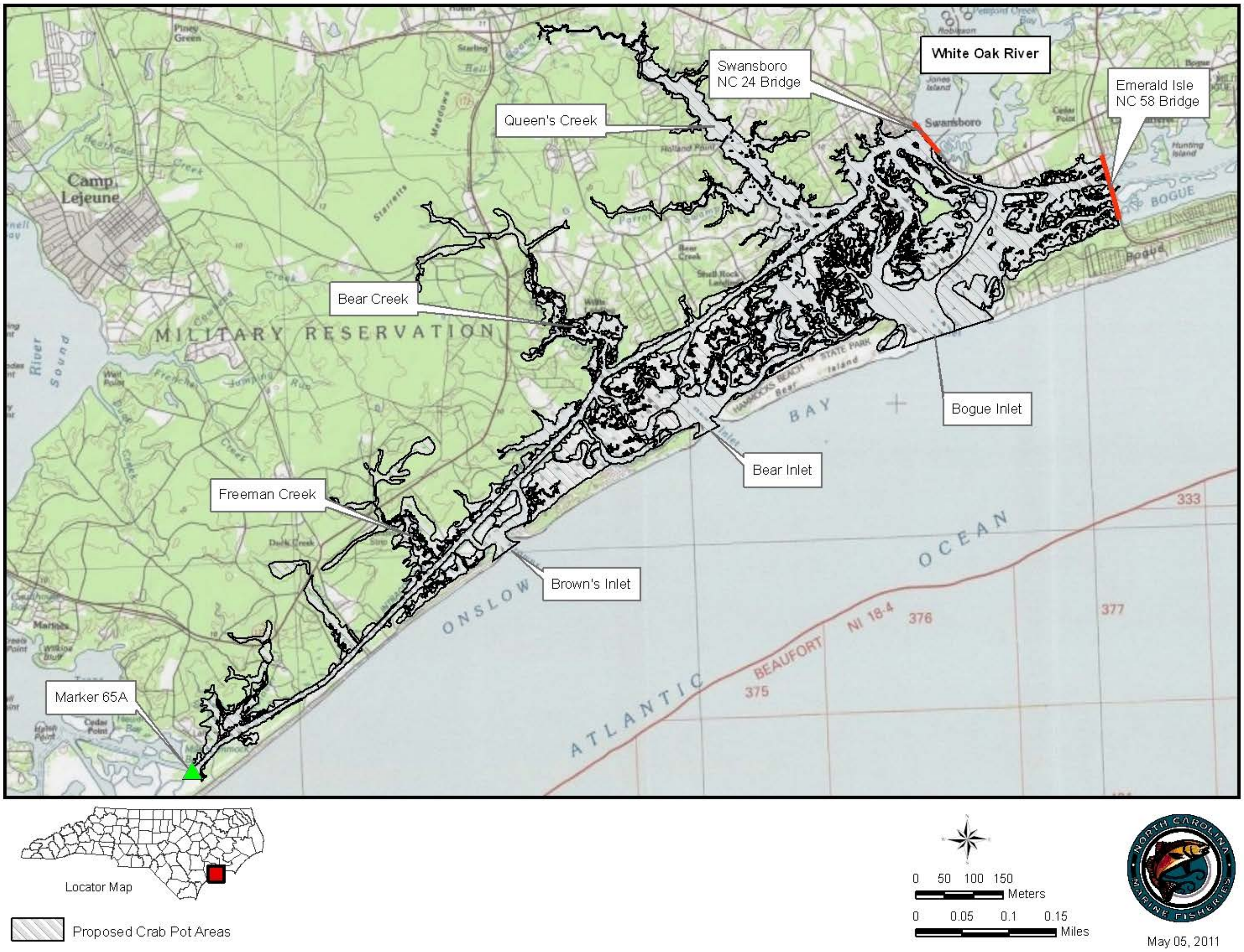


Figure 11.2.1 Proposed southern Bogue Sound area being considered for crab pot limits.

IV. AUTHORITY

G. S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52 MARINE FISHERIES COMMISSION –POWERS AND DUTIES

15A NCAC 03J .0301 POTS
15A NCAC 03J .0302 RECREATIONAL USE OF POTS

V. DISCUSSION

The only existing crab pot limit in North Carolina is a 150 pot per vessel limit in Newport River, Carteret County. This limit was requested by the Newport River crab potters and has been in existence since 1985. The difficulty of enforcing a crab pot limit has been discussed in the previous Blue Crab FMPs; however, in the Newport River, the pot limit is self-enforced by the local potters. If a new operation shows up and deploys over 150 pots, Marine Patrol is called immediately by the potters who work the river.

Historically the southern Bogue Sound area has been used by several small fishing operations that deploy between 50 to 100 pots each even though there is no limit on the number of pots a person can set. This number of pots is based on the practicality of physically being able to work the pots given prevailing wind, shallow water, and waterbody size, depth and tidal conditions. Mr. Seigler described their current method of fishing as setting a relatively small number of pots in a small creek and after the best crabs have been taken, pots are relocated to the next creek, allowing the crabs in the previous creek to shed and quickly repopulate the area with legal-sized crabs. This process allows multiple users to take advantage of available resource with less gear and leaves a number of crabs in each creek insuring a maximum yield can be achieved without depleting resources.

According to Mr. Seigler, the arrival of the larger crab pot operations in the spring has placed increased pressure on the local crab population and displaced some of the local crabbers, contributing to poorer catches of smaller crabs and low economic return for investment. The proposed 75 pot per vessel limit in southern Bogue Sound /ICW is intended to benefit all users by providing the ability to catch and market quality crabs from a healthy and viable resource on a year round basis with a limited amount of gear.

Even though the contention that reduced effort early in the spring on crabs in the proposed area makes intuitive sense, the NCDMF has no empirical data to confirm or dispute that contention. If the pot limit simply causes a delay in the mortality of those crabs until they are larger, there is no benefit to the population. However, if the pot limit causes a delay in harvest, allowing larger crabs present to successfully spawn, then the population may benefit. Looking at trends in commercial effort data from trip tickets between 2003 and 2010, the number of participants and the average number of pots fished per trip has declined. The trip ticket waterbody used was ICW-Onslow, which incorporates the requested pot limit area. Between 2003 and 2005, from 45% to 99% of the trips used more than 75 crab pots per trip (Table 11.2.1). After 2005 there is a decline in the number of pots used per trip. Preliminary monthly commercial data for 2010 shows that 99% of the trips used less than 75 pots on average. In 2009 79% of the trips taken used less than 75 pots per trip and the 21% of the trips that used between 100 and 150 pots per trip occurred in November and December. The overall number of trips has declined from 393 in 2003 to 188 in 2010 (Table 11.2.2). The number of crab potters (participants) per month has ranged from 1 to 10 during 2003, to from 1 to 4 in 2010, with most months having only three potters or less reporting landings. NCDMF data shows that a 75 pot limit per vessel would not be very effective at reducing the number of pots fished since it is already below that level on a trip basis.

Table 11.2.1 Percent of trips from 2003 to 2010 within groupings of number of pots and percentage of trips, which used greater than 76 pots. *Data for 2010 are preliminary.

Average pots/trip	2003	2004	2005	2006	2007	2008	2009	2010*	Total
<25	0.00	0.00	0.00	0.00	0.00	4.93	0.00	0.53	0.65
25-50	0.51	0.39	32.14	76.98	64.60	43.84	73.68	80.32	37.89
51-75	0.00	0.00	22.02	16.67	35.40	15.76	5.26	19.15	11.46
76-100	48.35	15.29	45.83	6.35	0.00	24.14	0.00	0.00	21.56
100-150	46.31	38.82	0.00	0.00	0.00	11.33	21.05	0.00	20.43
>150	4.83	45.49	0.00	0.00	0.00	0.00	0.00	0.00	8.02
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
>76 pots	99.49	99.61	45.83	6.35	0.00	35.47	21.05	0.00	50.00

Table 11.2.2 Summary of trips and numbers of pots used from 2003 to 2010. *Data for 2010 are preliminary.

Average pots/trip	2003	2004	2005	2006	2007	2008	2009	2010*	Total
<25	0	0	0	0	0	10	0	1	11
25-50	2	1	54	97	104	89	140	151	638
51-75	0	0	37	21	57	32	10	36	193
76-100	190	39	77	8	0	49	0	0	363
100-150	182	99	0	0	0	23	40	0	344
>150	19	116	0	0	0		0	0	135
Total	393	255	168	126	161	203	190	188	1,684

The Blue Crab FMP Advisory Committee voted unanimously at its March 8, 2011 meeting that it did not want to consider statewide pot limits and pursuing a limit for this area would set the precedent for similar requests in other small creeks and rivers in the state, particularly in the southern portion.

In speaking with Marine Patrol and crabbers from the area, there is not unanimous support for the proposal. There are a few “full-time” crab potters that would be disadvantaged by a pot limit since they do not fish gill nets or participate in other fisheries to supplement their crab fishing income.

Mr. Seigler presented this request to the Blue Crab FMP Advisory Committee in the form of a petition for rulemaking, but since the FMP is being amended at this time, it was routed to the Advisory Committee for deliberation. If Mr. Seigler does not get the results he expects, he may still pursue filing a petition for rulemaking with the Marine Fisheries Commission.

VI. PROPOSED RULES

No rules changes are proposed at this time.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   + No additional restrictions on the commercial crab pot fishery
   + No additional burden on fishermen or Marine Patrol
   - Continued crowding of small water bodies with crab pots
   - Pot effort could remain the same, decrease, or increase with additional participants, vessels and gear
   - Regional crab population may become overfished leading to a reduced population and decreased income for local crabbers

2. Establish a 75 pot per vessel limit from the Emerald Isle Bridge to Marker #65A
   + May help alleviate crowded conditions in the smaller waterbodies
   + May reduce harvest pressure on crabs transiting the area to get to lower salinity creeks and rivers
   - Difficult for Marine Patrol to effectively enforce due to the dispersed nature of pots set by each potter and without marking the area and a costly and cumbersome pot tagging system
   - Requires a rule change
   - Precedent set for requests for numerous “local” small, congested waterbody pot limits
   - Number of pots may increase with the addition of additional vessels participating

3. Establish a 75 to100 pot per vessel limit from the Emerald Isle Bridge to Marker #65A from March through June
   + May help alleviate crowded conditions in smaller waterbodies only during the critical time the crowding occurs
   + May reduce harvest pressure on crabs transiting the area to reach lower salinity creeks and rivers
   - Difficult for Marine Patrol to effectively enforce due to the dispersed nature of pots set by each potter and without marking the area and a costly and cumbersome pot tagging system
   - Precedent set for requests for numerous “local” small, congested waterbody pot limits
   - Requires a rule change
   - Number of pots may increase with the addition of additional vessels participating

VIII. RECOMMENDATION

MFC selected management strategy
- Status quo, continue with no crab pot limit in this area.

AC - Status quo, continue with no crab pot limit in this area.

NCDMF - Status quo, continue with no crab pot limit in this area.

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March 23, 2011

Revised: April 15, 2011
May 6, 2011
February 27, 2012

11.3 CONSIDER ALLOWING NON-POT AREAS IN PUNGO RIVER AREA TO BE REDESIGNATED AS OPEN TO POTS[6]

I. ISSUE

Consider allowing the opening of eight non-pot areas ("long haul areas") in the Pungo River and Long Point non-pot area in Pamlico River to the use of pots.

II. ORIGINATION

Request to Marine Patrol officers made by local crab pot fishermen from the Pungo River area.

III. BACKGROUND

The requirement for pots to be placed in designated areas was initially instituted by proclamation during 1977/1978. Areas were mainly designated in Hyde, Beaufort, and Pamlico counties to alleviate competition for space between crab potters, long haulers, and shrimp/crab trawlers. Many areas were originally designated has non-pot areas to allow long haul fishermen to gather up their seines in recognized "footing" areas (i.e. long haul areas). The use of pots was restricted in other areas such as those in mid-Neuse River, to address competition between recreational users and crab potters (e.g. Camp Seafarer). All areas were designated by proclamation up until 1983 when areas were placed in rule (15A NCAC 03B .0504). In 1994, the NCDMF Director was given proclamation authority to open 11 "long haul areas" in Hyde, Beaufort and Pamlico counties to pots (15A NCAC 03R .0007). Since that date, these areas have been opened to potting every year by proclamation from May 1 through October 31 (or June 1 through November 30 after 2005) without incident. These areas may be closed to the use of pots in 48 hours, if long haulers want to haul those areas and potters do not voluntarily move their pots.

Long haulers and potters have used "gentlemen's agreements" to coordinate potting and long hauling activity in certain areas. Under this method local crab potters were notified by one of the haul crews that wanted to work a certain bay in the next week and the potters would move their pots. In 2004, the increasing number of crab pots set by Pamlico County crabbers in the Core Sound tributaries traditionally used in the spring for long haul seine operations made the "gentleman's agreement" method impractical. Marine Patrol could not locate all the non-local ("woodser") potters in order to tell them of the planned haul. Public meetings were held in Atlantic and Oriental between the potters and haulers and an agreement was reached using proclamation authority as a means to give potters 72-hours notice to move their pots before a long haul seine crew could work a particular bay for one day. This arrangement has worked

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[6] Presented to PDT on 7/19/11 and 1/4/12; Presented to AC on 5/23/11 and 1/10/12; Reviewed by RAT Subgroup on 6/21/11; Reviewed by RAT on 6/30/11 and 7/28/11; Presented to MRT on 9/28/11 and 1/18/12.

well each year since it was implemented in 2004. The Core Sound area (see following Section VI. rule reference) does not have discrete pot areas (pots are allowed in all waters).
The 1998 Blue Crab FMP contained the following recommendations in regards to this issue: change the area restriction time frame (at the time May – October) and change area restriction description from distance from shore to a depth criterion. The specifics on how to address each item were debated through the Marine Fisheries Commission AC structure. During these discussions the Central Regional AC raised a third item to review proclamation authority for opening "long haul areas". On March 14, 2001, the Central Regional AC passed a motion for all designated long haul areas to be managed by proclamation with preference for use given to long haulers. After numerous meetings and several motions, the Crustacean AC recommended (April 12, 2001) leaving the "long haul areas" as they currently were. In June 2001, the MFC voted to draft language to amend the rules giving the NCDMF Director proclamation authority to open long haul areas to crab potting. The implementation of the three items carried over into the 2004 amendment to the Blue Crab FMP. Under the 2004 Blue Crab FMP Amendment 1, the adopted management strategy was changed in September 2005 as follows:

- Modify time when pots have to be placed in shallow water from May 1 – October 31 to June 1 – November 30 north of Emerald Isle Bridge.
- Change designated pot area descriptions from distance from shore to a 6-foot depth.
- Provide authority to open specified non-pot areas ("long haul areas") to allow for the variable spatial distribution of crustacean and finfish (by proclamation). The rules that were implemented from the 2004 Blue Crab FMP Amendment 1 did not include the eight Pungo River non-pot areas or the Long Point non-pot area in Pamlico River under the proclamation authority.

These changes were incorporated by modifying rules 15A NCAC 03J .0301 and 03R .0107,

IV. AUTHORITY

G.S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52 MFC POWERS AND DUTIES

15A NCAC 03J .0301 POTS
15A NCAC 03R .0107 DESIGNATED POT AREAS

V. DISCUSSION

The NCDMF has received requests from up to 10 crab fishermen to allow pots in some of the non-pot areas. Some crab potters feel proclamation authority should be used to allow opening of the eight non-pot areas in Pungo River [see attached Rule 3R .0107 (5) (A-H); and Figure 11.3.1], and one area in Pamlico River [see attached Rule 3R .0107 (5) (I); and Figure 11.3.2]. This would allow potters to use this space when it is not needed by other commercial fisheries (long haul, crab trawl and gill net). Pungo River crab landings contribute, on average, 3% of the overall state crab landings. (Table 11.3.1). Since the early 1980s, long haul fishing activity has substantially declined and the designated non-crab pot areas have not been used as haul areas (Table 11.3.2). In a similar fashion the crab trawl fishery in the area has also declined (Table 11.3.2). Competition with shrimp trawlers is no longer a concern. Rules 15A NCAC 03L .0103 and 03R .0114, effective July 2006, prohibited shrimp trawling in areas of Pungo and Pamlico rivers and correspondingly shrimp effort declined (Table 11.3.2). Several of the non-pot areas in Pungo River were popular recreational shrimping areas, prior to this rule change.

Staked and run around gill nets are other gears that potentially compete with crab pot use in the area. Complying with Estuarine Striped Bass FMP measures, large mesh gill nets are required to be greater than 50 yards from shore during the majority of the main potting season in the Pungo and Pamlico rivers. Under the Red Drum FMP measures small mesh gill nets must be attended at all times if within 200 yards of shore in the lower reaches of the rivers. The fishermen actively setting run around gill nets would benefit from maintaining areas free of pots. Staked nets were restricted in May 2010 as part of the sea turtle settlement agreement (May 2010) with the Karen Beasley Sea Turtle Rescue and Rehabilitation Center; however, run around nets are exempt. Trends in gill net effort are shown in Table 11.3.2.

Recreational uses of the non-pot areas were a consideration during the 2000-2004 AC discussions. Fishing for spotted seatrout and red drum is common and other water-related recreational activities may also occur during the warmer months.

When the current rule (15A NCAC 03R .0107) was passed in 2005 both NCDMF and MFC were aware of the lack of hauling effort, but marine patrol officers and fisheries management staff recommended they remain closed to pots because of other uses and opening to pots might increase conflict among users. Basically these areas were near-shore “sanctuaries”, free of pots (see Figures 11.3.1 and 11.3.2). As noted by the lengthy time required (2001-2005) to implement the 2005 rules, it took substantial effort to produce the rule language with the various GIS-verified coordinates. As with all FMP rules, rule 15A NCAC 03R .0107 went through extensive public review and while several local crabbers wanted the areas open, the Crustacean AC supported (April 14, 2004) the version of the rule that was adopted (Pungo River areas and Long Point area stay closed to pots). Regional AC positions were mixed but the rule changes were also part of pots staying within the 6-foot water depth, so it is hard to determine which rule aspect they were most concerned with.

Circumstances that have changed since 2004 when the rule was debated include: the prohibition of shrimp trawling as shown in Figures 11.3.1 and 11.3.2, and declining commercial trips for most gear types including crab pots (Table 11.3.2). Participant numbers mirror the trends in trips. Competition between and among the various commercial fisheries would have been highest when effort and participants were at their peak, during the late 1990s. Effort trends do not support the need to have additional areas open to potting. Areas designated to address competition between recreational users and crab potters should remain closed. In the Pamlico River, the Long Point non-pot area is adjacent to a recreational park.

Table 11.3.1 Pungo River total blue crab commercial landings (pounds), state landings (pounds) and number of Pungo River crab pot fishermen by year, 1995-2009.

	Pungo River			
Year	Pounds	Percent of total	State total (pounds)	Pungo crab pot fishers
1995	540,376	1%	46,443,541	84
1996	2,249,253	3%	67,080,200	158
1997	2,514,498	4%	56,090,109	168
1998	1,692,466	3%	62,076,170	133
1999	2,147,732	4%	57,546,676	119
2000	2,159,741	5%	40,638,384	142
2001	862,754	3%	32,180,390	133
2002	1,472,347	4%	37,736,319	144
2003	1,434,822	3%	42,769,797	126
2004	1,349,696	4%	34,130,608	121
2005	1,079,125	4%	25,430,119	108
2006	1,223,158	5%	25,343,159	92
2007	550,642	3%	21,424,960	65
2008	598,383	2%	32,916,691	61
2009	495,420	2%	29,707,232	55
Average	1,358,027	3%	44,335,165	114

*all gears combined, no data for Pungo River in 1994

Table 11.3.2 Pungo River annual number of commercial fishing trips for selected gears, 1995-2009.

Year	Crab pots	Crab trawl	Shrimp trawl	Runaround gill net	Anchored gill net	Long haul
1995	2,074	57	1	0	36	0
1996	5,189	599	4	0	242	0
1997	6,497	960	16	8	363	0
1998	5,177	1,248	0	20	193	0
1999	5,190	624	13	5	263	0
2000	6,103	741	37	17	1,147	0
2001	5,214	653	43	0	798	0
2002	4,947	128	51	8	641	0
2003	4,544	417	21	17	655	0
2004	4,471	306	0	2	757	0
2005	3,783	176	6	1	1,032	0
2006	3,350	48	2	2	775	0
2007	2,560	46	0	1	632	0
2008	2,063	2	0	29	496	0
2009	2,174	9	0	12	462	0
Average	4,222	401	13	8	566	0

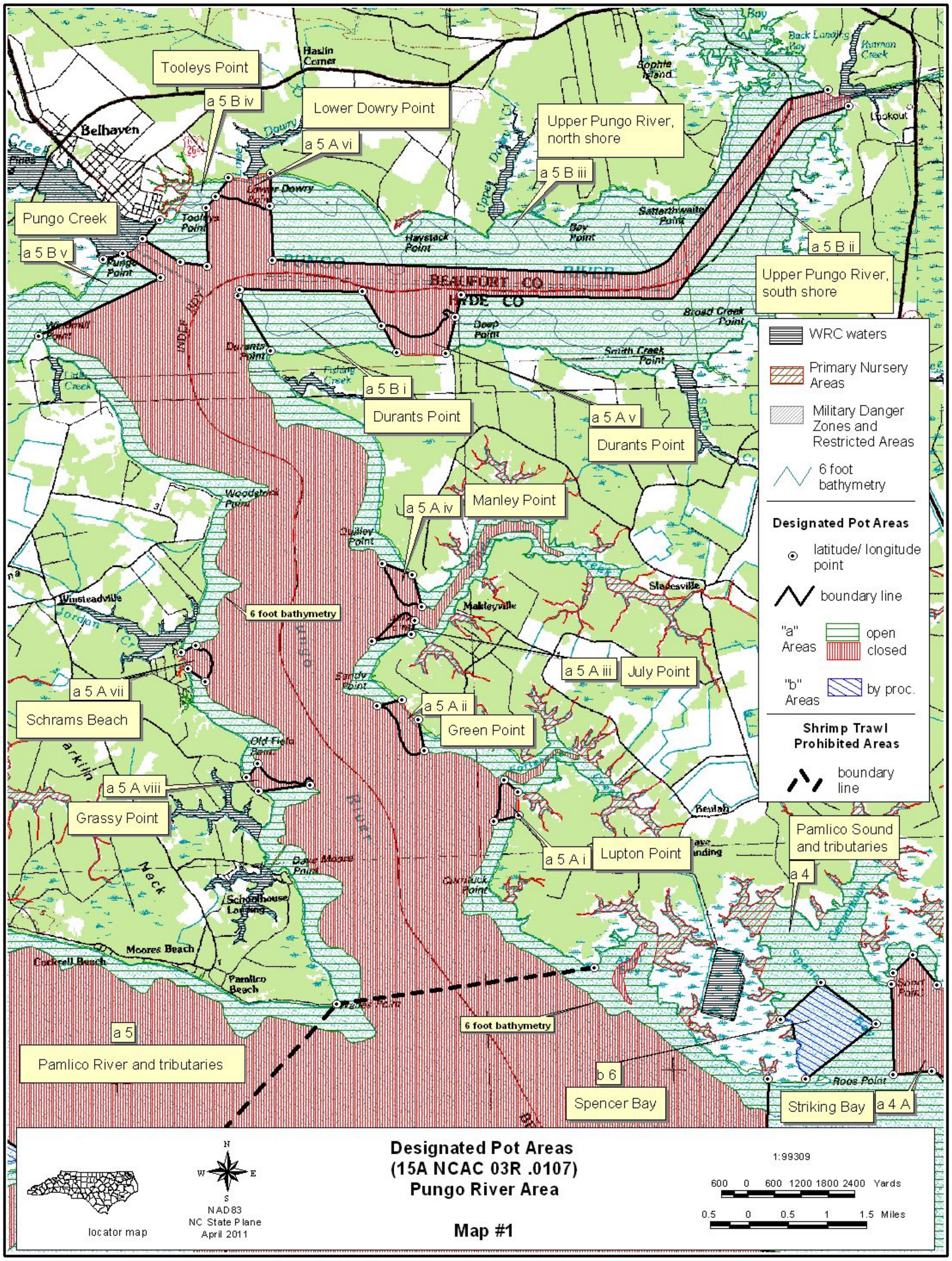

Figure 11.3.1 Designated pot areas in the Pungo River.

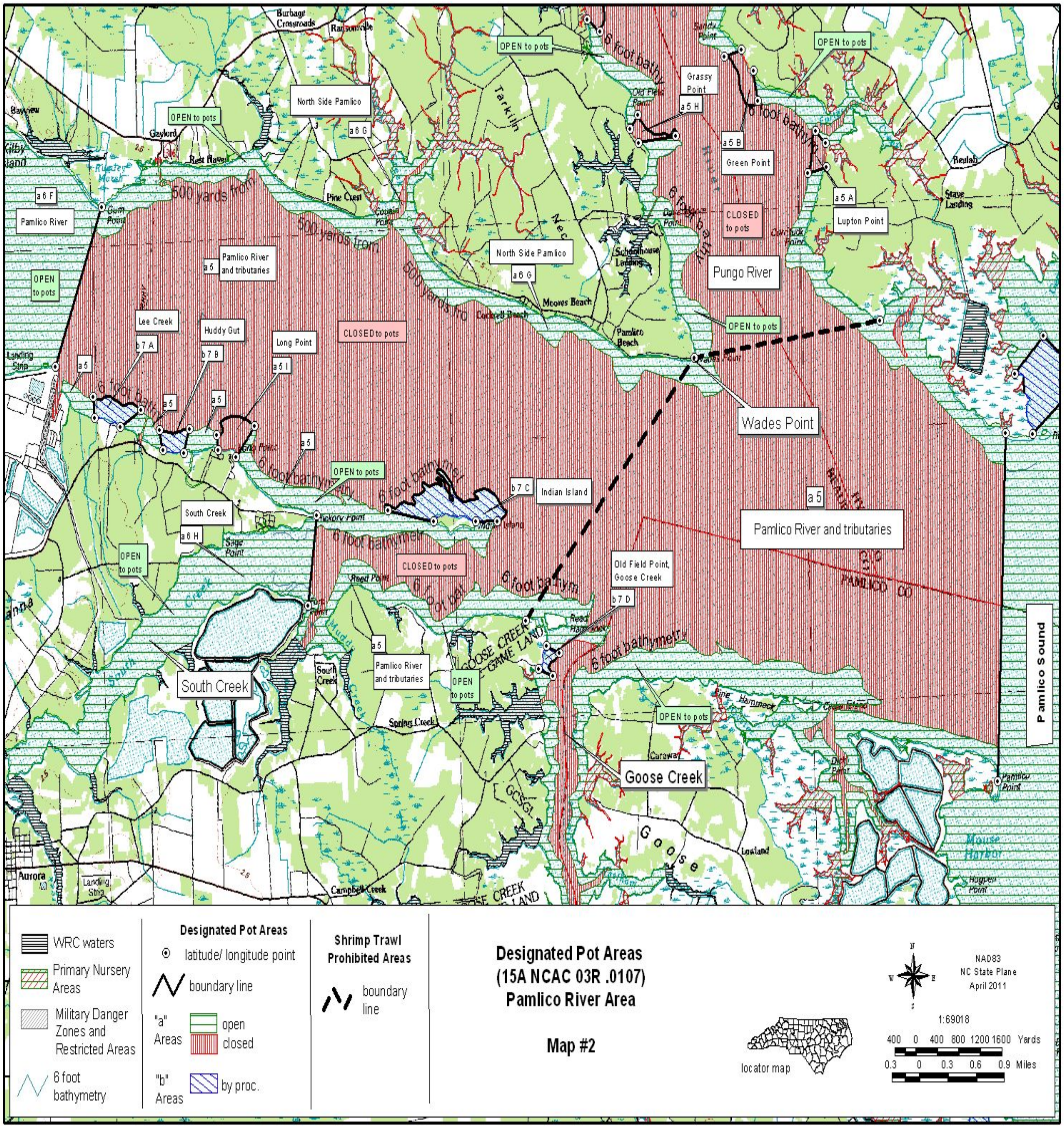

Figure 11.3.2 Designated pot areas in the Pamlico River.

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   + No rules change
   + Current benefits of rule in reducing conflict between potters and other users are preserved
   - Loss of potential economic benefit to a declining fishery
   - Same space competition between potters

2. Modify rule to allow for all or selected non-pot areas to be opened by proclamation
   + Increased yield for the crab pot fishery
   + Decreased space competition among crab potters
   - Public will have to search for the proclamation
   - Increased space competition between potters and other users
   - Requires rule change

VIII. RECOMMENDATION

MFC selected management strategy
- Open the non-pot (long haul net) areas all the time by rule in the Pungo River and keep status quo in the Long Point area on the Pamlico River.

AC - Open the haul net areas all the time by rule in the Pungo River and keep status quo in the Long Point area on the Pamlico River.

NCDMF - Open the haul net areas all the time by rule in the Pungo River and keep status quo in the Long Point area on the Pamlico River.

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July 20, 2011
July 28, 2011
August 17, 2011
February 27, 2012

11.4 INCORPORATE THE LOWER BROAD CREEK CLOSURE OF POT AREA INTO RULE[7]

I. ISSUE

Incorporate the current annual closure of a designated pot area at lower Broad Creek (Neuse River) to the use of pots into NC. Marine Fisheries rule.

II. ORIGINATION

North Carolina Division of Marine Fisheries (NCDMF)

III. BACKGROUND

In 2008, the NCDMF proposed that a portion of a designated pot area at the mouth of Broad Creek in the lower Neuse River be changed so that pots would be prohibited there (Figure 11.4.1). The intent of the proposal was to reduce conflict between crab pot fishermen and shrimp trawlers by removing pots from the designated pot area six foot contour so the trawlers would have ample room to turn around at the mouth of the creek during trawling operations. Under the user conflict authority of Rule 15A NCAC 03J .0301 the NCDMF held a public meeting on Thursday, May 22, 2008 to gather input on the proposal. Comments were sought on closing the designated six foot contour pot area to the setting of crab pots from the secondary nursery line outward to the “2A” marker. There was support for the proposal at the meeting and as a result, the Director issued Proclamation PT-6-2008 suspending the portion of Rule 15A NCAC 03R .0107 (a) (8) and modifying it so pots were prohibited in that area from June 1 through November 30.

IV. AUTHORITY

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION – POWERS AND DUTIES

15A NCAC 03J .0301 POTS
15A NCAC 03R .0107 DESIGNATED POT AREAS

V. DISCUSSION

Proclamations implementing the pot area closure from June 1 through November 30 have been issued each year since 2008 without complaint and the solution has been effective at eliminating conflict in that area between the crab potters and the shrimp trawlers. The NCDMF has a policy which recommends moving long-standing proclamations into rule to aid in the clarity of regulations and that is what is proposed here.

[7] Presented to PDT on 4/18/11 and 1/4/12; Presented to AC on 5/2/11 and 1/10/12; Reviewed by RAT Subgroup on 5/19/11 and 6/21/11; Reviewed by RAT on 6/2/11 and 6/30/11; Presented to MRT on 9/28/11 and 1/18/12.

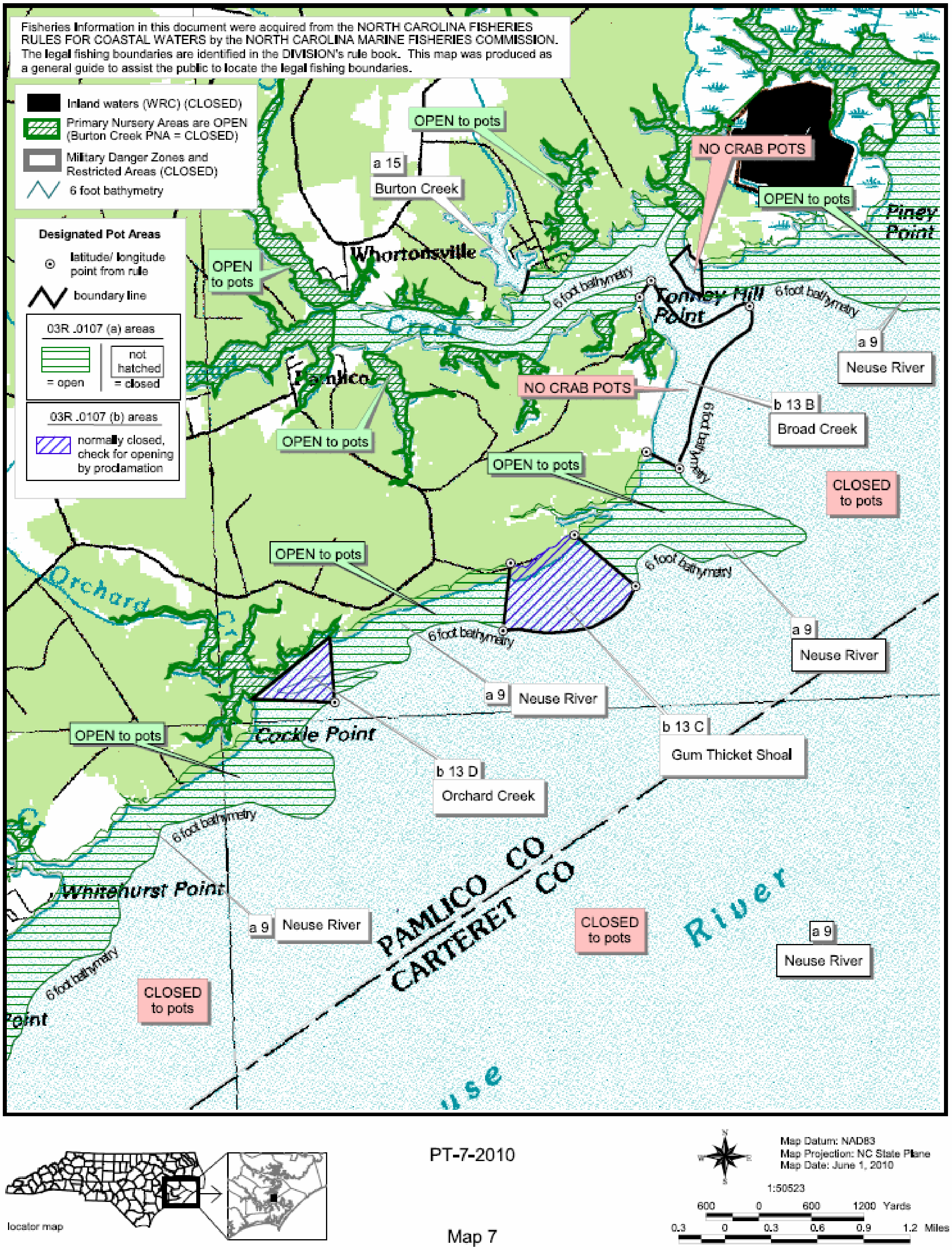

Figure 11.4.1. Proclamation PT-7-2010, Map 7 (see "NO CRAB POTS" area at mouth of Broad Creek north of Tonney Hill Pt.)

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   + No rules change
   - Continued burden on the public and NCDMF staff to remain aware of proclamations that may or may not prohibit activities

2. Modify rule to include lower Broad Creek area that is closed to potting June 1 through November 30
   + Public and NCDMF staff will not have to search for the proclamation to determine if the area is closed to potting
   + Adheres to NCDMF's policy to move longstanding proclamations into rule
   + Assists in clarifying the regulations for the public
   - Requires rule change

VIII. RECOMMENDATION

MFC selected management strategy
- Modify the rule to include the lower Broad Creek area that is closed to crab pots from June 1 through November 30.

AC - Modify the rule to include the lower Broad Creek area that is closed to crab pots from June 1 through November 30.

NCDMF - Modify the rule to include the lower Broad Creek area that is closed to crab pots from June 1 through November 30.

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11.5 CLARIFY CRAB DREDGING RESTRICTIONS[8]

I. ISSUE

The management of taking blue crabs with dredges does not match the restrictions on crab dredging in Marine Fisheries Commission Rule 15A NCAC 03L .0203 CRAB DREDGING.

[8] Presented to PDT on 4/18/11 and 1/4/12; Presented to AC on 5/2/11 and 1/10/12; Reviewed by RAT Subgroup on 5/19/11 and 6/21/11; reviewed by RAT on 6/2/11 and 6/30/11; Presented to MRT on 9/28/11 and 1/18/12.

II. ORIGINATION

N.C. Division of Marine Fisheries staff

III. BACKGROUND

The rule restricting use of crab dredges has existed in a form similar to the current rule since 1983. The crab dredging rule in place immediately prior to the change in 1983 simply stated that taking crabs by the use of dredges was prohibited between April 1 and November 30.

Landings for blue crabs taken with crab and oyster dredges are not a significant contributor to the blue crab fishery, accounting for only 0.035% of the total blue crab landings from 1994 through 2002.

Concerns about the crab dredging rule surfaced during discussions on enforcement of the daily harvest hours allowed in the 2010-11 oyster dredge fishery. Harvesters were not allowed to continue to take crabs with dredges after the 2:00 p.m. daily closure of oyster dredging.

IV. AUTHORITY

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION – POWERS AND DUTIES

15A NCAC 03L .0203 CRAB DREDGING
15A NCAC 03R .0109 TAKING CRABS WITH DREDGES

V. DISCUSSION

The current interpretation of Rule 15A NCAC 03L .0203, and staff's widely-held belief as to the intent of the implementation of restrictions on crab dredging in 1983, is that crabs may be taken without harvest limits during the January 1 through March 1 time period in the northern Pamlico Sound area specified in Rule 15A NCAC 03R .0109. Furthermore, the rule is interpreted to allow crabs to be taken as bycatch in the oyster dredge fishery according to the prescribed limits whenever and wherever oyster dredging is allowed. A straightforward reading of the rule, without benefit of knowing the management intent, indicates crabs can only be taken with dredges in the prescribed area and that they may be taken only as bycatch there within the established limits and season. A strict interpretation of the rule would create waste of the bycatch of crabs taken in the oyster dredge fishery outside of the crab dredging area and place significant restrictions on the catch of crabs within it.

VI. PROPOSED RULES(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   + No rule change
   + Current rule has been in place for years without incident
   - Rule restrictions will not match actual harvest management creating confusion for the uninitiated public

2. Amend Rule 15A NCAC 03L .0203 to conform to current harvest management
   + Rule restrictions will match actual harvest management alleviating confusion for the uninitiated public
   + Rule restrictions will allow for effective use of crab bycatch during oyster dredging in all areas
   - Rule change required

3. Apply a strict interpretation of Rule 15A NCAC 03L .0203 to taking crabs with dredges
   + Rule restrictions and management of the fishery will coincide
   - Waste of blue crab bycatch in the oyster dredge fishery and significant reductions in the crab dredge fishery in northern Pamlico Sound will occur

VIII. RECOMMENDATION

MFC selected management strategy
- Amend the rule to match the harvest management provisions.

AC - Amend the rule to match the harvest management provisions.

NCDMF - Amend the rule to match the harvest management provisions.

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11.6 INCORPORATE THE PAMLICO SOUND CRAB TRAWLING PROCLAMATION INTO RULE[9]

I. ISSUE

Incorporate the current requirement for the use of four-inch crab trawl mesh in western Pamlico Sound and the adjacent rivers into NC Marine Fisheries Commission rule.

II. ORIGINATION

North Carolina Division of Marine Fisheries

[9] Presented to the AC on 5/1/11, 9/19/11, and 1/10/12; Reviewed by the PDT on 4/18/11, 7/19/11, and 1/4/12; Reviewed by the RAT Subgroup on 5/19/11 and 6/21/11; Reviewed by RAT on 6/2/11 and 6/30/11; Presented to MRT on 9/28/11 and 1/18/12.

III. BACKGROUND

The N.C. Marine Fisheries Commission adopted the 2004 Amendment 1 to the Blue Crab Fishery Management Plan (FMP) with a management strategy that allows the Fisheries Director to specify a four-inch (stretched mesh) crab trawl mesh size in western Pamlico Sound and tributaries, and a three-inch (stretched mesh) crab trawl mesh size on the eastern side of Pamlico Sound. A line dividing Pamlico Sound down the middle would be established by proclamation. The Blue Crab FMP Advisory Committee (AC) and the Southern Flounder FMP AC supported this management strategy. The intent of increasing the trawl mesh size from three inches to four inches was to decrease harvest of juvenile southern flounder as well as sublegal blue crabs.

In 2005, the DMF issued Proclamation SH-18-2005 which divided Pamlico Sound into two areas and required that the crab trawl minimum mesh length to the west of that line be four inches. To the east of that line, three-inch crab trawl mesh could still be used. That line begins at Point of Marsh at the mouth of the Neuse River, runs easterly to the “BI” Beacon at Brant Island Shoal, continues easterly to the “BL” Beacon at Bluff Shoal, runs northeasterly to the “S” Beacon at Long Shoal, then runs northerly to a point at the southern end of Roanoke Island, and finally runs westerly to a point on Roanoke Marshes Point (see Figure 1). An identical proclamation (SH-5-2007) was issued in 2007 and that one is still in effect. The rationale for the four-inch mesh was to reduce the catch of sublegal crabs, southern flounder and other finfish species with the four-inch mesh in western Pamlico Sound and the rivers, while allowing the take of legal mature female crabs in the fall and winter, and peeler crabs in the spring in eastern Pamlico Sound.

IV. AUTHORITY

G.S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES
15A NCAC 03L .0202 CRAB TRAWLING

V. DISCUSSION

The proclamation implementing the crab trawl line has been in existence since 2005 with no changes and without complaint. Proclamation authority is used to address variable conditions and, at this point, the distribution of blue crabs and southern flounder on which the line is based appears to be reasonably static. At its April 4, 2011 meeting, the Blue Crab FMP Advisory Committee voted unanimously to leave the existing provisions now in proclamation as they are. The DMF has a policy which recommends moving long-standing proclamations into rule to aid in the clarity of regulations and that is what is proposed here.

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   + No rules change
   - Continued burden on the public and DMF staff to remain aware of proclamations that may or may not prohibit activities
   - Dubious variable condition for proclamation issuance

2. Modify Rule 15A NCAC 03L .0202 CRAB TRAWLING to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four-inch mesh crab trawl line)
   + Public and DMF staff will not have to search for the proclamation to determine allowed crab trawl activity on Pamlico Sound and tributaries
   + Adheres to DMF's policy to move long-standing proclamations into rule
   + Assists in clarifying the regulations for the public
   - Requires rule change to make area changes in minimum mesh size for crab trawls

3. Remove the Fisheries Director's proclamation authority to increase the minimum trawl mesh length to no more than four inches to take hard crabs
   + Rule would be more stable and not subject to change
   +/- Reduces flexibility of the Director to regionally manage the fishery by mesh size
   - Requires rule change to make area changes in minimum mesh size for crab trawls

VIII. RECOMMENDATION

MFC selected management strategy

- Modify Rule 15A NCAC 03L .0202 to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four inch mesh crab trawl line), and retain the Director's proclamation authority to restrict crab trawl mesh size.

AC - Modify Rule 15A NCAC 03L .0202 to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four inch mesh crab trawl line), and retain the Director's proclamation authority to restrict crab trawl mesh size.

.

NCDMF - Modify Rule 15A NCAC 03L .0202 to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four inch mesh crab trawl line), and retain the Director's proclamation authority to restrict crab trawl mesh size.

Prepared by: David Taylor
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252-808-8074
April 19, 2011

Revised: May 2, 2011
May 19, 2011
June 2, 2011
June 21, 2011
June 30, 2011
September 19, 2011
October 5, 2011
February 27, 2012

11.7 EXPLORE OPTIONS FOR ESCAPE RING EXEMPTIONS IN HARD CRAB POTS TO HARVEST PEELER CRABS[10]

I. ISSUE

Address problems with the use of crab pots as peeler pots.

II. ORIGINATION

North Carolina Division of Marine Fisheries (NCDMF) Fisheries Management Section

III. BACKGROUND

Peeler crabs are exempt from the five inch minimum size limit, because they are only in this stage of development for short periods of time and yield a significantly higher price per crab compared to hard crabs, due to the higher market value for soft crabs. Most of the peelers harvested in NC are smaller than five inches; and thus, could easily leave the pot through the two required 2 5/16 inch escape rings in pots with a mesh size of 1 1/2 inches and greater. Therefore, the Fisheries Director was given proclamation authority to allow pots to be set without escape rings or with closed escape rings to prevent the loss of small peeler blue crabs [Rule 15A NCAC 03J .0301 (g)]. However, this proclamation authority has never been used to allow escape rings to be closed to enhance peeler harvest due to:

1) only a small number of requests to close escape rings for directed peeler harvest,
2) the contention of some crabbers that a "hard crab pot" is not as efficient for harvesting peelers as traditional smaller mesh pots designed for taking peeler crabs,
3) the potential risk of inadvertent and/or deliberate baiting of pots with fish; thereby, enhancing the harvest and capture of under size hard crabs; and thus, promoting increased mortality and sale, and
4) the lack of proclamation authority to specify means and methods (e.g., that only male crabs can be used as bait in escape ring exempt pots).

In recent years, crabbers in Dare and New Hanover counties have requested that the Fisheries Director use the proclamation authority in NC Marine Fisheries Rule 15A NCAC 03J .0301 (g) to exempt the escape ring requirement for hard crab pots in order to allow for the harvest of peeler crabs. Reasons given by the crabbers for requesting the escape ring exemption are:

1) to enhance their ability to harvest peeler crabs from hard crab pots,
2) to reduce the number of pots employed in fishing operations during the principal peeler season (i.e., many crabbers now set both peeler and hard crab pots prior to and during the peeler season), and
3) to reduce frequent replacement costs associated with the less durable, non-coated wire peeler pots.

IV. AUTHORITY

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION – POWERS AND DUTIES

[10] Presented to AC on 6/13/11 and 1/10/12; Presented to PDT on 6/1/11, 7/19/11, and 1/4/12; Reviewed by RAT Subgroup 7/22/11 and 9/7/11; Reviewed by RAT 7/28/11 and 9/15/11; Presented to MRT on 9/28/11 and 1/18/12.

V. DISCUSSION

Peeler crab harvest with both hard crab and peeler pots takes place in all months of the year (Table 11.7.1). However, the vast majority of the harvest takes place during April to June (81%) with the predominant harvest in May (57%) (Table 11.7.1). During the principal spring peeler season, many crabbers simultaneously set and tend stands of both peeler and hard crab pots; thus, they are sometimes setting twice the normal amount of gear during peeler season and taking up additional water area and potentially causing additional conflict among crabbers and other user groups.

Table 11.7.1 Monthly contribution of pot-caught shedders from single gear trip tickets in North Carolina, 1994 – 2009.

	Crab pot		Peeler pot		Total pots	
Month	Pounds	% of total	Pounds	% of total	Pounds	% of total
January	783	0.01	726	0.01	1,509	0.01
February	1,588	0.01	0	0.00	1,588	0.01
March	18,697	0.13	3,067	0.05	21,764	0.10
April	1,156,525	8.08	547,607	8.43	1,704,132	8.19
May	7,003,344	48.90	4,787,889	73.69	11,791,233	56.64
June	2,663,528	18.60	691,678	10.65	3,355,205	16.12
July	1,024,749	7.16	74,440	1.15	1,099,189	5.28
August	1,582,267	11.05	272,616	4.20	1,854,883	8.91
September	715,493	5.00	104,662	1.61	820,155	3.94
October	137,868	0.96	12,861	0.20	150,729	0.72
November	15,823	0.11	572	0.01	16,395	0.08
December	1,074	0.01	870	0.01	1,944	0.01
Total	14,321,739	100.00	6,496,990	100.00	20,818,728	100.00

In recent years, crabbers in Dare and New Hanover counties have requested that the Fisheries Director use the proclamation authority to exempt the escape ring requirement in order to enhance their ability to harvest peeler crabs with hard crab pots.

The Division has been reluctant to use the established proclamation authority due to lack of authority to specify means and methods for exempting escape rings for peeler crab harvest. Allowing for further consideration and use of the escape ring exemption for the harvest of peeler crabs would potentially require additions to the rule to broaden the Fisheries Director's proclamation authority to specify:

1) quantity (e.g., number of peelers),
2) means and methods (e.g., method to identify pots with no or closed escape rings, maximum water depth, the type of bait that may or may not be used, number of pots per operation),
3) size (e.g., minimum size for peelers), and
4) stage or type of peeler crab (e.g., only allow harvest of pink and red-line peelers from pots with the escape ring exemption).

Adding this supplemental authority to the rule would allow additional control of the exempted gear and harvest from the gear. Consequently, the added authority could assist in reducing waste and circumvention of the minimum size limit for hard crabs.

Also, it was felt that management criteria should be established to help evaluate requests to use this authority. Potential criteria to evaluate and consider escape ring exemption requests for peeler harvest are proposed to allow the exemption only during the peak spring peeler season (e.g., April, May, or June), and to meet one of the following two criteria:

1) in high flow and/or deep water areas where pots are subject to move, or
2) in areas that are historically congested with large numbers of pots and boat activity particularly during the spring peeler season.

Existing rule criteria for exempting peeler pots from the escape ring requirements establishes that peeler pots with a mesh size less than 1 1/2 inches shall be exempt from the escape ring requirement. Crabbers targeting peeler crabs use unbaited pots and pots baited with a male crab during the relatively short 2-3 month peeler season. Rather than using the mesh size of pots which can be quite variable by manufacturer, type of wire coating, and method of measurement, using the pot baiting method employed by the crabber to exempt escape ring requirements allows for better and more consistent enforcement of intent to capture peeler crabs. Therefore, an option would be to use the method of baiting the pot as the criteria to determine if a crab pot is exempt from the escape ring requirement.

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   - \+ No rules change
   - \- NCDMF will continue to have serious concerns with the use of the current proclamation authority for escape ring exemptions for peeler harvest

2. Add these supplemental specifications to the existing proclamation authority outlined in the rule and develop criteria for escape ring exemptions for taking peeler crabs
   - \+ Allows for enhanced peeler harvest capabilities with traditional hard crab pots
   - \+ Allow NCDMF to better manage escape ring exempt pots and reduce the potential risks associated with the deliberate baiting of pots with fish; thereby, reducing the mortality and sale of undersize hard crabs (i.e., green peelers and white-line peelers)
   - \+ May alleviate user conflicts during the peak, spring peeler harvest season
   - \- Requires NCDMF to evaluate requests for escape ring exemptions based on management criteria and to specify management authority via proclamation
   - \- Requires a rule change

3. Redefine criteria for exempting escape rings in crab pots from the 1½-inch pot mesh size to unbaited pots and pots baited with a male crab
   - \+ Eliminates the use of crab pot mesh size as the criteria for exempting escape rings in crab pots
   - \+ Uses an established peeler pot baiting practice as the criteria for exempting escape ring use in peeler pots

- \+ Using the pot baiting method employed by the crabber to exempt escape ring requirements allows for better and more consistent enforcement of intent to capture peeler crabs
- \+ Incorporates the traditional peeler pot baiting methods into the rule that establishes the requirements for escape ring requirements and exemptions
- \- Requires a rule change

4. Repeal the Fisheries Director's proclamation authority that allows for exempting the escape ring requirement in order to allow the harvest of peeler crabs
   - \+ Eliminates the peeler crab portion of the rule that has never been utilized
   - \+ This portion of the rule would no longer be necessary if the pot baiting criteria for exempting escape ring use is adopted
   - \- Requires a rule change

VIII. RECOMMENDATION

MFC selected management strategy
- Redefine criteria for exempting escape rings in crab pots from the 1½-inch pot mesh size to unbaited pots and pots baited with a male crab.
- Repeal the proclamation authority that allows for exempting the escape ring requirement in order to allow the harvest of peeler crabs.

AC
- Redefine criteria for exempting escape rings in crab pots from the 1½-inch pot mesh size to unbaited pots and pots baited with a male crab.
- Repeal the proclamation authority that allows for exempting the escape ring requirement in order to allow the harvest of peeler crabs.

NCDMF
- Redefine criteria for exempting escape rings in crab pots from the 1½-inch pot mesh size to unbaited pots and pots baited with a male crab.
- Repeal the proclamation authority that allows for exempting the escape ring requirement in order to allow the harvest of peeler crabs.

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July 22, 2011
July 28, 2011
September 7, 2011
September 15, 2011
February 27, 2012

11.8 CONVERT CRAB POT ESCAPE RING PROCLAMATION EXEMPTIONS FOR MATURE FEMALES INTO RULE[11]

I. ISSUE

Convert the crab pot escape ring exempted areas currently defined by proclamation into Rule 15A NCAC 03J .0301 (g) POTS.

II. ORIGINATION

North Carolina Division of Marine Fisheries Marine Patrol and Fisheries Management Sections

III. BACKGROUND

North Carolina Marine Fisheries Rule 15A NCAC 03J .0301 (g) POTS gives the Fisheries Director proclamation authority to allow commercial and recreational crab pots to be set without escape rings or with closed escape rings to prevent the loss of peeler crabs and sexually mature female blue crabs in crab pots. Currently, proclamations allow escape ring exemptions to enhance harvest opportunity only for sexually mature female blue crabs in two specified areas in only three counties in the state:

1) Dare, Hyde, and Carteret counties - in the Pamlico Sound out to six miles from the western shore of the Outer Banks from Oregon Inlet to Wainwright Island [since PT-4-1999, effective December 20, 1999) (Attachment A)] (A previous proclamation M-6-1994, dated March 3, 1994, established the area out to four miles from the Outer Banks.); and
2) Carteret County – in Newport River bounded by the Highway 70 Bridge in the south and the Highway 101 Bridge at Core Creek in the north (currently PT-1-2011, effective April 10-June 15, 2011) (Attachment B). This exemption has occurred annually since April 19, 2003.

Mature females are exempt from the five inch minimum size limit (Rule 15A NCAC 03L .0201 (a) SIZE LIMIT AND CULLING TOLERANCE, because some females reach maturity at sizes less than five inches and would be unavailable for harvest, because they will not grow larger subsequent to reaching maturity. Particularly in high salinity areas, such as those with the current escape ring exemption, a significant portion of the available mature females may be of such a small size that they may leave the pot through the minimum 2 5/16 inch escape rings. Therefore, the Fisheries Director was given proclamation authority to allow pots to be set without escape rings or with closed escape rings to prevent the loss of small sexually mature female blue crabs through the escape rings.

IV. AUTHORITY

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION – POWERS AND DUTIES
15A NCAC 03J .0301	POTS

[11] Presented to AC 6/13/11 and 1/10/12; Presented to PDT on 7/19/11 and 1/4/12; Reviewed by RAT Subgroup 7/22/11 and 9/7/11; Reviewed by RAT on 7/28/11, 9/15/11, and 9/28/11; Reviewed by MRT on 9/28/11 and 1/18/12.

V. DISCUSSION

Proclamations allowing escape ring exemptions for mature female harvest have been in place in two areas for many years. It is standard practice for the NCDMF and MFC to evaluate and place long-standing proclamations into rule. Therefore, the NCDMF is considering converting the specifics of these two proclaimed areas (PT-4-1999 and PT-1-2011) into rule with clearly recognized or delineated boundaries (e.g., navigation markers, coordinates, or depth) for the Outer Banks Pamlico Sound area. The boundaries for the Newport River exempted area are clearly defined in Proclamation PT-1-2011, and would not present a problem in conversion to rule.

Proclamation PT-4-1999 presents a problem in its current format because the boundary “out to six miles from the western shore of the Outer Banks from Oregon Inlet to Wainwright Island” is indistinct and difficult to establish in the field due to the irregular shoreline of the Outer Banks. Also, Marine Patrol and many potters do not have the capability to determine the actual six mile boundaries without specifically-delineated markings. Therefore, specific coordinates and land marks are recommended to clarify the boundary for adherence and enforcement. Two areas of Pamlico Sound, adjacent to the six mile area delineated in Proclamation PT-4-1999, currently have specific coordinates and landmarks as part of their legal boundary descriptions (Table 11.8.1, A and B). The lines and areas identified in either A or B in Table 11.8.1 below would only need to be modified slightly to be used for the proposed Outer Banks escape ring boundaries rule. Therefore, the relevant boundaries established by these rules are presented as potential options for a proposed rule. The area delineated in A is significantly smaller than the current six mile boundary, and the area delineated in B is significantly larger.

Another option would be to consider using a specified water depth to delineate the Outer Banks/Pamlico Sound boundary [e.g., 6- or 12-foot depth (Table 11.8.1, C and D)]. Normal tidal variation within this area of Pamlico Sound is only about 1 to 2 feet. Water depth can be easily determined with simple measuring devices; and thus, makes it easier for crabbers and enforcement to determine compliance. Also, navigational charts delineate the approximate 6 or 12-foot depth contours. Compared to the current six mile boundary, both the 6 and 12-foot depth options would significantly reduce the current escape ring exempted area.

Based on NCDMF crab fishery sampling, the escape ring exemption as provided in Proclamation PT-4-1999 does not appear to be widely utilized by crabbers who fish the Outer Banks/Pamlico Sound area. Perhaps in the past when the southern Outer Banks fishery was robust with more crabs and crabbers, the practice of closing escape rings was more prevalent. NCDMF sampling, in recent years, has documented that some crabbers in this area do not close escape rings, while some close one of the two required escape rings, and others close the escape rings. Therefore, to accommodate the current level of usage, the area may not need to be as expansive as 6 miles, and could be reduced. Recently, NCDMF staff contacted and discussed the Outer Banks escape ring exemption and potential options to modify the boundary with area crabbers. Overall opinions were mixed; but, several crabbers indicated that they would like to maintain the flexibility to set pots with closed escape rings.

Table 11.8.1 Potential options to establish alternative boundaries for the Outer Banks/Pamlico Sound escape ring exemption rule. (Note: Pot use and crab harvest within all the boundaries outlined below is further restricted by Rules 03L .0205 and 03R .0110 CRAB SPAWNING SANCTUARIES.)

A. Rule 15A NCAC 03R .0106 TRAWL NETS PROHIBITED
"The trawl net prohibited areas referenced in 15A NCAC 03J .0104 (b)(4) are delineated in the following coastal water areas:
(1) In Pamlico, Core and Back sounds….. " (see full Rule language in Attachment C and map of area in Attachment E.)
- Only, use those points covering the area from near Oregon Inlet to Wainwright Island that are within the current boundaries of Proclamation PT-4-1999.
- Points referenced in this rule range from approximately 2.2 to 5.5 miles west of the Outer Banks western shoreline from Oregon Inlet to Wainwright Island (see Attachment E for approximate boundary line).

B. Proclamation SH-18-2005 requiring 4 inch mesh crab trawls west of a line with coordinates in Pamlico Sound (see Proclamation SH-18-2005 and map in Attachment D).
- Establish additional coordinates on the Outer Banks and in Old House Channel near Oregon Inlet, and on Wainwright Island and Portsmouth Island to complete the area boundaries.
- Points referenced in this proclamation range from approximately 5.8-18 miles west of the Outer Banks western shoreline from Oregon Inlet to Wainwright Island (see Attachment E for approximate boundary line).

C. Six-foot water depth or less (pots may be used without escape rings or with escape rings closed within an area of Pamlico Sound bound by the western shoreline of the Outer Banks from Oregon Inlet to Wainwright Island to the depth of six feet).
- This delineation would cover most of "the reef" (shallow water) area in Pamlico Sound west of the Outer Banks (see Attachment E for approximate boundary line).
- Escape rings would be required in some deeper areas (channels and holes) within "the reef".
- The approximate boundary of the six foot depth contour ranges from 1-7.5 miles west of the Outer Banks western shoreline from Oregon Inlet to Wainwright Island (see Attachment E for approximate boundary line).

D. Twelve-foot water depth or less (pots may be used without escape rings or with escape rings closed within an area of Pamlico Sound bound by the western shoreline of the Outer Banks from Oregon Inlet to Wainwright Island to the depth of twelve feet).
- This delineation would essentially cover "the reef" area and waters just outside "the reef" in Pamlico Sound west of the Outer Banks (see Attachment E for approximate boundary line).
- Escape rings would be required in only a few of the deeper areas (channels and holes) within "the reef" and waters just outside "the reef".
- The approximate boundary of the twelve foot depth contour ranges from 2-7.6 miles west of the Outer Banks western shoreline from Oregon Inlet to Wainwright Island (see Attachment E for approximate boundary line).

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   + No rules change
   - Continue to use proclamations (annual and standing) that may not be widely distributed and difficult to find for some resource users
   - Maintains the poorly defined 6-mile boundary that is subject to a wide range of interpretations due to a very irregular shoreline
   - Continued burden on the public to determine varying boundaries and comply with law
   - Continued burden on law enforcement to determine arbitrary boundaries for enforcement

2. Place exempted escape ring area delineations into rule as they are written now in proclamation
   + Escape ring exemptions will be published with other rules and easier for resource users to find
   - Continued burden on the public to determine varying boundaries and comply with law
   - Continued burden on law enforcement to determine indistinct boundaries for enforcement
   - Requires rule change

3. Place exempted escape ring area delineations into rule and clearly define the boundaries.
   + Escape ring exemptions will be published with other rules and easier for resource users to find
   + Establishing clearly defined boundaries in rule would make it easier for the public to determine escape ring exempted areas
   + Makes the boundary easier to explain and enforce (reduce gray areas of the law)
   - Requires rule change

VIII. RECOMMENDATION

MFC selected management strategy
- Adopt the no trawl line along the Outer Banks in Pamlico Sound as the new boundary in Pamlico Sound, and the Newport River boundaries as delineated in the proposed rule as new boundaries for the area where closure of escape rings to take small mature females is allowed.

AC - Adopt the four inch mesh size crab trawl line as the new boundary in Pamlico Sound, and the Newport River boundaries as delineated in the proposed rule as new boundaries for the area where closure of escape rings to take small mature females is allowed.

NCDMF - Adopt the no trawl line along the Outer Banks in Pamlico Sound as the new boundary in Pamlico Sound, and the Newport River boundaries as delineated in the proposed rule as new boundaries for the area where closure of escape rings to take small mature females is allowed.

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June 2, 2011

Revised: July 22, 2011
July 28, 2011
September 7, 2011
September 15, 2011
October 5, 2011
February 27, 2012

ATTACHMENT A. Proclamation PT-4-99 (Outer Banks escape ring exemption area)

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

James B. Hunt, Jr., Governor
Bill Holman, Secretary
Preston P. Pate, Jr., Director

NCDENR
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

PT-4-99

PROCLAMATION

RE: CRAB POTS

Preston P. Pate, Jr., Director, Division of Marine Fisheries, hereby announces that effective **6:00 A.M., Monday, December 20, 1999**, the following provisions will apply to crab pots:

DARE, HYDE, AND CARTERET COUNTIES

Commercial and recreational crab pots may be set without escape rings or with closed escape rings in the Pamlico Sound from the western shore of the Outer Banks out to six miles from Oregon Inlet to Wainwright Island. (See Map)

GENERAL INFORMATION

A. This proclamation is issued under the authority of G.S. 113-182; 113-221(e); 143B-289.52, and N.C. Marine Fisheries Rules 15A NCAC 3H .0103 and 3J .0301 (g).

B. It is unlawful to violate provisions of any proclamation issued by the Fisheries Director under his delegated authority per 15A NCAC 3H .0103.

C. The intent of this proclamation is to prevent the loss of sexually mature female blue crabs, which are exempt from the five-inch minimum size limit, through escape rings in crab pots.

D. This proclamation supersedes Proclamation M-6-94, dated March 3, 1994 and extends the area exempted two miles offshore.

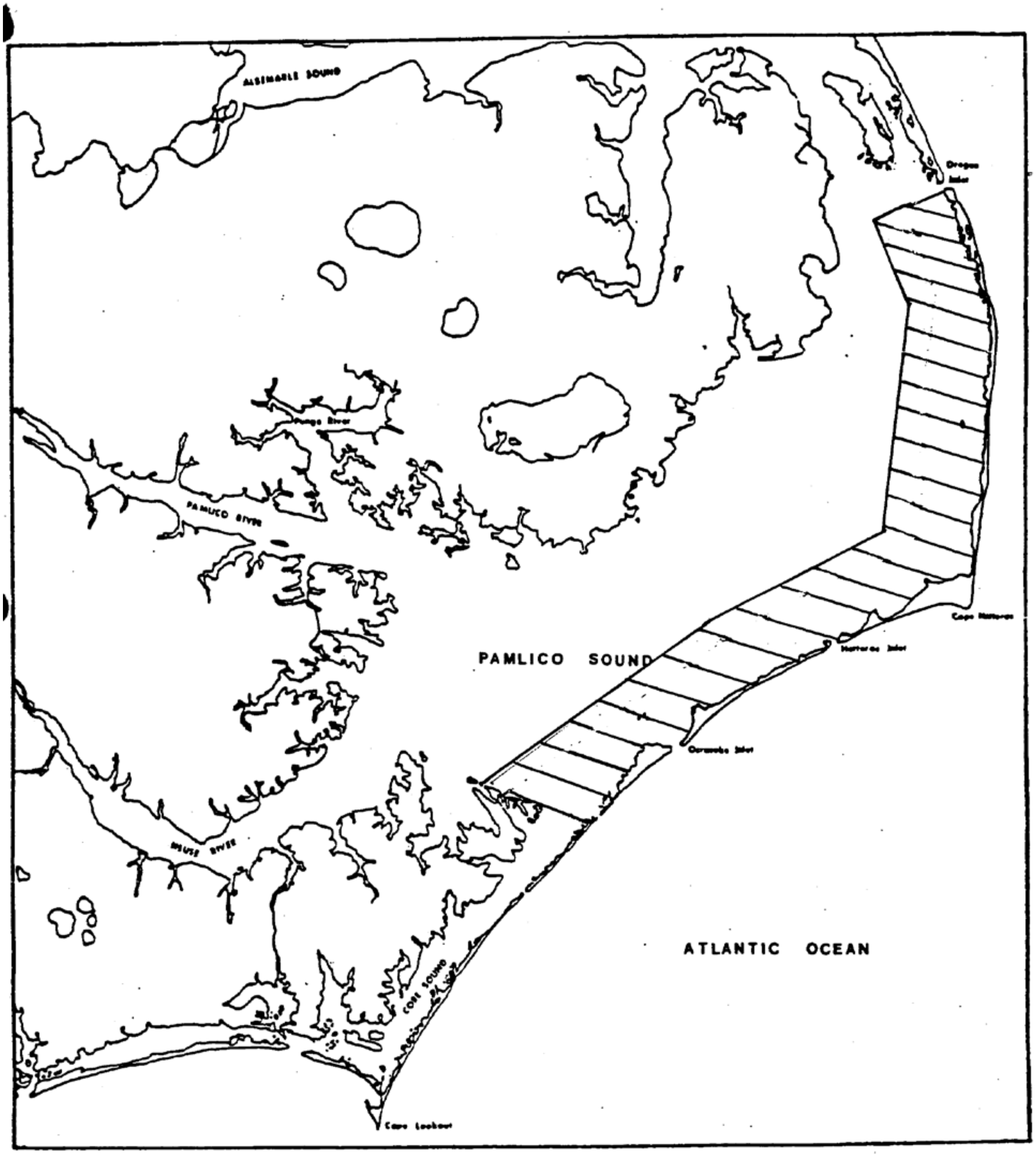
BY: Preston P. Pate, Jr.
Preston P. Pate, Jr., Director
Division of Marine Fisheries

December 15, 1999
4:00 P.M.
PT-4-99
/sab

600 copies of this public document were printed at a cost of 5 cents per copy.

P.O. Box 769, Morehead City, North Carolina 28557-0769 Telephone 252-726-7021 FAX 252-726-0254

ATTACHMENT A. Proclamation PT-4-99 (Map of Outer Banks escape ring exemption area)



PROCLAMATION PT-4-99

Crab Pots Without Cull Rings May Be Set in Hatched Areas

ATTACHMENT B. Proclamation PT-1-2011 (Newport River escape ring exemption)

PT-1-2011

PROCLAMATION

RE: CRAB POT ESCAPE RINGS

Dr. Louis B. Daniel III, Director, Division of Marine Fisheries, hereby announces that effective at **10:00 A.M., Sunday, April 10, 2011**, the following area will be exempt from the escape ring requirement in crab pots until 12:01 A.M., June 15, 2011.

I. AREA DESCRIPTION:

Newport River bounded by the Highway 70 Bridge in the south and the Highway 101 Bridge at Core Creek in the north. (No Map)

II. GENERAL INFORMATION:

A. This proclamation is issued under the authority of N.C.G.S. 113-170.4; 113-170.5; 113-182; 113-221.1; 143B-289.52 and N.C. Marine Fisheries Rule 15A NCAC 03H .0103 and 03J .0301.

B. It is unlawful to violate provisions of any proclamation issued by the Fisheries Director under his delegated authority pursuant to N.C. Marine Fisheries Rule 15A NCAC 03H .0103.

C. This action is being taken to allow the harvest of mature female crabs. During this period of exemption, escape rings in crab pots may be obstructed to retain the crabs in the area described above.

D. Fisheries Rule 15A NCAC 03J .0301 (g) authorizes the Fisheries Director exempt crab pots from the escape ring requirement.

April 8, 2011
10:00 A.M.
PT-1-2011

ATTACHMENT C. NC Marine Fisheries Rule 15A NCAC 03R .0106 TRAWL NETS PROHIBITED

NC Marine Fisheries Rule **15A NCAC03R .0106 TRAWL NETS PROHIBITED**
The trawl net prohibited areas referenced in 15A NCAC 03J .0104 (b)(4) are delineated in the following coastal water areas:

(1) In Pamlico, Core and Back sounds - within the area described by a line beginning at a point 35° 43.7457' N - 75° 30.7014' W on the south shore of Eagles Nest Bay on Pea Island; running westerly to a point 35° 42.9500' N - 75° 34.1500' W; running southerly to a point 35° 39.3500' N – 75° 34.4000' W; running southeasterly to a point 35° 35.8931' N - 75° 31.1514' W in Chicamacomico Channel near Beacon "ICC"; running southerly to a point 35° 28.5610' N - 75° 31.5825' W on Gull Island; running southwesterly to a point 35° 22.8671' N - 75° 33.5851' W in Avon Channel near Beacon "1"; running southwesterly to a point 35° 18.9603' N - 75° 36.0817' W in Cape Channel near Beacon "2"; running westerly to a point 35° 16.7588' N - 75° 44.2554' W in Rollinson Channel near Beacon "42RC"; running southwesterly to a point 35° 14.0337' N - 75° 45.9643' W southwest of Oliver Reef near the quick-flashing beacon; running westerly to a point 35° 09.3650' N – 76° 00.6377' W in Big Foot Slough Channel near Beacon "14BF"; running southwesterly to a point 35° 08.4523' N – 76° 02.6651'W in Nine Foot Shoal Channel near Beacon "9"; running westerly to a point 35° 07.1000' N – 76° 06.9000' W; running southwesterly to a point 35° 01.4985' N – 76° 11.4353' W near Beacon "HL"; running southwesterly to a point 35° 00.2728' N - 76° 12.1903' W near Beacon "2CS"; running southerly to a point 34° 59.5027' N – 76° 12.3204' W in Wainwright Channel immediately east of the northern tip of Wainwright Island; running easterly to a point 34° 58.6760'N – 76° 12.4164'W; running southerly to a point 34°56.6697'N – 76° 13.6052'W near Marker "15"; running southwesterly to a point 34° 54.1584'N – 76° 16.9016'W; running southwesterly to a point 34° 52.1484'N – 76° 19.2607'W; running southwesterly to a point 34° 51.0617'N – 76° 21.0449'W; running southwesterly to a point 34° 48.3137' N - 76° 24.3717' W; running southwesterly to a point 34° 46.3739' N – 76° 26.1526' W; running southwesterly to a point 34° 44.5795' N – 76° 27.5136' W; running southwesterly to a point 34° 43.4895' N – 76° 28.9411' W near Beacon "37A"; running southwesterly to a point 34° 40.4500' N – 76° 30.6833' W; running westerly to a point 34° 40.7061' N – 76° 31.5893' W near Beacon "35" in Back Sound; running westerly to a point 34° 41.3178' N - 76° 33.8092' W near Buoy "3"; running southwesterly to a point 34° 39.6601' N – 76° 34.4078' W on Shackleford Banks; running easterly and northeasterly along the shoreline and across Barden Inlet following the COLREGS Demarcation line; then running northerly along the shoreline across the inlets following the COLREGS Demarcation line up the Outer Banks to Eagles Nest Bay at the point of beginning.

ATTACHMENT D. Proclamation SH-18-2005 (Requiring 4-inch mesh crab trawls west of a line with coordinates in Pamlico Sound)

DMF FISHERIES MGT. Fax:252-726-6062 Jan 31 2006 12:39 P.01

SH-18-2005

NCDENR

North Carolina Department of Environment and Natural Resources

Division of Marine Fisheries

Michael F. Easley, Governor
William G. Ross Jr., Secretary

Preston P. Pate Jr., Director

PROCLAMATION

RE: 2005 SHRIMPING AND CRAB TRAWLING

Preston P. Pate, Jr., Director, Division of Marine Fisheries, hereby announces that the following change will occur in crab trawling restrictions, effective at **12:01 a.m., Monday, October 24, 2005:**

I. AREA DESCRIPTION

Western Pamlico Sound – West of a line beginning at a point 35° 4 .6167' N – 76° 27.8000'W on Point of Marsh; running easterly to a point 35° 8 .1000'N – 76° 17 .5000'W at the "BI" Marker at Brant Island Shoal; running easterly to a point 35° 12 .6167'N – 76° 4 .3833'W at the "BL" Marker on Bluff Shoal; running northeasterly to a point 35° 30 .7500'N - 76° 40 .5667'W at the "S" Marker at Long Shoal; running northerly to a point 35° 48 .3000'N – 75° 37 .1167'W at Marker "1" at the southern end of Roanoke Island; running westerly to a point on shore 35° 48.3693'N – 75° 43.7232'W on Roanoke Marshes Point.

(SEE MAP ON BACK)

II. HARVEST RESTRICTION

It is unlawful to use a crab trawl in the area described above with a trawl mesh size less than four (4) inches.

III. GENERAL INFORMATION:

A. This proclamation is issued under the authority of G.S. 113-170.4; 113-170.5; 113-182; 113-221.1; 143B-289.52 and Marine Fisheries Rules 15A NCAC 3H .0103; 3L .0101 and .0202.

B. It is unlawful to violate the provisions of any proclamation issued by the Fisheries Director under his delegated authority per Marine Fisheries Rule 15A NCAC 3H .0103.

C. This action is being taken to implement a provision of the Blue Crab Fishery Management Plan.

By: Preston P. Pate, Jr.

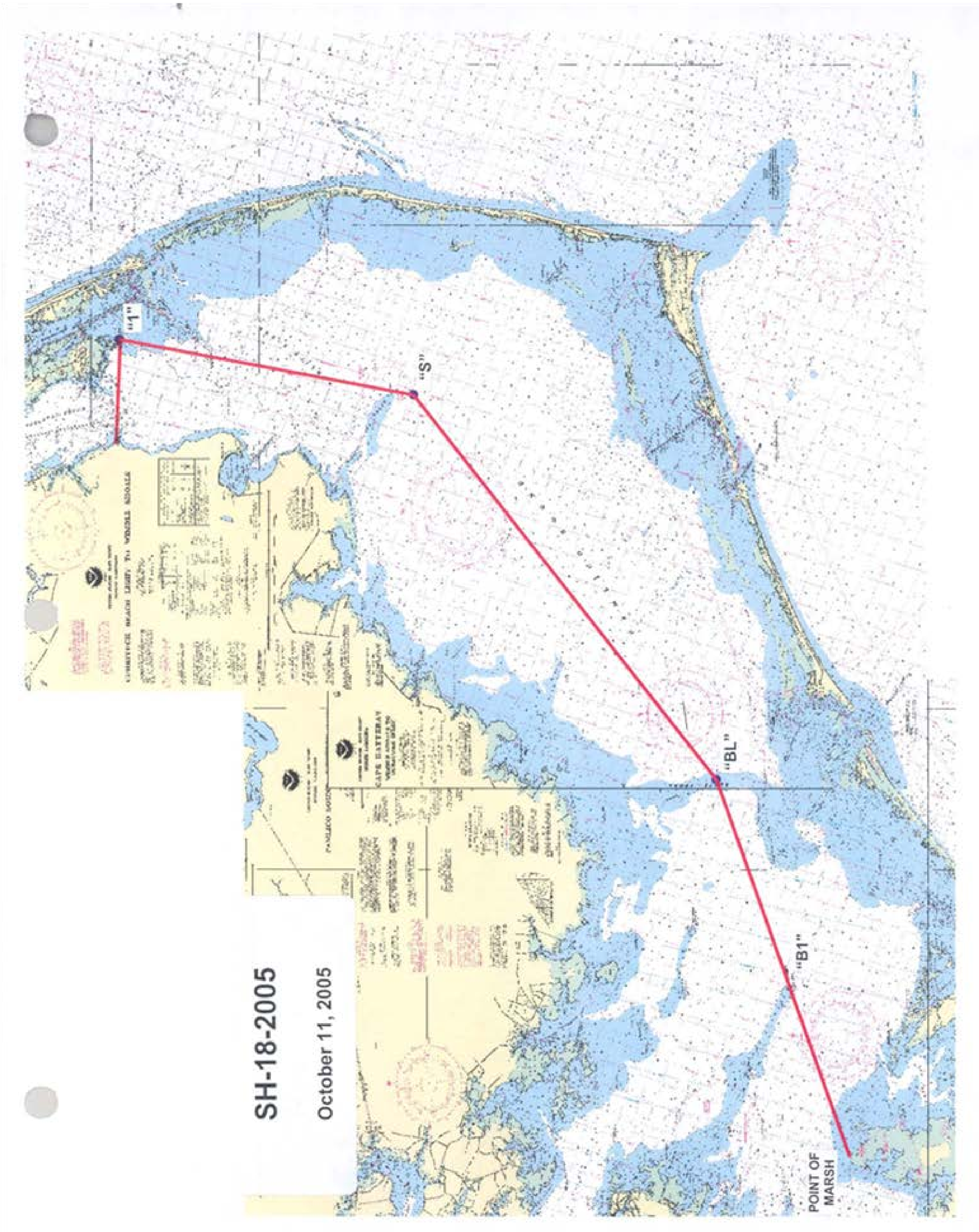
Preston P. Pate, Jr., Director
Division of Marine Fisheries

October 11, 2005
12:30 P.M.
SH-18-2005
/sab

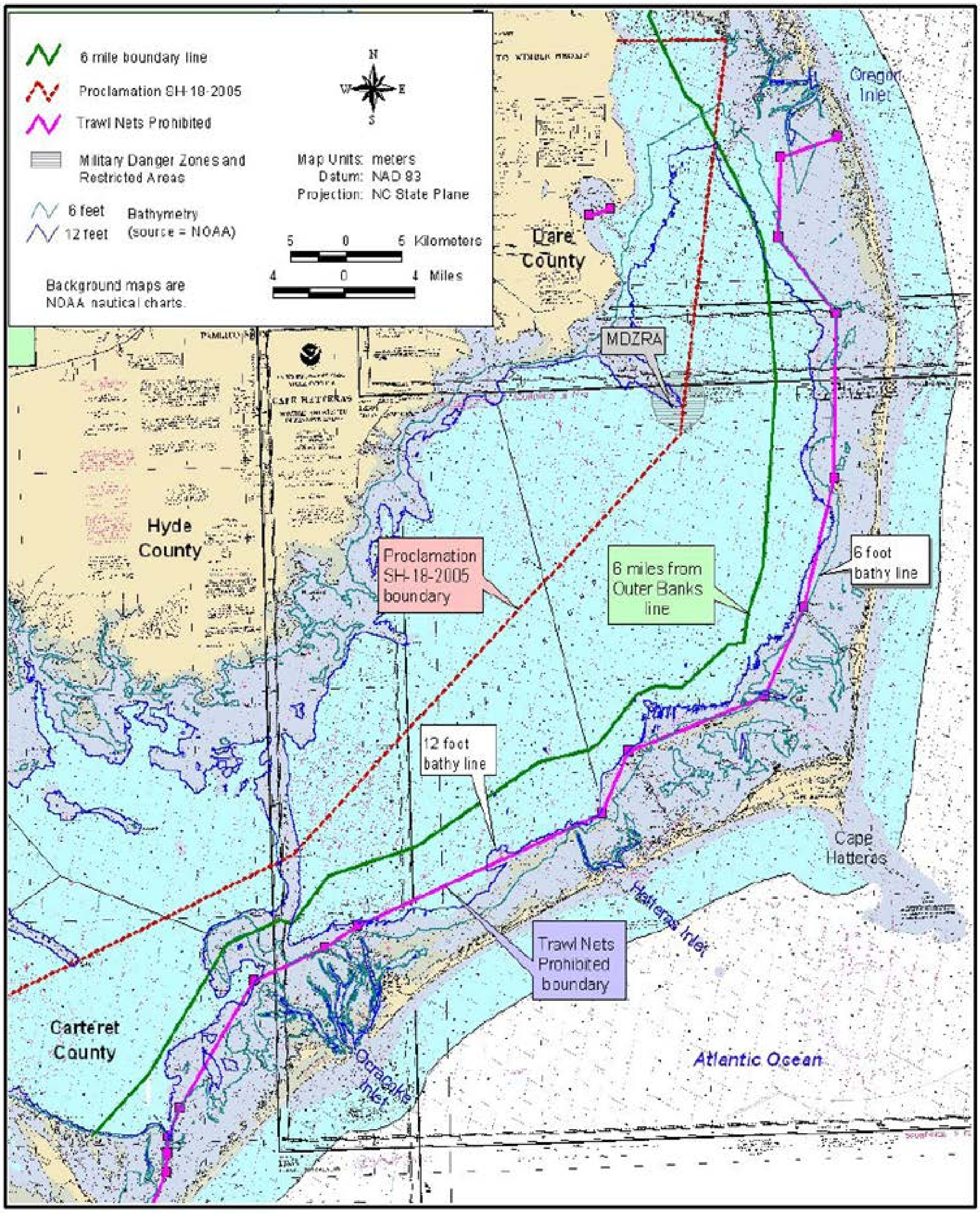
One North Carolina Naturally

3441 Arendell Street, P.O. Box 769, Morehead City, North Carolina 28557
Phone: 252 726-7021 \ FAX: 252 726-6062 \ Internet: www.ncdmf.net

ATTACHMENT D. Proclamation SH-18-2005 (Map of Pamlico Sound showing area where west of a line 4-inch mesh crab trawls are required).



ATTACHMENT E. Map depicting approximate boundary lines for Proclamation PT-4-1999 (Outer Banks 6-mile escape ring exemption line), Proclamation SH-18-2005 (Crab Trawl Line), and Rule 15A NCAC 03R .0106 TRAWL NETS PROHIBITED (No Trawl Line), and 6- and 12-foot bathymetry.



11.9 CORRECTION OF PEELER TRAWL EXCEPTION RULE[12]

I. ISSUE

An incorrect reference in the Trawl Nets rule exists concerning the area where the Director has proclamation authority to open peeler crab trawling and needs to be corrected.

II. ORIGINATION

Blue Crab FMP Plan Development Team

III. BACKGROUND

During the drafting of the several proposed rules for Amendment 2 of the Blue Crab FMP, it was discovered that Rule 03J .0104 (b)(4) contains a reference to item (6) in Rule 03R .0106 (Cape Lookout Bight), which is incorrect and needs to be changed. The reference should be to 03R .0106 (1) Pamlico, Core and Back sounds.

IV. AUTHORITY

G. S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52 MARINE FISHERIES COMMISSION –POWERS AND DUTIES
15A NCAC 03J .0104 TRAWL NETS
15A NCAC 03R .0106 TRAWL NETS PROHIBITED

V. DISCUSSION

One of the rule changes that resulted from the Shrimp FMP in 2006 was an extension of the trawl net prohibited areas to include the area north of Drum Inlet on the banks side of Core Sound. In revising that description, the Core and Back sounds description, which was 03R .0106 (6) at the time, was modified and added to 03R .0106 (1), the Pamlico Sound description. That change caused a renumbering of the list as the items moved up with the elimination of the Core and Back sounds description and (6) became the Cape Lookout Bight description. What should have occurred with that change was a corresponding change to Rule 03J .0104 (b)(4), which references that item as the area which the Director has proclamation authority to open to peeler crab trawling. That was overlooked, however, and needs to be corrected at this time.

The Division has issued peeler crab trawling proclamations in the early spring since prior to 2000 and, being unaware of the error, has continued to do so from 2006 to the present. The areas currently opened by proclamation are located mainly in Carteret County, with two bays in Dare County and an area near Swansboro. The present open areas include Core Sound, Cedar Island Bay, Nelson Bay, Brett Bay, Jarrett Bay, North River, Ward Creek, Back Sound, Bear Island, Outer Shallowbag Bay and Kitty Hawk Bay. Bear Island is intended to be dropped next spring due to lack of activity in that area. North River, Ward Creek, Jarrett Bay, Brett Bay, Nelson Bay, Cedar Island Bay, Outer Shallowbag Bay and Kitty Hawk Bay are designated as Special Secondary Nursery Areas and do not open to shrimp and crab trawling except from August 14 through May 14. According to the Shrimp FMP, the Core Sound tributaries do not

[12] Presented to AC on 9/19/11 and 1/10/12; Presented to PDT 9/26/11 and 1/4/12; Reviewed by RAT Subgroup on 9/7/11; Reviewed by RAT on 9/15/11 and 9/28/11; Presented to MRT on 9/28/11 and 1/18/12.

open until mid-October. The banks side of Core Sound is the location in the Trawl Nets Prohibited Area that is the subject of this correction and would not open to trawling if not for the exception for peeler trawling. Peeler trawls are limited to combined headrope lengths of 25 feet and a minimum mesh length of two inches (stretched mesh). According to the peeler crab proclamations, no shrimp can be retained while peeler crab trawling

The early spring peeler crab trawl fishery provides the first peeler crabs of the year for northeast markets and is very lucrative to the participants. An uncorrected rule would only permit peeler trawling in Cape Lookout Bight, which would be devastating to the peeler trawl fishery.

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   - Error perpetuated in the reference to the area which can be opened by proclamation to peeler crab trawling
   - Peeler trawling would be prohibited in Core Sound

2. Modify Rule 15A NCAC 03J .0104 (b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation
   + Unintentional error discovered will be corrected as soon as possible within process
   + Rule will be corrected and allow spring peeler trawling as presently practiced

VIII. RECOMMENDATION

MFC selected management strategy
- Modify Rule 15A NCAC 03J .0104 (b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation.

AC - Modify Rule 15A NCAC 03J .0104 (b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation.

NCDMF - Modify Rule 15A NCAC 03J .0104 (b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation.

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August 17, 2011

Revised September 7, 2011
September 15, 2011
February 27, 2012

11.10 BLUE CRAB SIZE LIMIT AND CULLING TOLERANCE[13]

I. ISSUE

Rule 15A NCAC 03L .0201 SIZE LIMIT AND CULLING TOLERANCE (SECTION .0200 – CRABS) is unclear as worded and the rule intent as it applies to the exemptions to the five-inch minimum size limit, culling tolerance, and separation requirements for soft and peeler crabs and male crabs to be used as bait is not clearly stated.

II. ORIGINATION

North Carolina Division of Marine Fisheries Marine Patrol and Fisheries Management Sections.

III. BACKGROUND

Some DMF staff concluded that the wording of Rule 03L .0201 is somewhat confusing as to intent. Therefore, the rule should be modified to clearly identify exemptions to the size limit, and state the intent of culling tolerance and separation requirements for the various categories of blue crabs.

Mature females are exempt from the five-inch minimum size limit, because some females reach maturity at sizes less than five inches and would be unavailable for harvest, as they will not grow larger subsequent to reaching maturity. Soft and peeler crabs are exempt from the five-inch minimum size limit because they are only in this stage of development for short periods of time and yield a significantly higher price per crab. Male crabs to be used as peeler crab bait from March 1 through October 31 are exempt from the five-inch minimum size limit because these crabs are not harvested for the consumptive market and will likely be released alive after their use to attract female peeler crabs.

Rule 03L .0201 (a) establishes a five-inch minimum size limit for male and immature female blue crabs and specifies exemptions to the size limit for:

(1) mature females,
(2) soft and peeler crabs, and
(3) from March 1 through October 31 male crabs to be used as peeler bait.

There is a culling tolerance of not more than 10 percent by number in any container which is based on all crabs in a container, regardless of category. However, due to the size limit exemptions, only those male and immature female blue crabs less than five inches are counted when calculating adherence to the 10 percent by number culling tolerance.

Part (b) of Rule 03L .0201 specifies the separation requirements for possession of peeler crabs. Based on recommendations from the 2004 amendment to the Blue Crab Fishery Management Plan, part (b) of the rule was previously modified to establish separation requirements and a

[13] Presented to AC on 4/4/11 and 1/10/12; Presented to PDT on 3/24/11 and 1/4/12; Reviewed by RAT Subgroup 5/19/11; Reviewed by RAT 4/7/11 and 6/2/11; Presented to MRT on 9/28/11 and 1/18/12.

culling tolerance for white-line peelers. However, the rule does not identify similar separation requirements for two other categories of crabs that are exempt from the five-inch size limit (i.e., soft crabs, and from March 1 through October 31 male crabs to be used as peeler bait). Further separation requirements, for soft crabs and from March 1 through October 31 male crabs to be used as peeler bait, are needed to aid in enforcement of the size limit and exemptions.

IV. AUTHORITY

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION – POWERS AND DUTIES

15A NCAC 03L .0201 SIZE LIMIT AND CULLING TOLERANCE

V. DISCUSSION

The following points discuss and outline the need for proposed changes to the rule.

1. Clarify 15A NCAC 03L .0201 (a) by specifically listing those categories of crabs that are subject to and exempt from the size limit and culling tolerance per container.
2. In 15A NCAC 03L .0201 (a), clarify that the “culling tolerance of not more than 10 percent by number in any container” applies to all crabs in the container. By only placing the “culling tolerance” language at the end of the current rule, some have interpreted the rule as implying that there is also a “10 percent by number in any container” tolerance for “mature females, soft and peeler crabs and from March 1 through October 31, and male crabs to be used as peeler bait”. Applying a “10 percent by number” “culling tolerance” to “mature females, soft and peeler crabs and from March 1 through October 31, and male crabs to be used as peeler bait” in the container is not the intent of the rule.
3. Clarify in 15A NCAC 03L .0201 (b) that “from March 1 through October 31” “male crabs to be used as peeler bait” are exempt from the five-inch minimum size limit. The current rule [in (a), see below] contains an “and” preceding “male crabs to be used as peeler bait”. The insertion of “and” seems unnecessary and sets this portion of the rule apart from the phrase “and from March 1 through October 31”, which sets the period for “male crabs to be used as peeler bait”.
4. In 15A NCAC 03L .0201 (b), further clarify separation requirements for soft and peeler crabs, “and from March 1 through October 31” “male crabs to be used as peeler bait”.

In the proposed rule below with underlined insertions and strike-through modifications, we have attempted to clarify the intent of the rule as it applies to those categories of crabs that are subject to and exempt from the size limit, culling tolerance, and separation requirements for soft and peeler crabs, and male crabs to be used as peeler crab bait.

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo

+ No rules change
- Intent of the rule is not clearly stated; and therefore, difficult to understand and enforce
- Maintain an unclear rule that is subject to a wide range of interpretations
- Continued burden on the public to decipher and comply with the rule
- Continued burden on law enforcement to explain the rule and enforce intent of the rule

2. Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs
   + Intent of the rule is clearly stated
   + Clarified rule would make it easier for the public to understand rule exemptions, culling tolerance, and separation requirements
   + Make rule easier to explain and enforce (reduce gray areas of rule)
   - Requires rule change

VIII. RECOMMENDATION

MFC selected management strategy
- Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs.

AC - Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs.

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NCDMF - Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs.

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March 1, 2011

Revised: March 8, 2011
April 7, 2011
May 19, 2011
June 3, 2011
February 27, 2012

11.11 ALLOW FLOATING CRAB POT LINES IN AREAS WHERE OBSTRUCTIONS EXIST[14]

I. ISSUE

Consider allowing buoyant line, or line that floats to connect a crab pot to the buoy as long as line is not floating on the surface.

II. ORIGINATION

[14] Presented to the PDT on 4/19/11 and 1/4/12; Presented to the AC on 5/2/11 and 1/10/12; Presented to MRT on 9/28/11 and 1/18/12.

Blue crab and stone crab pot fishermen who fish around submerged obstructions.

III. BACKGROUND

There have been several requests from blue crab and stone crab fishermen who fish around jetties and other submerged obstructions as well as in areas of strong tidal flow to be able to use a type of line that is buoyant or to use portions of floating line from the pot buoy to the crab pot so that it does not get entangled, resulting in lost pots. An example of an area where this is a problem is the Radio Island jetty near Beaufort Inlet. This area has ideal habitat for stone crabs and floating line at least near the bottom would stay up in the water column and not be entangled as easily among the rocks of the jetty by the strong tidal flow. Another situation where non-floating line has been reported to be a problem is pots that are set among stumps.

IV. AUTHORITY

G.S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

15A NCAC 03J .0301 POTS

V. DISCUSSION

The current requirement for crab pot line is in Rule 15A NCAC 03J .0301 (k). It states that “it is unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating.” This rule was implemented from the Blue Crab Fishery Management Plan Amendment 1 in an attempt to reduce interaction between boaters and crab pot buoy lines floating on the surface. Lines were being cut by propellers resulting in ghost pots and damaging propellers and shafts. The rule for non-floating line appears to have reduced interactions between boaters and pot buoy lines and therefore, pot loss.

Several possible solutions to the problem have been employed successfully. One method is to secure a cork or float on the non-floating line several feet up from the pot on the non-floating line. This method helps to keep the line from being snagged on the pot or other obstructions and tangling around them. The distance would depend on the depth of the water and the height of the obstruction to be avoided. Another solution would be to attach weights to the upper portion of a floating line so that the line is not visible near the surface, but it is buoyant near the bottom. A third option may be to use floating line near the bottom (again depending on water depth and height of the obstruction) and non-floating line near the surface so the floating portion of the line will not be cut by passing boats.

All of these methods of ensuring that the crab pot line hangs vertically from the pot for enough distance that it does not pose a navigational hazard for boaters, while allowing the lower section of line to be less restricted to avoid obstructions seem to follow the intent of the rule if the line is non-floating near the water’s surface. The need for pot lines to be floating near the bottom seems to be restricted to areas around inlets or in rivers with strong tidal flow and areas of rough bottom around stumps and jetties. The existing rule has worked since 2005 and there have only been a few complaints by fishermen in these areas. Drafting a rule describing each acceptable method of modifying lines to be legal or exempting certain methods or areas from the non-floating line rule would be a difficult and never-ending task.

VI. PROPOSED RULE(S)

No rule changes are proposed.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   + No rules change
   + Current benefits of rule in reducing conflict between potters and boaters are preserved
   - Individual “legal” methods of weighting or buoying line are not spelled out, nor are areas delineated where “floating line” could be used
   - Marine Patrol is left to interpret non-floating line as different methods to reduce line entanglement crop up

2. Modify rule to describe specific configurations of line deemed within the “non-floating line” interpretation
   + Public and Marine Patrol officers will know exactly what line configurations are allowed and ambiguity is eliminated
   - Impossible to codify all configurations; there may be other possibilities not in rule
   - Much effort expended for a very few situations
   - Requires rule change

3. Modify rules to delineate areas in which floating lines could be used
   + Public will know exactly where they are exempt from the non-floating line rule
   - Difficult to identify all areas where this exemption may be useful; always be another area to include
   - Much effort expended for a very few situations
   - Requires rule change

4. Modify rule to replace non-floating language with line that “does not float at the surface”
   + May make the rule’s intention more clear to the public and NCDMF staff
   + Mirrors language used by NMFS for pots in the Atlantic Ocean
   - Present rule working now with few exceptions
   - Acceptable solutions available within present rule
   - Requires rule change that may still present problems of interpretation

VIII. RECOMMENDATION

MFC selected management strategy
- Status quo, continue with non-floating line on crab pots.

AC - Status quo, continue with non-floating line on crab pots.

NCDMF - Status quo, continue with non-floating line on crab pots.

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April 19, 2011

Revised: February 27, 2012

11.12 DIAMONDBACK TERRAPIN INTERACTIONS WITH THE BLUE CRAB POT FISHERY[15]

I. ISSUE

Diamondback terrapins are currently classified by the state as a "Species of Concern" due to low population levels in some areas, and their capture and mortality in crab pots is a concern.

II. ORIGINATION

Blue Crab Plan Development Team.

III. BACKGROUND

Ranging from Cape Cod to Texas, the diamondback terrapin, *Malaclemys terrapin*, is the only turtle in North America that lives mainly in salt marshes, estuaries, and tidal creeks. Diamondback terrapins are found throughout North Carolina's high salinity coastal marshes. However, all coastal areas do not contain suitable terrapin habitat as outlined by Palmer and Cordes (1988). Preferred habitats are the waters immediately adjacent to the marsh, small creeks, and mosquito control ditches. In a South Carolina study (Bishop 1983), terrapins were captured in salinities ranging from 4.3 to 22 parts per thousand (ppt), with most captures in 10.1 to 15 ppt. Terrapins are highly mobile, moving between water of different salinities in order to feed, mate, and brumate (brumation is a reptilian state analogous to hibernation). The pattern of these movements differs between age and gender classes of terrapins.

Terrapins are a long-lived species, probably surviving in excess of forty years. Females mature in 7 to 9 years (varies with latitude), and fecundity is relatively low (Hildebrand 1932). During the spring mating period numerous males are attracted to females. Male terrapins first reproduce after their fourth year and do not grow as large (shell depth and length) as females, and may remain vulnerable to pot entrapment throughout their life. However, small terrapins of either sex are vulnerable to capture. Female terrapins become too large to enter crab pots by the time they reach age eight (Roosenburg 1997). An unpublished tall pot gear study in the Masonboro Island area of southeastern North Carolina (Southwood Williard and Alford 2010) found the sex ratio of captured terrapins was 2.86:1 males to female (20 males and 7 females). The average carapace height for the captured females was 5.7 cm and for the males, 5.1 cm. With this long life span, delayed sexual maturity, low reproductive rates, and strong site fidelity, the elimination of just a few individuals over several years can result in substantial population declines or even local extirpations (Seigel and Gibbons 1995; Dorcas et al. 2007).

Diamondback terrapins are listed by the WRC as a North Carolina species of "Special Concern" statewide and as a Federal Species of Concern in Dare, Pamlico and Carteret counties in NC. The status of "Special Concern" or species of concern does not provide any special protection

[15] Presented to AC on 6/13/11 and 1/10/12; Presented to PDT on 7/19/11 and 1/4/12; Reviewed by RAT Subgroup7/22/11 and 9/7/11; Reviewed by RAT 7/28/11 and 9/15/11; Presented to MRT on 9/28/11 and 1/18/12.

under the federal Endangered Species Act. The status may be upgraded to “Threatened” or deleted from the list as more information is collected on the species. An issue paper on protected species, which included discussion of diamondback terrapins, was included in the 1998 Blue Crab FMP and 2004 amendment due to concerns that the nearshore blue crab pot fishery may be a major source of mortality during certain time periods in some areas. In February 2011, the WRC Nongame Wildlife Advisory Committee received a report from the Scientific Council on Amphibians and Reptiles (a group of scientists identified and assembled by the WRC North Carolina Nongame Wildlife Advisory Committee to review the scientific evidence and to evaluate the status of wildlife species that are candidates for inclusion on a protected animal list). The Scientific Council recommended that the diamondback terrapin be listed as “Threatened” (Dorcas et al. 2011). This report cited various studies concluding that incidental bycatch, particularly in crab pots, is considered to be the most serious threat to terrapins in North Carolina and elsewhere (Seigel and Gibbons 1995; Roosenburg et al.1997; Butler et al. 2006; Dorcus et al. 2007).

The North Carolina Diamondback Terrapin Conservation Network is an informal assemblage of individuals, organizations, and agencies concerned about the well-being of terrapin populations in North Carolina. This network, an unofficial working group, formed as a result of two meetings held early in 2008: The Southeast Regional Diamondback Terrapin Workshop (Charleston, SC; 27 February) and North Carolina Partners in Amphibian and Reptile Conservation (NCPARC) (Salter Path, NC; 6-7 March). Individuals attending these two meetings concluded that awareness and coordination of research, conservation, management, and educational efforts would elevate terrapin conservation efforts within the state. Continued education and coordination of research on diamondback terrapins in North Carolina are recommended to accurately determine the health of the terrapin population in coastal waters.

The NCPARC has submitted two recommendations to NCDMF (Attachment A). The first recommendation is to require an appropriately sized (5.0 cm, 2 inch) Bycatch Reduction Device (BRD) on recreational pots, and the second is to allow any pot left in the water during the winter clean-up period, to be removed by permitted volunteers. The second issue has been addressed by the North Carolina Legislature through General Statute 113-268, which states that only the owner of that gear may fish his pots, or handle them, which would eliminate the possibility of volunteers removing or handling pots which are marked with an owners required identification. Marine Patrol has identified ghost pots as those with no buoy or identifying tag attached to the pot; therefore, any person can collect and possess ghost pots at any time.

In the 2004 Amendment 1 of the Blue Crab FMP, the MFC recommended no comprehensive terrapin exclusion or avoidance measures due to the lack of a quantified spatial problem assessment and the lack of a terrapin exclusion device for crab pots that would reduce terrapin bycatch while maintaining crab catch. Their selected management strategies included: 1) further research before issuing any new regulations to minimize diamondback terrapin bycatch; 2) the goals and objective for the conservation of terrapins need to be more clearly defined; and 3) further education is necessary to eliminate diamondback terrapin bycatch in crab pots (NCDMF 2004). Since that time, various research projects have been completed through the North Carolina Blue Crab and Shellfish Research Program administered by North Carolina Sea Grant. Findings of this research pertinent to the conservation of the diamondback terrapin and the importance of the state’s blue crab fishery is presented below. Recommendations of PARC and the Scientific Council’s recommendation to WRC to upgrade the status of the diamondback terrapin to “Threatened”, warrant a serious re-evaluation of crab pot terrapin bycatch and consideration of regulations to reduce it.

IV. AUTHORITY

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 113-221.1	PROCLAMATION; EMERGENCY REVIEW
G.S. 143B-289.52	MARINE FISHERIES COMMISSION – POWERS AND DUTIES

15A NCAC 03J .0301 POTS
15A NCAC 03J .0302 RECREATIONAL USE OF POTS
15A NCAC 03L .0204 CRAB POTS

V. DISCUSSION

Diamondback Terrapin and Crab Pot Gear Distributions

The likelihood of fisheries interactions with endangered or threatened species will vary depending on where fishing is taking place and the abundance of protected species in the same locale. Terrapins are bycatch in the blue crab pot fishery. Bycatch is defined as "the portion of a catch taken incidentally to the targeted catch because of non-selectivity of the fishing gear to either species or size differences". Blue crabs and diamondback terrapins are both found in most of North Carolina's coastal estuarine habitats. Both of these aquatic predators are attracted to baited crab pots and because terrapins are air-breathing reptiles, they sometimes drown when trapped in a crab pot. Crowder et al. (2000) noted that terrapins can hold their breath for a maximum of 5 hours, and during the summer only 45 minutes. Most terrapins are captured in pots fished near shore in shallow water (12-feet or less). Southwood et al. (2009) used radiotelemetry and remote monitoring to investigate seasonal variation in habitat use and activity patterns of diamondback terrapins within the lower Cape Fear River and the Intracoastal Waterway in New Hanover County, North Carolina. These waters serve as important habitat for both terrapin and blue crabs and incidental capture and mortality of terrapins in crab pots have been documented in these regions. Results indicated that potential for overlap appeared to be site-specific in shallow waters near shore during the spring and summer.

Various data sources show that diamondback terrapins inhabit most of the state, with areas of higher occurrences along the Pamlico Sound shoreline of Ocracoke and Hatteras islands, lower Cape Fear River, and Masonboro Sound. Other areas have no reports of terrapins, for example, the New River area.

In September of 2010, Southwood Williard and Harden received a "minigrant" from the North Carolina Sea Grant Blue Crab and Shellfish Research Program, and employed a postcard survey to investigate potential interactions between blue crab fisheries and diamondback terrapins in North Carolina (Southwood Williard and Harden 2010). With assistance from NCDMF to obtain the crabbing universe from 10 coastal counties, the survey was sent out to 696 crabbers soliciting basic information on fishing effort and the potential for overlap between productive fishing grounds and critical terrapin habitat within those counties. Preliminary unpublished data show that out of the 74 postcards (10.6%) returned, 18 crabbers have seen terrapins in their potting areas in 7 of the 10 counties (Figure 11.12.1). Of the 18 crabbers that saw terrapins, 56% were from Beaufort, Dare or Hyde counties. These northern crab fishermen averaged 300 hard crab pots per operation in the spring, 422 in the summer, 416 in the fall, and 200 in the winter months. They set out an average of 212 peeler pots in the spring and summer months.

Grant (1997) fished Stump Sound placing 823 pots within 50 m of shoreline, with the majority placed along the edges of the Intracoastal Waterway (ICW), frequently within 20 m of shore. No terrapins were caught along the ICW from the Pender/Onslow County line to the New River.

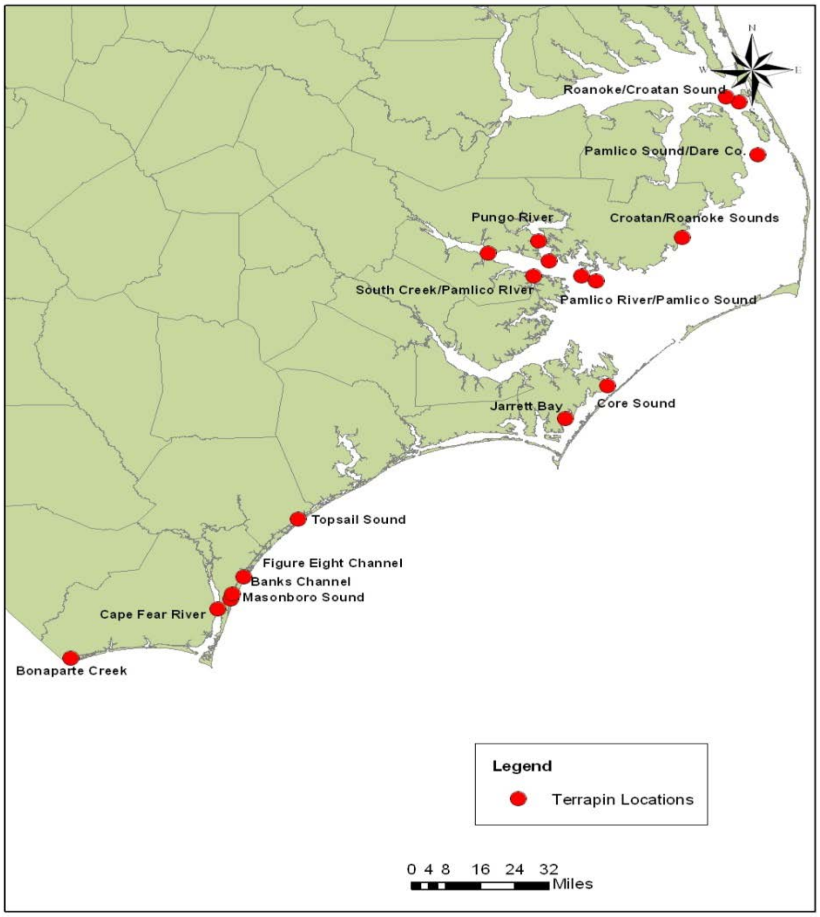

Figure 11.12.1 Diamondback terrapin locations based on Southwood Williard and Harden's (2010) postcard survey returns. Eighteen of 74 respondents had seen terrapins in these pot fishing locations.

Several sampling programs conducted by the NCDMF encounter diamondback terrapins. These programs, a trawl survey (Program 120), a gill net observer program (Program 466), and an independent gill net study (IGNS)(Program 915), are all conducted in brackish marsh areas that are potentially suitable terrapin habitat. Figure 11.12.2 depicts locations of diamondback terrapins from NCDMF sampling from 1990 through 2010. The trawl survey is conducted in May and June and captured 22 terrapins from 1990 to 2010. The observer program recorded 102 terrapins from 2001 to 2010. The IGNS captured 89 terrapins from 2001 to 2010. These three programs combined yielded 213 terrapin captures. The majority of the terrapins (180) were captured in the Pamlico region where most of the sampling is conducted and 33 terrapins were captured from the southern region in Core Sound and south (Table 11.12.1; Figure 11.12.2). The release condition of the diamondback terrapins are sometimes recorded in the two sampling programs (Programs 466 and 915) and from 2001 to 2010 it was estimated that 94% of terrapins were released alive when condition was recorded (Table 11.12.2). The gill net data from the southern district shows many terrapins are caught in the lower Cape Fear River, but few in the New River. The stations for this program in the New River were located in areas up river, away from the brackish tidal marsh areas generally known for terrapin habitat. Distribution patterns may be influenced by sampling protocols. Additional sampling is necessary to identify the full extent of terrapin populations throughout the coast.

Table 11.12.1 Number of diamondback terrapins captured in NCDMF long-term sampling programs from 1990 to 2010.

Season	Pamlico	Southern	Total
Jan-Apr*	34	7	41
May-Aug	85	24	109
Sep-Dec	61	2	63
Total	180	33	213

*No diamondback interactions occurred in January or February. Only limited sampling occurs in these months.

Table 11.12.2 Condition (alive or dead) of diamondback terrapins captured in NCDMF long-term sampling programs from 1990 to 2010.

	Alive (Number)		Dead (Number)		Missing information		Percent	Percent
Season/Region	Pamlico	Southern	Pamlico	Southern	(Number)	Total	alive to known condition total	dead to known condition total
Jan-Apr*	34	5	0	0	2	41	26	0
May-Aug	38	14	5	0	52	109	34	3
Sep-Dec	49	2	5	0	7	63	34	3
Total	121	21	10	0	61	213	94	6

*No diamondback interactions occurred in January or February. Only limited sampling occurs in these months

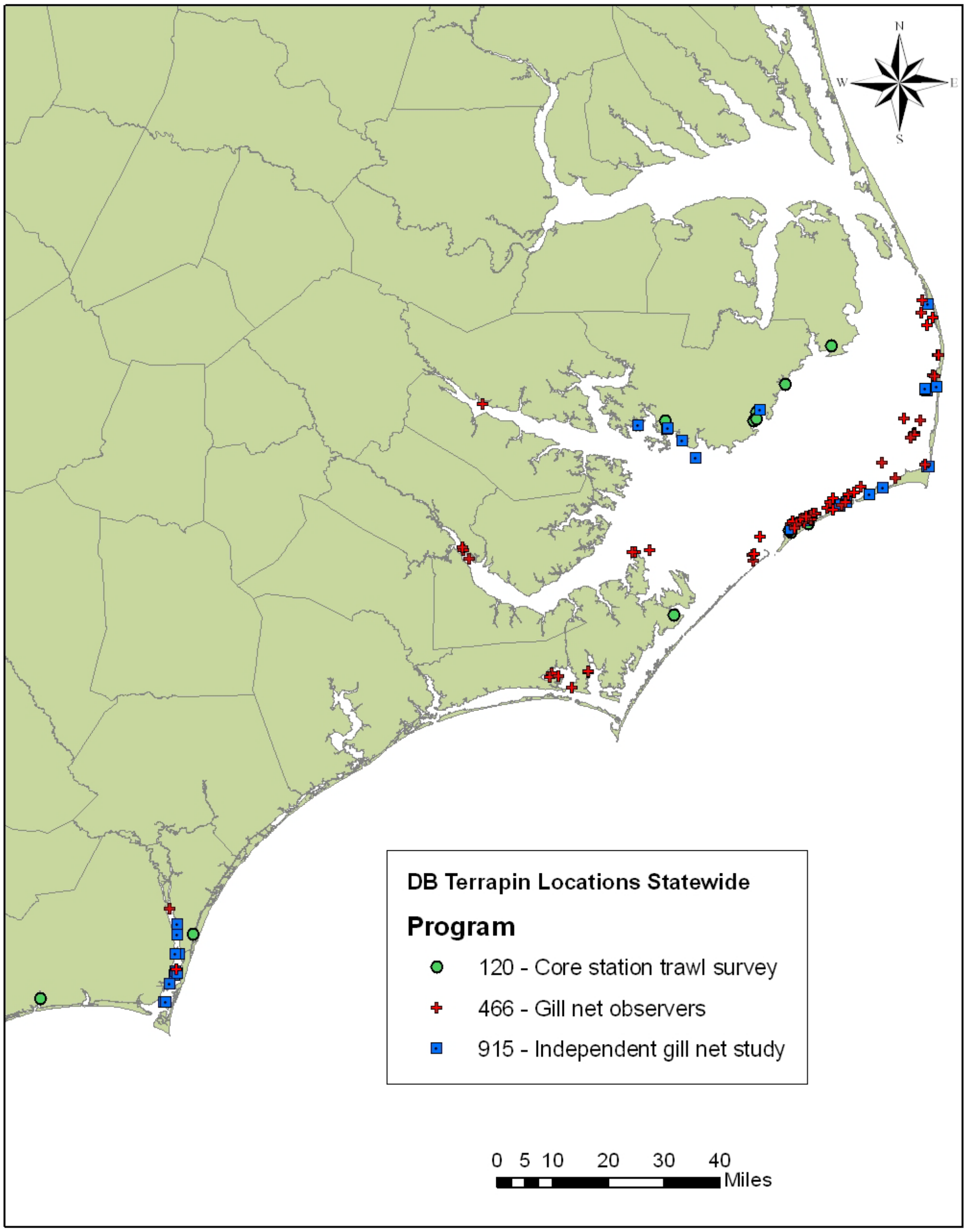

Figure 11.12.2 Diamondback terrapin locations based NCDMF long-term sampling programs, 1990-2010.

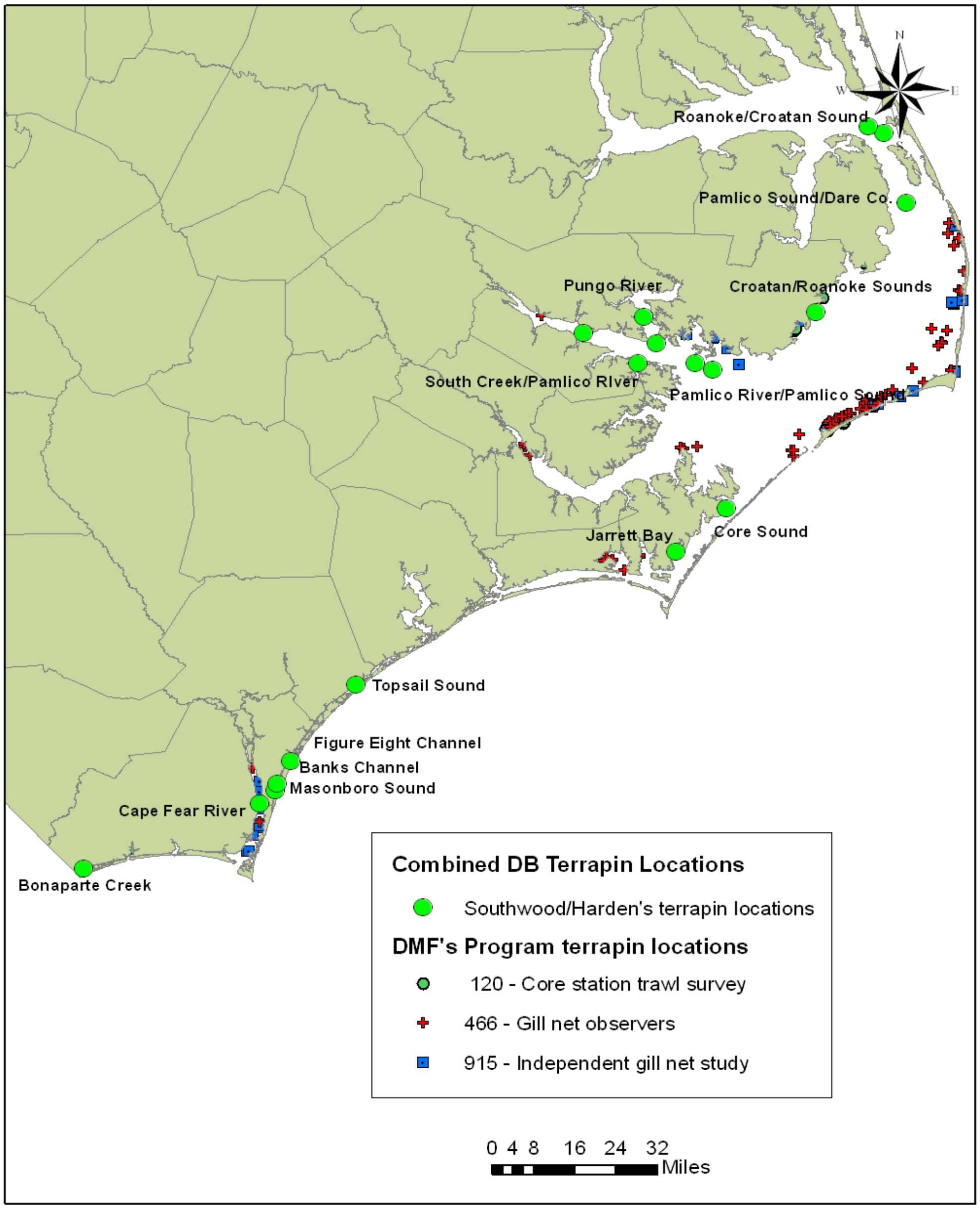

Figure 11.12.3 Combined Diamondback terrapin locations showing geographical use of habitat throughout the entire state, 1990-2010.based on information from Southwood Williard and Harden's (2010) postcard survey and NCDMF's survey data. (Combination of Figures 11.12.1 and 11.12.2).

Crab pots are one of the most widely distributed fishing gears, occurring throughout all coastal and joint fishing waters. Crab pots are not allowed in inland waters except for two recreational pots allowed from shore. To harvest blue crabs recreationally in joint and coastal waters with commercial gear an individual is required to purchase a Recreational Commercial Gear License (RCGL) that allows the use of 5 or less crab pots. The use of collapsible crab traps or dip nets to harvest crabs are exempt from this license, as well as one pot per person in coastal waters may be attached to the shore along privately owned land or to a privately owned pier without possessing a valid RCGL. From a NCDMF survey of RCGL holders, the peak months for RCGL blue crab harvest were June (18%), July (21%), August (17%), and September (14%). RCGL holders using crab pots used an average of 4 pots per license. From 2002-2008 RCGL holders statewide annually averaged 6,944 license holders and averaged 20,353 crab pot trips. The highest number of active crab pot RCGL participants normally occurs in July and has ranged from 726 to 1,056 individuals from 2002-2008. The average distribution RCGL of trips by region was northern 24% (4,793), Pamlico 30% (6,029), central 24% (4,797) and southern 22% (4,378) (note an average of 356 trips were of unknown region).

During 2002, a survey of North Carolina coastal property owners was conducted to determine blue crab harvest and effort (Vogelsong et al. 2003). The survey indicated that a significant portion (41%) of the coastal properties did not have a pier or dock; and interestingly, approximately one third (32.3%) responded that they did not know if the waters adjacent to their property was good for crabbing. Only thirty percent (29.8%) of the respondents crabbed from their property, and the vast majority (75.5%) used crab pots. Vogelsong et al. 2003 estimated that 5,491 of the 18,426 coastal land owners harvested 279,434 pounds of blue crab.

In the northern and central sections of the state from Albemarle Sound south to Highway 58, Emerald Isle bridge in Bogue Sound, pot placement is restricted to designated pot areas as described in Rule 15A NCAC 03R.0107 during the timeframe of June 1 – November 30. A proclamation comes out each year to cover the remaining water bodies south of the highway 58 bridge in Bogue Sound to the South Carolina line (Proclamation PT-3-2011). This area turns out to be approximately 204,280 acres, statewide. The designated pot areas in the Neuse, Pamlico, Pungo, and Bay rivers and their tributaries run along a 6 foot contour to avoid user conflict among trawlers, potters and other boaters. By default the shallow waters less than 6 feet tend to be considered terrapin habitat. The management intent was to reduce the gear conflict and provide areas where all users could co-exist. In doing so, this may also be forcing more pots into more compact, shallower areas where interactions with terrapins increase.

A single pot may entrap dozens of terrapins in just a few days, particularly during the spring mating period, when numerous males are attracted to females. In addition, abandoned or "ghost" pots continue to catch and kill terrapins and other marine life for months. Since 2003, NCDMF law enforcement has conducted an annual crab pot "clean-up" (removal) during the January 15th through February 7th time period when commercial crab pot fishermen are required to remove all pots from the water. An average of ~2500 abandoned/ghost pots per year has been collected by Marine Patrol officers during this clean-up period.

Distance of Crab Pots from Shore and Terrapin Bycatch

Diamondback terrapins typically spend most of their lives in shallow water adjacent to tidal wetlands, so during the summer, only a small portion of the crab fishery spatially intersects with turtle habitat (Roosenburg 2004). The water depths in these areas generally range from $\leq$ 1 foot to 6 feet. These waters can be narrow or wide, depending on the location along the coast. Grant (1997) showed a significant reduction in terrapin captures as distance from shore increased. The majority of the terrapins (84.5%) were captured less than 25 m from shore and 15.5% were taken between 26 and 50 m offshore. No terrapins were captured in pots more than 50 m from shore. He noted that few commercial crab pots are fished near-shore where most terrapins occur. Generally the water is too shallow near-shore for commercial crabbing operations, except in the deeper tidal creeks and along the Intracoastal Waterway (ICW). Most of the near-shore pots observed by Grant (1997) were along the edges of the ICW and within 20 m of shore. No diamondback terrapins were observed in the surveyed area of the ICW, Stump Sound, NC. Crabbing areas are very limited in the southern area and potters do sometimes fish in terrapin habitat. However, most commercial crab potters in the southern area of North Carolina indicate that they have knowledge of these prime terrapin habitat locations and try to avoid them. In a Jarrett Bay, NC study, all terrapin captures occurred from April to mid May within 321.4 m of the shoreline (Hart and Crowder 2011). Mean distance to shore for hard crab and peeler pots was 208.8 m and 121.7 m, respectively.

In the study on a shallow tidal marsh creek in Virginia, Morris et al. (2010) recognized several different reasons commercial pots would be utilized in shallow water habitat. First, commercial hard crab pot lines are often set along the mainstem of the tidal creeks. Second, peeler pots baited with jimmy crabs are utilized in this protected habitat of small tidal creeks where peelers concentrate. Third, many recreational crabbers place one or two commercial-type pots in these shallow tidal waters near their waterfront property homes or off piers. Finally, deep-water pots that have been abandoned or their buoys have been cut by props may be carried by storms or currents into shallow water habitat (Morris et al. 2010). Though not baited, these "ghost pots" continue to be a major cause of bycatch mortality (Morris et al. 2010; Chambers, VIMS personal communication). Like Virginia, North Carolina has similar shallow water tidal creeks and concentrated crabbing activities, particularly in the central and southern areas that overlap prime terrapin habitat and cause similar bycatch mortality. In a NCDMF Mock Ghost Pot Study conducted from 2002- 06, 28 pots were fished weekly in the Figure Eight Island area, a known terrapin habitat. Pots were fished from a minimum of 25 feet (7.6 m) to a maximum of 120 feet (36.6 m). From personal observations, the majority of terrapins were captured in the pots set closest to the shoreline. When set out in the middle of the bay area approximately 120 feet from shore, no terrapins were captured. In a study of bycatch potential, discard mortality, and condition of fish and terrapins associated with the spring commercial blue crab pot fishery, Thorpe et al. (2005) notes that in Carteret County, all pots were set greater than 91 m from shore and no terrapins were caught. In Brunswick County, all pots were set within 4.5 m to 91 m from shore and resulted in 9 terrapins caught. All nine terrapins were caught in pots that were set less than or equal to 12.2 m from shore. Also recreational pots were observed tied to piers, set close to shore in creeks, or set in the ICW (Teresa Thorpe, personal communication, 2011). Because the majority of recreational crabbers set their pots in shallow waters near shore or off private docks, these pots have the highest potential for terrapin captures. Also many waterfront community properties are rental or weekend retreats and pots deployed may be left unattended for extended periods; thereby, increasing the potential for terrapin bycatch mortality. The recreational crab pot fishery may provide an opportunity to utilize excluders in a portion of the fishery that is potentially the least monitored by the pot owner.

Seasonality of Crab Pot Terrapin Bycatch

Crab pot catch of terrapins was distinctly seasonal in South Carolina, with the majority of captures occurring during April and May (Bishop 1983). Fifty-five percent of the terrapins caught in this study occurred in April, while 32% were caught in May. The elevated catches in April and May were probably associated with post hibernation feeding and reproductive activity (Bishop 1983). Pots may be concentrated in shallow nearshore waters, near terrapin habitat, during the spring to catch peeler crabs. Peeler season spikes in early May and continues to decline during the following summer months. Peeler pots in these areas seem to decline during June through August. Hart and Crowder (2011) recorded that all 21 terrapin captures occurred from April to mid-May.

Of the recorded 213 terrapin interactions in the three NCDMF long-term sampling programs over half (51%) of the terrapins were captured between May and August (Table 1). Thirty percent of the terrapin interactions occurred from September through December and the remainder (19%) were captured from March through April. No diamondback terrapins were caught in January or February in these long-term sampling programs. In Southwood Williard and Alford's (2010) study with the "tall pot" configuration behind Masonboro, NC, sampling occurred from May to late October. During those months, 27 terrapins were captured; May had the highest capture rate with 12 terrapins, followed by June and July with 5 and 4, respectively. There were no takes in August, four in September and two in October. Terrapin mortality is highest in early spring for several reasons: food requirements are greater because of low food reserves from hibernation, several males may be attracted to one female for mating, and impending egg production for mature females. Mating occurs in early spring, and generally, egg laying from May through July.

Bycatch Reduction Factors and Management Considerations

There have been many studies conducted throughout the eastern United States documenting diamondback terrapin bycatch and mortality in crab pots. Many have established catch rates of terrapins captured as bycatch in crab pots and experimented with different size BRDs. Terrapin bycatch in crab pots has been a major concern for the continued survival of the species (Roosenburg et al.1997; Bishop 1983; Hart 2005). The mortality rate for diamondback terrapins caught in crab traps may be 10 - 78% (Roosenburg et al. 1997; Bishop 1983; Hart 2005). Another major threat adding to the decline of terrapin populations include high mortality rates associated with roadkill of female terrapins as they cross coastal marshland highways seeking nesting sites in the spring. Other threats include habitat loss, boat strikes and natural predation by crows, gulls, raccoons, foxes, and other animals on terrapin nests and hatchlings.

Hart and Crowder (2011) conducted terrapin bycatch research in eastern North Carolina (Jarrett Bay) from 2000 to 2004. One drawback to the study is that sampling occurred in only one small area. Their results identified complementary and economically feasible tools for blue crab fishery managers to exclude terrapins from commercially fished crab pots in North Carolina: 1) gear modifications (i.e., BRDs); 2) distance-to-shore restrictions; and 3) seasonal regulations. A combination of these 3 measures could provide a reduction in terrapin bycatch of up to 95% without a significant reduction in target crab catch

Since the first amendment to the FMP in 2004, several studies were conducted in other states and in North Carolina. In most of these studies the same limiting factors appear and confirm the findings of Hart and Crowder (2011). All these studies highlight factors affecting the bycatch of diamondback terrapins in crab pots which are: (1) terrapin morphometrics, (2) the abundance of terrapins, (3) distance of the crab pot from shore, (4) vertical height of the crab pot funnel, and (5) seasonality. Each of these interrelated factors is discussed below.

Terrapin excluder device on a commercial crab pot. (Wetlands Institute 2010)

Exclusion devices or BRDs, which restrict the vertical and horizontal dimensions of crab pot funnels, have been used to reduce or eliminate terrapin bycatch for years. Bycatch reduction devices and the impact on crab pot catch rates have been studied in estuarine systems in New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Mississippi, and Florida. Their general consensus is that crab catch is not dramatically compromised by BRDs (Table 11.12.3). A 90% reduction in terrapin captures and an increase in crab captures were reported by Wood (1995) in New Jersey for pots equipped with 5.0 cm X 10.0 cm (2 inch X 4 inch) excluders (Table 11.12.3). Grant (1997) conducted a study of the impacts of crab pots with and without excluder devices in North Carolina's estuarine waters near Ocracoke, Sneads Ferry, and Wrightsville Beach. He stated that each area contained small populations of terrapins and active commercial crab pot fisheries. The 5.0 cm X 10.0 cm (2 inch X 4 inch) excluder, tested in 1995-96, showed a 75.7% reduction in terrapin bycatch and a 19% reduction in legal-size crabs (Grant 1997). In an effort to further reduce small terrapin bycatch, Grant (1997) tested a more restrictive vertical dimension 4.1 cm X 12.1 cm (1 5/8 inch X 4 3/4 inch) excluder in 1997. The 4.1 cm X 12.1 cm (1 5/8 inch X 4 3/4 inch) excluder eliminated all terrapin bycatch and reduced legal crab harvest by about 29%.

Research by Southwood Williard and Harden (2010) has determined morphometrics of terrapins caught in areas of Bald Head Island, Masonboro Island and Figure Eight Island, NC. This study used seine nets to capture the terrapins which may account for the number of larger sized females. Carapace height for females averaged 5.34 cm at Figure Eight Island, 6.08 cm at Masonboro Island, and 6.40 cm at Bald Head Island. Male terrapins averaged 4.09 cm, 4.01 cm, and 4.43 cm, respectively, at the same locations. Carapace height is important because diamondback terrapins are more restricted from entering crab pots because of BRD height rather than width. Based on these average carapace heights, a BRD height of 4.0 cm (1½ inch) would exclude all the terrapins, both males and females.

From 2000 to 2004, Hart and Crowder (2011) conducted the first study in conjunction with commercial crabbers in North Carolina. They quantified the effect of various BRDs on catch of target male hard crabs and peeler crabs, as well as to characterize the timing, location, and magnitude of terrapin captures in actively fished commercial crab pots. They examined three sizes of excluders 5.0 cm (2 x 6 inch); 4.0 cm (1½ x 6 inch); and 4.5 cm (1¾ x 6 inch) verses control pots without excluders in Jarrett Bay, North Carolina. Hard pots were sampled for 75 total days occurring in May to June of 2000, September to November of 2000, and May to June of 2001. Soak time averaged 1.5 days in summer and 2.6 days in fall. Peeler pots were fished for 19 days from April to May of 2004. The majority of these pots soaked for 1-2 days (17 or 19 days) while the range was from 1 to 5 days. Excluders were tested on the internal end of the entrance funnels of the hard pots, and on the exterior of the entrance funnels on the peeler pots. Two wire ties were also used on the peeler pots across the funnels that measured 7.8 cm (3 inches) apart, vertically arranged. Catch rates for control pots in this study were 0.005 terrapins/hard crab pot/day and 0.02 terrapins/peeler pot/day. All 8 or 100% of the terrapins were caught in hard pots without BRDs. Thirteen total terrapins were captured in peeler pots; 8 were captured in pots without BRDs; 2 in 5.0 cm (2 x 6 inch) BRD pots; 0 in the 4.0 cm (1½ x 6 inch) BRD pots; and 3 in the wire tied BRD pot. Their results generally support those in previously published BRD studies, but whereas their data agreed that most (77%) terrapins captured would have been excluded with the 4.5-cm (1 ¾ inch x 6 inch) BRD, they found a 21.2% decrease in catch of the target legal-sized male blue crabs with the 4.5-cm (1¾ x 6 inch) BRD in the study. In contrast, the 5.0-cm (2 inch x 6 inch) BRD did not have a significant effect on catch of either large male blue crabs or peelers and 28% of the terrapins captured could have been excluded with the 5.0-cm (2 inch x 6 inch) BRD. Even though the reduction in crab catch was not significant, a small decline (5.7%) in hard crab catch may be expected with use of the 5.0-cm (2 inch x 6 inch) BRD during the hard crab season in this particular study site of Jarrett Bay, NC.

This study also evaluated the ability of various BRDs to reduce terrapin bycatch without significantly reducing the catch rate of blue crabs. Longer soak times produced more dead terrapins, with 4 live and 4 dead during hard crab experimental fishing and 11 live and 2 dead during peeler experimental fishing. The 4.0-cm (1 ½ inch x 6 inch) BRDs in fall and 4.5-cm (1¾ x 6 inch) and 5.0-cm (2 inch x 6 inch) BRDs in spring reduced the catch of legal-sized male hard crabs by 26.6%, 21.2%, and 5.7%, respectively. Only the 5.0-cm (2 x 6 inch) BRDs did not significantly affect the catch of legal-sized hard male crabs. However, BRDs had no measurable effect on catch of crabs in the peeler crab fishery.

As an alternative to excluders, a modified crab pot that maintains permanent access to air and prevents the drowning of terrapins has been tested by Roosenburg et al. (1997) in the Chesapeake Bay. The modified crab pot caught more crabs than standard pots. Southwood Williard and Alford (2010) found that modified crab pots similar to Roosenburg's were an effective method to determine potential interactions with blue crab fisheries in the Masonboro Island area of southeastern North Carolina. Roosenburg estimated a terrapin capture rate of 0.17 terrapins/pot/day in the shallow waters of the Chesapeake Bay. Using the same tall pot design, Southwood Williard and Alford (2010) estimated the terrapin capture rate at the backside of Masonboro Island, NC as 0.16 terrapins/pot/day. The average carapace height for the captured females was 5.7 cm and for the males, 5.1 cm. The smaller measurements of the females may reflect the restriction of the larger sized females entering the crab pot funnel of this "tall pot" design. This study provides a baseline on presence and abundance of diamondback terrapins on the backside of Masonboro Island. Southwood Williard and Alford (2010) plan to continue this study with additional pots. Further sampling and a longer term study of this area are needed to assess the health of the population and achieve a less skewed representation of these terrapin.

From the 2010, Southwood Williard and Harden (2010) post card survey study and using the average 300 pots set in the spring each day and applying the catch rate (0.005 for hard pots) that Hart (2005) calculated from her study in Jarrett Bay, NC, a low potential of 1.5 terrapins/300 pot operation/day could be captured from this area. The crabbers from Core Sound to the Brunswick County/South Carolina border are fishing a smaller average numbers of hard crab pots: 146 spring; 158 summer; 138 fall; and 132 winter; and about 75 peeler pots in the spring

Table 11.12.3 Summary of diamondback terrapin studies by state.

Location state of study	Study reference	Capture rates of terrapins	Excluder size	# or % reduction or mortality in terrapin catch	# or % reduction in legal crab catch	Depth	Distance from shore	# or % reduction in terrapin catch	Terrapin sex ratio: ♂ to ♀
New Jersey	Wood, 1997	0.017-0.49	Floats; 4X8						
			4X8brd		decrease size & #				
			4.5 X 8		0 effect on size;↓ in #				
			4.5 X 10		0 effect on size;↓ in #				
			5 X 10	90%	11-49%↑in #				
	Mazarella 1994	w/out BRD = 0.0054; 0.06;	5X10	no effect on size,2.5%					
		with BRD = 0, 0.0049	5X10cm	no effect, 14% increase in					
Delaware	Cole and Helser, 2001		5X10cm	59%	0%				
		recommended for rec pots	4.5X12cm	38%-♂ ; 96%-♀	12%↓				
			3.8X12cm	0 terrapins caught	26% ↓				
Maryland	Roosenburg and Green, 2000	0.17 terrapins/pot/day	4X10	100%					
			4.5X12cm	62%					
			5X10cm	53%					
	Roosenburg et al.,1997								
Virginia	Morris, Wilson, Dever Chambers 2010		12X4.5cm						
	Rook et al,.2010	0.20 t/pot/d w/o BRD; 0.10 t/pot/d w/BRD	4.5X12cm	95.70%		2ft (MLW)			2:1 ♂ to ♀
North Carolina	Southwood Williard and Alford (unpublished)	0.16 terrapins/pot/sampling event	chimney stack pot			< 6 ft.		30 terrapin, of which 3 were recaptures	2.86:1♂ to ♀
	Southwood Williard et.al. 2009								
	Thorpe and Likos, 2008		5X12cm		n=>4,000; 5.7% ↓ reduction				
			5X10cm		18.2% ↓reduction		129.5m avg.		
	Thorpe et al. 2005	16 sets in Carteret Co; 16 sets in Bruns. Co.					**Cart. Co . >300ft; Bruns. Co. 5 - 300 ft.**		
	Hart and Crowder, 2011	0.005 t/p/d- hard pots w/o BRD	4.0X16 cm		26.6% ↓		208.8m hard crab pots		1.3 : 1 ♂ to ♀
		0.02 t/p/d peeler pot w/o BRD	4.5X16 cm	77%	21.2%↓		121.7m peeler pots	100% reduction in catch of terrapin	
			5.0X16cm	28%	5.7% ↓			50% reduction	
	Thorpe, Hooper, and Likos 2005			N=9					
	Grant 1997		5X10 cm	75.70%	19%				1:1.69 ♂ to ♀
			4X12 cm	100%	29%				
South Carolina	Bishop 1983	0.16 terrapins/pot/day							2.3:1, (195♂s/86 ♀s)
	Hoyle and Gibbons 2000	0.027 terrapins/pot/day							
Georgia	Belcher and Sheirling 2007		4.5"X1.75"	significant difference					
			4.5X2	in all comparisons					
			2X6	of all treatments					
Florida	Butler and Heinrich 2007	0.007 - 0.147 terrapins/pot/day	4.5 X 12.0 cm	73.2%; 37 dbt w/o brd; 4 dbt w/ brd					
Louisianna	Guillory and Prejean 1998		5 X 10	none caught	14.5 - 32.9% increase				
Mississippi	Mann 1995	0.163 terrapins/pot/day							
	Cuevas et al. 2000		5 X 10	none caught	0 effect on size or #				

and summer months. Using Southwood Williard and Alford's (2010) catch rate from behind Masonboro Island waters (0.16) and the average of 146 pots set in spring in the southern areas, the potential catch rate goes up to 23.4 terrapin/146 pot operation/day. This data shows that if these pots were not fished or maintained on a regular basis, or did not incorporate some type of excluder device, there is potential for high mortality of diamondback terrapins in areas of high catch rate. Because the Southwood Williard and Alford (2010) research was conducted in an area of known terrapin habitat, with naturally high abundance, therefore the terrapin catch rate per pot is likely high as compared to other areas of coastal NC. In comparison, terrapin catch rates were significantly lower (i.e., 0 – 0.0068 terrapin/pot/day) in a NCDMF Mock Ghost Pot Study where pots were fished weekly during 2002-06 (Table 11.12.4). Two of the four ghost pot study areas (i.e., Bogue Sound and Figure Eight Island) were in similarly suitable terrapin habitat and in close proximity to the areas surveyed by Hart (2005) and Southwood Williard and Alford (2010). When compared, these studies support the contention of Palmer and Cordes (1988) that all coastal areas do not contain suitable terrapin habitat. Thus, terrapin catch rates could be expected to be highly variable even within similar estuarine habitat.

Most research indicates that excluders will reduce terrapin capture. Hart and Crowder (2011) recommend establishing no-fishing zones nearshore for the period with the highest recorded bycatch (i.e., spring) and requiring BRDs on all pots set. However, they do encourage further testing of innovative BRD and crab pot designs, "as neither the ideal crab pot nor the optimal BRD has yet emerged." Alternative pots like the "tall pot" design were also promoted as a conservation tool by Roosenburg et al. (2007): however, their actual use in the commercial fishery would seem unlikely due to their awkward shape and potential cost. Rook et al. (2010), in Virginia, suggest the immediate implementation of BRDs on all recreational blue crab traps throughout US waters and serious consideration of implementation of BRDs in commercial pots deployed in shallow waters (< 2 m water depth). When BRDs were used in shallow water recreational crab traps, crab catch was not affected. Studies in New Jersey, Maryland, and Florida reported similar findings when shallow water commercial potting techniques were employed (Wood 1997; Roosenburg 1997; Butler and Henrich 2007). Rook et al.'s (2010) findings, combined with those of other studies, suggest that shallow water commercial catch will also not be affected (Rook et al. 2010). Conversely, BRDs may not be necessary for crab pots set in deeper waters where terrapins are scarce. Other regulatory recommendations include targeting the terrapin habitat, (i.e., BRDs should be mandated for all pots in areas of potentially high terrapin density) (Randy Chambers, Virginia Institute of Marine Science, personal communication).

Morris et al. (2010) concludes that although the BRD requirement would be difficult to enforce, the potential benefits of reducing terrapin and fish bycatch and reducing the capture of crabs in infrequently checked pots (recreational) make a compelling case to require BRDs on crab pots in terrapin habitat. Thorpe and Likos (2008) conducted a study funded by North Carolina Sea Grant evaluating excluders in the spring commercial blue crab fishery in Brunswick County, North Carolina. Thirty-four sets of pots were used to look at two different size excluders 5 cmX12 cm (2 inch X 4¾ inch) and 5 cmX10 cm (2 inch X 4 inch). In the 5 cm x 12 cm (2 inch X 4¾ inch) BRD, they saw a 5.7% reduction in legal sized blue crab catch, while catching one terrapin. In the 5 cm x 10 cm (2 inch X 4 inch) excluder, a more significant drop in blue crab catch (18.2%) occurred.

Studies such as these and others have served as the scientific basis for legislating proactive management measures to protect and conserve terrapin populations. Currently, the State of New Jersey has implemented the use of 5-cm X 15-cm (2 inch X 6 inch) BRDs in commercial style crab pots fished in waters less than 4 m deep or in any man-made lagoon. Maryland has legislated the use of BRDs on recreationally fished pots. In May 1998, New Jersey modified their rule to allow rectangular and diamond shaped excluder devices no larger than six inches wide and two inches high. Delaware requires BRDs measuring 4.5-cm X 12-cm (1¾ inch x 4¾ inch) for all recreational pots set in Delaware state waters. Commercial pots are only allowed to fish in the Delaware Bay and ocean and not the shallower, tidal creeks and rivers of the shore. Therefore, commercial pots are not required to have BRDs due to the absence of diamondback terrapin in these deeper waters (personal communication, Rick Cole, Delaware DNR).

No standard configuration of BRD has been adopted because of potential morphological variations among terrapin populations in different geographic areas. However, some researchers conclude that the most effective tool for reducing the drowning of terrapins in crab pots is through the implementation of BRDs in the tidal tributaries and lower bays (Cole and Helser 2001).

The possible options discussed in this paper addressed some form of protection for the diamondback terrapin through: 1) the required use of terrapin Bycatch Reduction Devices (BRDs), 2) restricted pot areas based on depth or distance from shore, 3) additional diamondback terrapin awareness and educational programs for the public, or 4) a combination of those listed to reduce diamondback terrapin bycatch and mortality in the North Carolina crab pot fishery, the most effective combination of the following options could be implemented.

Table 11.12.4 Crab pot effort, diamondback terrapin catch, and CPUE per pot day estimates for NCDMF Mock Ghost Pot Study locations, 2002-2006 (pots were fished once per week, CPUE was estimated to pot day).

Location	Gear	Years	Number of terrapins	Number of pot days	Terrapin CPUE/pot day
Alligator River	Mock ghost crab pot	2002-2006	0	13,692	0.00000
Pamlico River	Mock ghost crab pot	2002-2005	1	16,436	0.00006
Hoop Pole Creek off Bogue Sound	Mock ghost crab pot	2002-2004	2	14,196	0.00014
Figure Eight Island Marsh in Middle Sound	Mock ghost crab pot	2002-2005	116	16,989	0.00683

VI. PROPOSED RULE(S)

See Appendix 14.7.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo. Take no regulatory action
   - \+ No additional regulations on fishery
   - \+ No increased costs for crabbers to modify pots
   - \+ No possible reduction in crab catch
   - \- Continued uncontrolled terrapin bycatch and mortality

2. Require terrapin excluders and/or modifications to crab pots (hard and/or peeler) fished within a specified distance of shore during the spring, within specified areas
   - \+ Reduce terrapin bycatch and mortality
   - \- Additional pot regulations on fishery
   - \- Increased costs for crabbers to modify pots
   - \- Potential reduction in crab catch
   - \- Increased enforcement burden

3. Require terrapin excluders in all recreational crab pots, statewide
   - \+ Reduce terrapin bycatch/mortality from recreational crabbers
   - \+ Reduce terrapin bycatch/mortality from recreational pots purchased by vacationers who

inadvertently leave the pots in the water at their weekly departures
- Despite low cost (~$0.50 ea.), the extra expense of the excluder
- Requires a rule change
- Increased enforcement burden

4. Require the use of terrapin excluders on all crab pots (hard and peeler) fished within 6 feet of water depth during April through October
   + Reduce terrapin bycatch/mortality statewide in areas of terrapin habitat and for the time period where terrapins are most active
   + Not all commercial crabbers would be affected, thus no additional cost or hardship on them
   - Does not protect terrapins when in deeper habitats
   - Requires extra cost for purchase of excluders for crabbers that fish shallow areas
   - Requires a rule change
   - May reduce crab catch
   - Increased enforcement burden

5. Close specific areas to pots based on timing of increased interactions with terrapins
   + Reduce terrapin bycatch/mortality statewide in areas of terrapin habitat and for the time period where terrapins are most active
   + Not all commercial crabbers would be affected, thus no additional cost or hardship on them
   + Would not require an excluder device and the added cost
   - Requires a rule change
   - May reduce crab catch
   - Increased enforcement burden
   - Would prohibit crab potting in some areas

6. Require that all commercial pots used in waters less than 150 feet wide at low tide or in any man-made lagoon must be fitted with Bycatch Reduction Devices (BRD) designed to exclude diamondback terrapins. These devices may be either rectangular or diamond shaped and no longer than 6 inches wide or 2 inches high. These devices should be attached across the opening at the narrow end of each funnel entrance
   + Decrease in the number of terrapins captured in pots
   + No decrease in the number of harvestable sized crabs
   - Cost and hardship of requiring excluder
   - Requires rule change
   - Southern and central area waterbodies consist of numerous waterbodies ≤ 150' width.
   - Increased enforcement burden

7. Require the use of terrapin excluders on all crab pots (hard and peeler) in specified areas only
   + Reduce terrapin bycatch/mortality statewide in areas of terrapin habitat and for the time period where terrapins are most active
   + Not all commercial crabbers would be affected, thus no additional cost or hardship on them
   + Terrapins will be protected inside specified areas
   - Does not protect terrapins when in deeper habitats
   - Requires extra cost for purchase of excluders for crabbers
   - Requires a rule change
   - May reduce crab catch

- Increased enforcement burden
- Terrapins will not be protected outside of specified areas

VIII. RECOMMENDATIONS

MFC selected management strategy

- Establish:
  1. Proclamation authority for requiring terrapin excluder devices in crab pots; and
  2. A framework for developing proclamation use criteria and terrapin excluder specifications which may extend until after adoption of the amendment.
- The recommendation is contingent on:
  a. Consultation with the Crustacean AC on developing criteria; and
  b. No use of the proclamation authority until criteria are approved by the MFC.

AC - Establish:
  1. Proclamation authority for requiring terrapin excluder devices in crab pots; and
  2. A framework for developing proclamation use criteria and terrapin excluder specifications which may extend until after adoption of the amendment.
- The recommendation is contingent on:
  a. Consultation with the Crustacean AC on developing criteria;
  b. No use of the proclamation authority until criteria are approved by the MFC; and
  c. A terrapin excluder device of 2-inches by 6-inches located in all lower entrance tunnels to allow blue crab catch.

NCDMF- Establish:
  1. Proclamation authority for requiring terrapin excluder devices in crab pots; and
  2. A framework for developing proclamation use criteria and terrapin excluder specifications which may extend until after adoption of the amendment.
- The recommendation is contingent on:
  a. Consultation with the Crustacean AC on developing criteria; and
  b. No use of the proclamation authority until criteria are approved by the MFC.

Research Recommendations

- Expand research state wide on the use of terrapin excluder devices in crab pots
- Implement outreach programs to inform state agencies, the public, and the commercial and recreational fishing industries about issues relating to protected species and fishery management
- Continue gear development research to minimize species interactions

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August 2, 2011
September 7, 2011
September 15, 2011
February 27, 2012

ATTACHMENT A. North Carolina Partners in Amphibian and Reptile Conservation (NC PARC) Resolution Pertaining to the Use of By-Catch Reduction Devices (BRDs) and other Diamondback Terrapin Conservation Measures in the Blue Crab Fishery of North Carolina. Submitted to NCDMF by NCPARC on January 14, 2011, based on Resolution drafted at NCPARC meeting on December 2, 2011

Whereas, diamondback terrapins are a North Carolina species of Special Concern (SC) and Federal Species of Concern (FSC) whose populations are known to be in decline (Crowder et al. 2000, 2004 NC BCFMP, Section 10.3.5); and

Whereas, diamondback terrapins face multiple human-generated threats including blue crab fishery by-catch (Grosse et al. 2009), road mortality (Szerlag and McRobert 2006), and egg and nestling depredation by “human-subsidized” predators (predators with high populations due to the exploitation of human waste such as raccoons, foxes, and feral cats) (Seigel 1980); and

Whereas, by-catch reduction devices do not appreciably reduce legal crab catch (Wood 1995, Roosenberg and Greene 2000, Crowder et al. 2000, Cahoon and Hart 2003, Butler and Heinrich 2007; 5.0 cm, Hart and Crowder, *in press*); and

Whereas, derelict crab traps capture and kill many individuals and species, including diamondback terrapins (Guillory 1998, NC DENR DMF Final Report March 2008; Grosse et al. 2009); now, therefore, be it

Resolved, that NC Marine Fisheries is advised to regulate recreational crab pots, regardless of Recreational Commercial Gear License, by the requirement of appropriately sized (5.0 cm, Hart and Crowder *in press*) and attached by-catch reduction devices (BRD) for the purpose of protecting the diamondback terrapin; and, be it further

Resolved, that NC Marine Fisheries, during winter closure of the Blue Crab season, is advised to allow any pot left in the water to be removed by permitted volunteers.

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11.13 MULTIPLE POTS ATTACHED TO A SINGLE BUOY[16]

I. ISSUE

The use of multiple pots on a line in the commercial blue crab fishery.

II. ORIGINATION

Marine Fisheries Commission (MFC)

III. BACKGROUND

During the February 2006 MFC meeting, Commissioner David Beresoff requested that the Crustacean Committee look into the issue of allowing multiple crab pots attached to a single buoy in the Atlantic Ocean as a way to reduce marine mammal interactions (Figure 11.13.1). Current MFC rule 15A NCAC 03J .0301 (c) makes it unlawful to use pots in a commercial

[16] Presented to AC 6/13/11 and 1/10/12; Presented to PDT 7/19/11 and 1/4/12; Reviewed by RAT Subgroup 6/21/11, 7/22/11, and 9/7/11; Reviewed by RAT 7/28/11 and 9/15/11: Presented to MRT on 9/28/11 and 1/18/12.

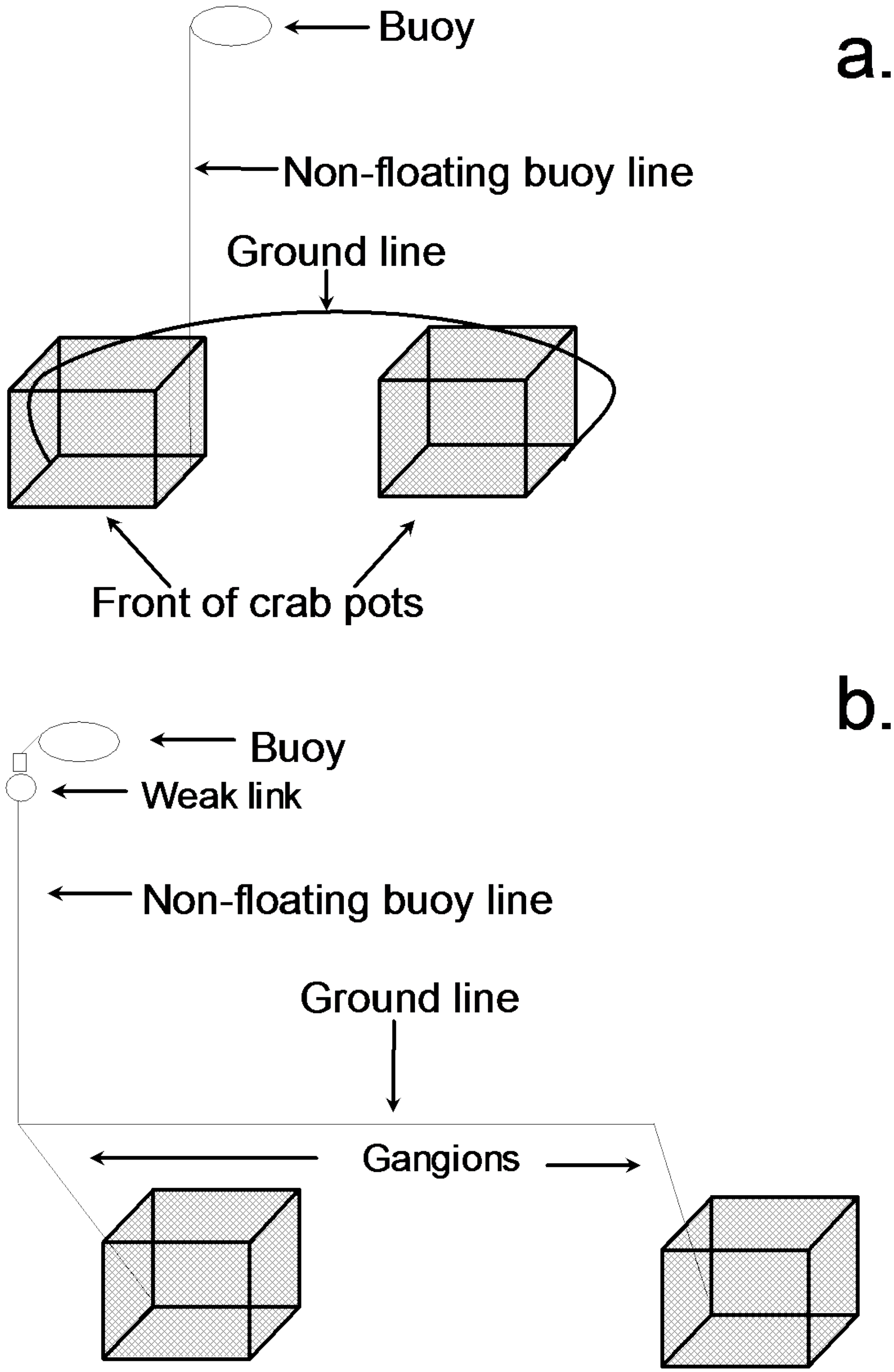

Figure 11.13.1 Diagram of multiple pots to a single buoy tested in the Pamlico River [a (Stoker and Hassell 2011)], and Atlantic Ocean [b (Thorpe and Beresoff, 2008)].

fishing operation unless each pot is marked by attaching a floating buoy. The Marine Fisheries Commission Crustacean Advisory Committee discussed this issue during three meetings [March 13, 2006, October 3, 2007, and November 2, 2007 (Attachment A)]. Concurrent with these discussions modifications to the Atlantic Large Whale Take Reduction Plan (ALWTRP) were being considered (October 2007, April and September 2008), and Thorpe and Beresoff (2008) were testing multiple pots per buoy in a commercial fishing operation in the Atlantic Ocean. All of this activity led to the decision to include multiple pots per buoy as a management issue in the formal review of the Blue Crab Fishery Management Plan (BCFMP). The Crustacean AC and MFC identified the following issues concerning multiple pots per buoy that needed to be addressed:

1. marine mammal interactions, and regulatory requirements;
2. gear conflicts (shrimp trawl, other potters, etc.) leading to damaged gear and lost pots (ghost pots); and
3. stock protection
    a catch,
    b bycatch, and
    c participation.

IV. AUTHORITY

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION – POWERS AND DUTIES
15A NCAC 03J .0301	POTS

U.S. Office of the Federal Register. 2006. Taking of Marine Mammals Incidental to Commercial Fishing Operations; Bottlenose Dolphin Take Reduction Plan (BDTRP) Regulations; Sea Turtle Conservation; Restrictions to Fishing Activities; Final Rule, Federal Register 71:80(26 April 2006):24776-24797.

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V. DISCUSSION

Marine Mammal Interactions and Regulatory Requirements

The primary threat that commercial fishing poses to marine mammals is the risk of incidental entanglement in commercial fishing gear. Of 31 recorded right whale entanglement events examined between 1993 and 2002, 24 (77.4 percent) involved animals with gear in the mouth and 16 (51.6 percent) were entangled only at the mouth (Johnson et al. 2005). This suggests that a large number of entanglements occur while right whales feed, since open mouth behavior is generally associated with feeding only. The Atlantic Large Whale Take Reduction Plan (ALWTRP) went into effect in 1997. The intent of the plan is to reduce the risk of serious injury to or mortality of large whales due to incidental entanglement in commercial fishing gear. The regulations contained in the 1997 rule were updated in February 1999, December 2000, January 2002, June 2007, October 2007, April 2008, and September 2008 (73 FR 51228, September 2, 2008). These regulatory changes included additional gear marking requirements; changes in boundaries; seasonal restrictions for gear modifications; expanded exempted areas; expanded weak link; and, sinking groundline requirements. The final rule provided an additional six months (through April 5, 2009) for trap/pot fishermen along the Atlantic coast to comply with the AWLTRP's sinking groundline requirement.

The trap/pot gear requirements in the ALWTRP vary by geographic area. The plan currently recognizes seven trap/pot areas. The offshore waters of North Carolina are in two of the areas, Southern Nearshore and Offshore Trap/Pot Waters (Figure 11.13.2). Current regulations in these areas include:

Southern Nearshore Trap/Pot Waters

September 1-May 31:

- Compliance with the Universal Requirements:
    - No buoy line floating at the surface.
    - No wet storage of gear (all gear must be hauled out of the water at least once every 30 days).
    - Fishermen are encouraged, but not required, to maintain knot-free buoy lines.
- Trap/pot surface buoys to be marked to identify the vessel or fishery with one of the following:
    - The owner's motorboat registration number and/or U.S. vessel documentation number; the federal commercial fishing permit number; or whatever positive identification marking is required by the vessel's home-port state.
    - When marking is not already required by state or federal regulations, the letters and numbers to mark gear must be at least 1 inch (2.5cm) in height, block letters or Arabic numbers, in a color that contrasts with the color of the buoy.
- Buoy lines to be marked with one 4-inch (10.2 cm), ORANGE, mark midway along the buoy line.
- All buoys, flotation devices and/or weights must be attached to the buoy line with a weak link having a breaking strength of no greater than 600 lb;
    - Weak links must be chosen from the list of NMFS approved gear, which includes: off the shelf weak links, rope of appropriate breaking strength, hog rings, and other materials or devices approved in writing.
    - Weak links must be designed in such a way that the bitter end of the buoy line is clean and free of any knots when the weak link breaks.
- All groundlines must be made of sinking line.

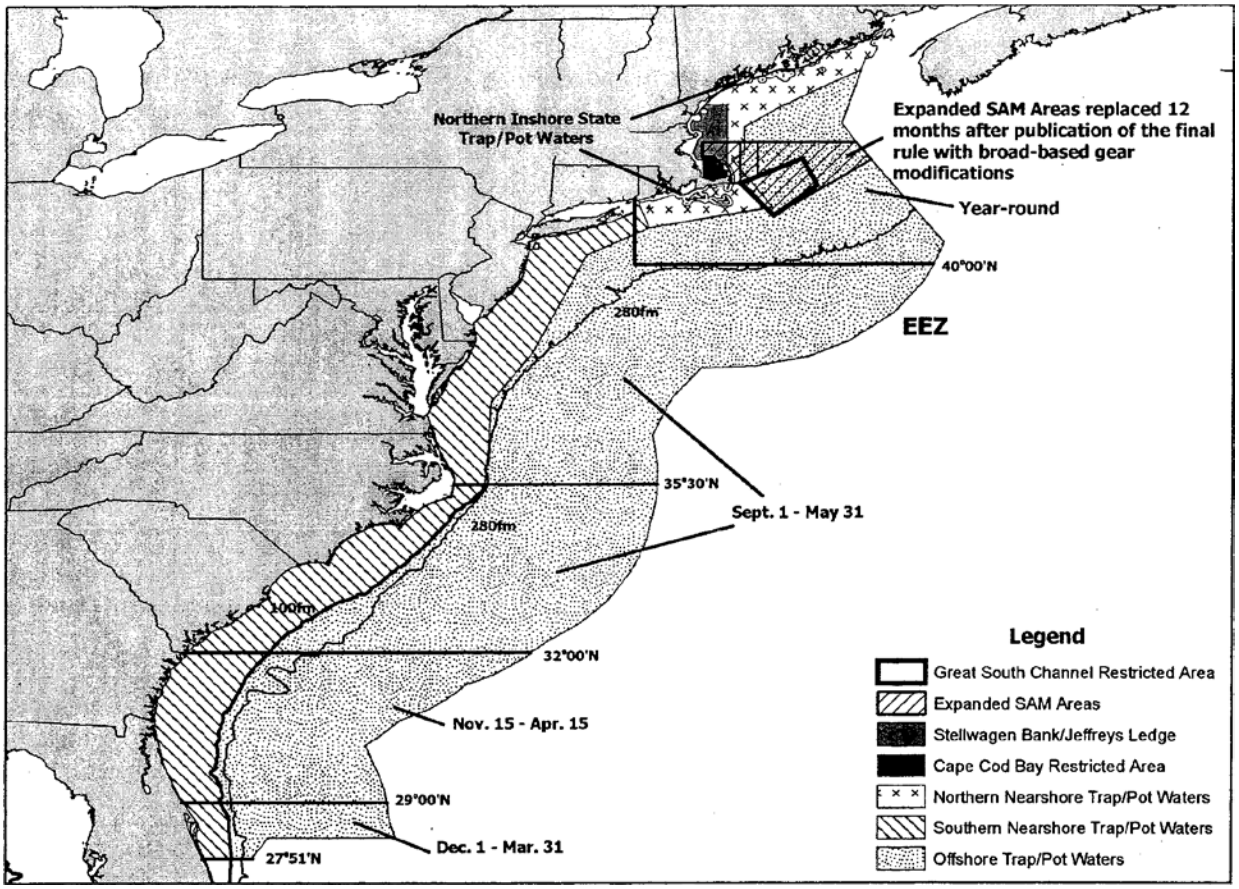

Figure 11.13.2 Map of Atlantic Large Whale Take Reduction Plan (ALWTRP) trap/pot management areas. Map taken from 72 FR 57104, October 5, 2007.

Offshore Trap/Pot Waters

September 1-May 31:

- Compliance with the Universal Requirements:
    - No buoy line floating at the surface.
    - No wet storage of gear (all gear must be hauled out of the water at least once every 30 days).
    - Fishermen are encouraged, but not required, to maintain knot-free buoy lines.
- Trap/pot surface buoys to be marked to identify the vessel or fishery with one of the following:
    - The owner's motorboat registration number and/or U.S. vessel documentation number; the federal commercial fishing permit number; or whatever positive identification marking is required by the vessel's home-port state.
    - When marking is not already required by state or federal regulations, the letters and numbers to mark gear must be at least 1 inch (2.5cm) in height, block letters or Arabic numbers, in a color that contrasts with the color of the buoy.
- Buoy lines to be marked with one 4-inch (10.2 cm), BLACK, mark midway along the buoy line.
- All buoys, flotation devices and/or weights must be attached to the buoy line with a weak link having a breaking strength of no greater than 1,500 lb;

- o For the red crab trap/pot fishery, weak links with a maximum breaking strength of 2,000 lb are required;
  - o Weak links must be chosen from the list of NMFS approved gear, which includes: off the shelf weak links, rope of appropriate breaking strength, hog rings, and other materials or devices approved in writing.
  - o Weak links must be designed in such a way that the bitter end (the end of a line that detaches from a weak link) of the buoy line is clean and free of any knots when the weak link breaks.
- All groundlines must be made of sinking line.

In addition to whales there are also concerns with bottlenose dolphin interacting with crab pot fishing gear (Burdett and McFee 2004). Bottlenose dolphins in the Indian River Lagoon, Florida, and parts of Georgia have been observed tipping pots in an attempt to feed on crab pot bait (Nokes and Odell 2002; Haymans 2005). Entanglement in buoy lines is another possible source of mortality (McFee et al. 2007). The 2006 Bottlenose Dolphin Take Reduction Plan (BDTRP) included five non-regulatory recommendations that may reduce interactions between bottlenose dolphins and crab pot fishing operations.

- Use a sinking or negatively buoyant line, such as nylon or polyester, to minimize excess line floating at the surface*.
- Deploy line in an untangled, straight line to help reduce the risk of it coming off the bottom.
- Limit line to minimum length necessary, especially in shallow or slack water.
- Use an inverted or modified bait well to discourage bottlenose dolphins from attempting to feed on bait.
- Collaborating with states to establish programs for removing lost or abandoned (derelict) blue crab pots*.
  *Currently addressed by NC rules (nonfloating line; pot clean-up period) and practices (MP Pot clean-up).

The use of multiple pots per buoy would reduce the amount of vertical line in the water minimizing interactions with whales and bottlenose dolphins. However the use of gangions and groundlines may increase the chance of interactions between bottlenose dolphin and crab pots (stealing bait). Crab pot gear, configured as a trawl, is comprised of a groundline (the line that connects the traps to each other), gangions (line connecting pot to ground line), and a buoy line [the line that connects the pots to a surface buoy system (Figure 1)]. Two pots set under current requirements and practices in the Atlantic Ocean would have a total of 96’ of vertical line (personal communication, David Beresoff 2007). Two pots on a single buoy would have 138’ feet of line [48’ buoy line, 30’ of ground line, and 60’ of gangions (Thorpe and Beresoff 2008)]. In the Pamlico River 30’ of buoy line would be required for two pots while a 2-pot trawl had 45’ of total line [15’ buoy line, and 30’ ground line, no gangions were used (Stoker and Hassell 2011)]. If multiple pots per buoy were allowed, inverted bait wells and sinking ground lines should be required to minimize interactions with bottlenose dolphin. Also if multiple pots per buoy were limited to just two pots, then gangions would not be needed.

Gear Conflicts and Ghost Pots

The first crab pot landings in North Carolina were in 1952 and by 1955 harvest seasons and a 100 pot limit were implemented to deal with user conflicts. The increased number of crab pots, principally in the 1980’s and 1990’s has resulted in more frequent and severe conflicts over fishing space between crab potters (full and part-time), other fisheries (trawlers, haul seiners, etc.), and recreational activities (swimming, fishing, and boating access and navigation). Conflicts also arise from damage to vessels encountering gear, and may result in fishing gear being moved, damaged, destroyed, or stolen. Stoker and Hassell (2010 and 2011) conducted studies in the Pamlico River from May through October with two pot trawls hoping to minimize conflicts between recreational boaters and crab potters by reducing the number of crab pot buoys in the water. These studies showed that it was feasible to fish a two pot trawl configuration in the Pamlico River without any conflict with other crabbers or recreational boaters, also the amount of time required to fish pots in a trawl configuration was half that of a single pot rig and crab catches were 3% higher in the pot trawls than the control pots (Stoker and Hassell 2010 and 2011). Thorpe and Beresoff (2008) tested multiple pots on a single buoy in the Atlantic Ocean. Trawl sizes included two, three, ten, and twenty pot configurations. Fishing in this study occurred from December through March, and conflicts between shrimp trawlers and the longer (≥10 pots) configurations were observed. These authors suggested that multiple pots in a line in the Atlantic Ocean should have no more than three pots per line since loner lines may exacerbate conflicts between shrimp trawlers and crab potters.

Ghost pots are pots that either through abandonment or loss (float lines cut by boats, storm events, etc.), continue to catch crabs and finfish (see ghost pot issue paper for more information). Currently, if a buoy is lost only one crab pot is affected. Once pots are put into a trawl configuration the number lost pots will increase proportionally. Stoker and Hassell (2011) tested two pot trawl configurations In the Pamlico River from May through October and reported no lost gear or conflicts with other fishermen. In the Atlantic Ocean one ten pot trawl was dragged to deeper water however the pots were recovered (Thorpe and Beresoff 2008).

Stock Protection

a Catch,
b Bycatch, and
c Participation.

The final issue has to do with stock protection and the concern that by allowing multiple pots on a single buoy an increase in participation and/or catch would occur especially in the Atlantic Ocean where a large percentage of the catch is composed of mature females. Tagging studies indicate that the Atlantic Ocean serves as an important migration route and possible over wintering area for mature female blue crabs. In 2005 and 2006, the southern N.C. offshore crab pot fishery for blue crabs was examined (Logothetis et al. 2007). Overall, 48% of the total catch was composed of blue crabs and 78% of the crabs were mature females. In 2008, Thorpe and Beresoff (2008) tested multiple pots on a single buoy in the Atlantic Ocean. Results showed 96% of the blue crabs captured were female and 99% of those females were mature. The NCDMF utilizes spawning sanctuaries as an important component of its stock protection strategy. No spawning sanctuaries have been established south of Cape Lookout, N.C. The need for sanctuaries in this part of the state has usually been dismissed since ocean inlet areas are small and directed crab fishing effort in the ocean has been relatively low (Table 11.13.1).

Table 11.13.1 Yearly landings (pounds), trips, and participants for North Carolina and the Atlantic Ocean blue crab pot fishery.

	Ocean crab pot			State crab pot		
Year	Pounds	Trips	Participants	Pounds	Trips	Participants
1994	7,500	35	24	50,907,839	122,160	4,476
1995	14,881	39	16	45,018,314	131,167	4,904
1996	6,826	30	9	63,525,801	127,957	5,222
1997	1,437	21	4	52,218,665	138,274	5,270
1998	4,247	42	2	57,733,112	147,349	4,479
1999	3,876	41	4	54,831,657	170,123	4,252
2000	127	3	3	38,808,867	126,730	4,409
2001	1,864	28	2	29,852,289	124,648	4,254
2002	1,280	33	4	35,728,178	106,218	3,938
2003	8,811	88	4	40,685,787	104,364	3,794
2004	6,656	88	5	32,208,926	86,676	3,309
2005	5,717	67	4	23,869,284	68,680	2,585
2006	20,324	151	6	24,661,828	56,972	2,031
2007	21,369	161	4	20,909,150	60,696	2,041
2008	6,683	67	3	30,967,910	59,078	1,958
2009	17,453	87	5	28,431,358	67,996	2,234
Total	129,051	981	99	630,358,966	1,699,088	59,156
Average	8,066	61	6	39,397,435	106,193	3,697

Thorpe and Beresoff (2008) saw a slight decrease in blue crab catch in the two (0.037 lbs/pot/hour) and three (0.028 lbs/pot/hour) pot configurations compared to the control pots (0.047 lbs/pot/hour). Catches in the ten pot trawl were 0.036 lbs/pot/hour, and 0.026 lbs/pot/hour in the twenty pot trawl. Stoker and Hassell (2011) saw a 3% increase in total crab catches in the two pot trawl compared to single pot catches. Bycatch was not quantified by Stoker and Hassell (2011); however, Thorpe and Beresoff (2008) noted that although more species were caught in the longer trawl lines the proportions remained the same to the smaller trawls and individual pots. Information was not collected on the amount of time required to fish the various trawl configurations in the Atlantic Ocean. Stoker and Hassell (2011) found that it took half the time to fish pots rigged in the two pot trawl configuration (10 trawls, 20 total pots) compared to the 20 control pots.

VI. PROPOSED RULE(S)

No rule changes are proposed.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

1. Status quo
   - \+ No rules change
   - \+ Potentially less pot loss than multiple pots per buoy

- Possible marine mammal interactions
- Unresolved conflicts with recreational boaters

2. Allow multiple pots on a line in the Atlantic Ocean (define maximum number of pots per line)
   - \+ Possible increase in catch
   - \+ Reduce user conflicts in certain areas
   - \+ Reduce interactions with marine mammal
   - \+ Reduce fuel cost
   - \+ Increase quality of catch
   - \+ May reduce movement of pots in storm events
   - \- Requires rule change or new rule
   - \- Possible increase in number of ghost pots
   - \- Possible increase in effort on mature females

3. Allow multiple pots on a line in all waters open to potting (define maximum number of pots per buoy)
   - \+ Possible increase in catch
   - \+ Reduce user conflicts in certain areas (Small creeks or around the mouths of creeks)
   - \+ Reduce interactions with marine mammal
   - \+ Reduce fuel cost
   - \+ Increase quality of catch
   - \- Increase user conflicts in certain areas (Sounds)
   - \- Possible increase in number of ghost pots
   - \- Possible increase in effort on mature females

4. Proclamation authority for multiple pots on a line (areas, means, methods, etc.)
   - \+ Possible increase in catch
   - \+ Reduce user conflicts in certain areas (Small creeks or around the mouths of creeks)
   - \+ Reduce interactions with marine mammals
   - \+ Reduce fuel cost
   - \+ Increase quality of catch
   - \- Increase user conflicts in certain areas (Sounds)
   - \- Possible increase in number of ghost pots
   - \- Possible increase in effort on mature females

VIII. RECOMMENDATION

MFC selected management strategy
- Status quo, do not allow multiple pots to a single buoy.

AC - Allow proclamation authority for multiple pots on a line not to exceed two pots per buoy.

NCDMF - Status quo, do not allow multiple pots to a single buoy.

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Revised: May 25, 2011
June 2, 2011
June 21, 2011
July 22, 2011
July 28, 2011
September 7, 2011
September 15, 2011
February 27, 2012

ATTACHMENT A. North Carolina pot modifications proposal (3/6/2007). Handout to MFC Crustacean AC at the November 2007 meeting

Background:

There has been a burgeoning crab pot fishery in the Atlantic Ocean off shore of the southern part of NC for the last few years. NC fishermen have found that fishing crab pots in the winter months (best months are December, January and February) can be very lucrative since the price is generally in the .80 cent to $1.00 lb. for females and around $1.50 lb. for males. In conjunction with blue crabs, fishermen have been creative in marketing their whelks and stone crab claws by catch to local restaurants and seafood vendors. This fishery is becoming attractive to crab pot fishermen since it provides a lucrative option for winter income and their gear tends to ride out winter weather with minimal loss.

At this time, NCDMF regulations state that there must be one buoy per crab pot. My first experience with this issue came as co-chair for the NCMFC Crustacean Committee. David Beresoff petitioned the committee to initiate a rule change to allow multiple crab pots per buoy which would allow fishermen to deploy crab pots in a manner similar to northern lobster strings. Unlike many pot fisheries, the bottom close to shore tends to be sandy and featureless which makes the use of sinking rope for the ground lines less problematic. His proposal offers winter crab pot fishermen a way to reduce risk to marine mammals by reducing vertical lines and using sinking ground lines.

Crab Pot Trawl Configuration:

- If a rule change was passed by the NCMFC, the crab pots would be fished in about 5 to 7 fathoms and the primary areas of effort would be between Southport, NC and the SC border.
- The trawl observed had 3 crab pots connected in series but it was noted that as many as twenty per trawl can work. Boat size and available bottom tend to dictate gear configuration.
- Ground line between crab pots averaged 8 fathoms and the rope used was #8 or # 10 Osprey brand. This rope is very common throughout the state since it sinks; works well with a pot puller, abrasive resistant and is cheap. I can mail you a sample if that would be useful.
- Crab pots are attached to the ground line by a leader that is about 3 fathoms in length. This allows the pot puller to haul the ground line to the tie in point of the leader and then allow the fishermen to bring the pot to the boat by hand.
- The vertical lines average length was 8 to 10 fathoms and the most common buoy used was a standard round float (6 to 8 in. diameter).

Sink Net:

- After fishing crab pots we fished about 2,000 yards of 3 in. sink net. All weak links and anchors were appropriately rigged.
- A question surrounding the anchor regulations is what does NMFS mean when they require a 22 lb. anchor? Is this meant to mean a #22 anchor (which weighs about 28 lbs. when rigged out with a shackle and clip) or does this mean a # 18 anchor which actually weighs about 22 pounds? Based on my conversation with David Beresoff, this is a commonly asked question by fishermen.

Observations:

- One crab pot does not likely have enough resistance to warrant a weak link but it might be necessary if multiple crab pots were rigged to one line (I believe Glen has looked into this). If a rule change was passed by the NCMFC that allowed crab pots to be fished in this manner, the weak line of choice would be the 600 lb. plastic swivel.

- At this time, David Beresoff estimates that there are about 4 or 5 participants in this fishery (Southport, NC to SC border) and they fish on average about 100 pots per person.
- David Beresoff could not estimate effort in SC.
- Winter off shore crabbing effort in NC has the potential to grow since crab prices fall quickly in March and the picking house market has been decimated by imports.
- Fishermen are continually looking for niche fisheries that offer high price. There are few fishermen who can make it only participating in one fishery. This trend will most likely continue since there are few fisheries that are stable from a stock or regulatory perspective.
- Crab trawls could be a useful risk reduction option for NMFS when reviewing gear regulations in the southeast restricted area.
- Previous efforts to change one buoy per crab pot have not worked. The reason for this resistance is unknown but based on my conversations with Red Munden there may be some renewed interest. He expressed interest in this project and would like to review this report.
- Multiple crab pot configurations tend to travel less on the bottom during winter weather. Ghost pot concerns could be addressed by requiring end lines on both sides of trawl.

The weather was choppy enough that the pictures were not very useful. I will fax a sketch of a proposed crab trawl.

Prepared by: David Hilton/NMFS-SER Fisheries Liaison

ATTACHMENT B. Proclamation example for AC recommendation

PT--2012

PROCLAMATION

RE: CRAB POT BUOYS

Dr. Louis B. Daniel III, Director, Division of Marine Fisheries, hereby announces that effective at **7:00 A.M., Monday, July 1, 2012,** the following will apply to the marking of crab pots with buoys:

I. AREA DESCRIPTION:

The Atlantic Ocean from Bogue Inlet south to the North Carolina-South Carolina state line.

II. MARKING REQUIREMENTS:

From **July 1 through September 30, 2012,** the following restrictions apply to the marking of crab pots with buoys:

A. A maximum of two (2) crab pots may be attached to one (1) floating buoy of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length in the areas described in I. above.
B. The buoy must be fluorescent orange in color and have a black cable tie attached to the pot line at the buoy.

II. GENERAL INFORMATION:

A. This proclamation is issued under the authority of N.C.G.S. 113-170.4; 113-170.5; 113-182; 113-221.1; 143B-289.52 and N.C. Marine Fisheries Rule 15A NCAC 03H .0103 and 03J .0301.

B. It is unlawful to violate provisions of any proclamation issued by the Fisheries Director under his delegated authority pursuant to N.C. Marine Fisheries Rule 15A NCAC 03H .0103.

C. This action is being taken to allow multiple pots on one buoy to reduce obstruction to navigation and marine mammal interactions in this area from July through September, 2012.

D. Fisheries Rule 15A NCAC 03J .0301 authorizes the Fisheries Director to exempt crab pots from the single buoy requirement in accordance with the N.C. Blue Crab Fishery Management Plan.

By: ________________________________

Dr. Louis B. Daniel III, Director
DIVISION OF MARINE FISHERIES

June 23, 2012
8:30 A.M.
PT--2012
/sab

175 copies of this document were printed at a cost of 5 cents per copy.

11.14 POT LOSS AND GHOST POT BYCATCH MORTALITY[17]

I. ISSUE

Reducing pot loss and the continued bycatch and mortality of blue crabs and finfish in abandoned, unattended and ghost pots is needed.

II. ORIGINATION

North Carolina Division of Marine Fisheries Management Section

III. BACKGROUND

An issue specific to the blue crab pot fishery is abandoned and lost (ghost) pots. These are pots that either through abandonment by the fishermen or loss (buoy lines cut by boats, storm events, etc.) continue to catch crabs and finfish. Historically, it was generally assumed that it was illegal to possess any gear that did not belong to you. Due to discussions generated by public concern, the issue on retrieval of abandoned gear was further clarified by Marine Patrol in the summer of 2002. This clarification separates gear into two groups; abandoned and ghost. Abandoned pots are those that carry an owner's identification (marked buoy or tag), as the law requires; but, their owners have not checked them in five days. Only the Marine Patrol or owner of the pots can remove abandoned pots. Ghost pots are those with no buoy or identifying tag attached to the pot. Any person can collect and possess ghost pots at any time. Concern stems from the significant increase in the numbers of crab pots deployed, the long life of vinyl-coated pots, the pots ability to continue to trap blue crabs and finfish to varying degrees, and the mortality associated with prolonged entrapment.

The issue of ghost pots in the North Carolina crab fishery is not unique; it has been a major concern in other pot fisheries: Caribbean spiny lobster (Seaman and Aska 1974); Dungeness crab (Breen 1987); American lobster (Sheldon and Dow 1975); snow crab (Gagnon and Boudreau 1991); and sablefish (Scarsbrook et al. 1988). For the most part, these fisheries now require that some sort of escape mechanism be incorporated into the various pot designs. In 1976, the state of Alaska passed legislation, which required all pots (crab and fish) to have a biodegradable termination device, which in time breaks down and allows crabs and fish to escape (Paul et al. 1993). Florida, Texas, and New Jersey are the only states that require biodegradable panels in blue crab pots.

The annual number of crab pots in North Carolina has been tracked in earlier years by NMFS' annual boat and shore report or more recently NCDMF fiscal year licensee reported gear used from self reported commercial fishing license applications (see FMP Section 7.1.1.1). The number of crab pots listed for use by commercial fishermen (NCDMF license gear survey) in North Carolina has increased from 350,379 in 1983 to 1,282,898 in 2000 and in 2011 was 1,043,587 pots (~9% increase over the past 5 year mean of ~960,000 pots). Several studies (Table 11.14.1) have reported estimates of pot loss.

[17] Presented to PDT on 9/26/11 and 1/4/12; Presented to MRT on 9/28/11 and 1/18/12; Presented to AC on 10/3/11 and 1/10/12.

Table 11.14.1 Estimated total crab pots listed for use by commercial fishermen (NCDMF license gear survey) and pot loss during various time periods for North Carolina.

Year	Estimated total pots deployed	Estimated percent hard crab pot loss	Estimated percent peeler crab pot loss	Estimated pot loss (numbers)	Area	Reference
1991	No data	14	No data	No data	Pamlico/Pungo rivers	McKenna and Camp (1992)
1998	1,016,917	17	11	163,087	NC statewide	NCDMF unpublished
1999	957,625	12	No data	111,247	NC statewide Hurricanes Dennis and Floyd	NCDMF unpublished (Hurricane Floyd Relief Program)
2006	210	17	No data	36	Pamlico River	Hassell 2007

In a North Carolina study on crab pot escape panels and degradable materials, Winslow (2004) noted that as abandoned and ghost pot numbers continue to rise, the need for escapement devices in crab pots also increases to reduce waste in North Carolina's most valuable fishery. It was further suggested by Winslow (2004) that the impact of the number of abandoned pots left each year in North Carolina waters (Table 11.14.2) could be limited by the possible implementation of mandatory escape panels, multiple enforcement citations, or license revocation for repeat offenders. Using a conservative average (Table 11.14.1) of 12% annual pot loss (120,000 lost pots) for approximately 1,000,000 pots set annually (Table 11.14.2), the North Carolina Marine Patrol's annual statewide pot removal program averaging approximately 1,000 pots in recent years (Table 11.14.2) is accounting for less than one percent of the lost pots.

Table 11.14.2 Number of abandoned and ghost pots documented during North Carolina Marine Patrol's annual statewide pot removal program and pots listed for use statewide (NCDMF license gear survey). (Jan. 15 through Feb. 7 is the current period for no potting in internal waters. From 2003 – 2005, the period for no potting was Jan. 24 through Feb. 7.)

	Number of pots				
Year	Northern District I	Central District II	Southern District III	Total	Deployed statewide
2003	4,047	900	127	5,074	1,165,818
2004*	7,708	527	108	8,343	1,165,228
2005	2,168	missing data	missing data	2,735	1,108,103
2006	1,117	391	24	1,532	999,910
2007	896	135	24	1,055	964,231
2008	757	190	110	1,057	899,621
2009	589	257	60	906	906,897
2010	570	154	24	748	984,104
2011	656	183	141	980	1,043,587

* During the winter of 2004, the high number of abandoned pots encountered was apparently a result of pot loss due to Hurricane Isabel (Sept. 2003).

Throughout the development of the North Carolina Blue Crab Fishery Management Plan (BCFMP 1998 and 2004) over the past decade, the Marine Fisheries Commission (MFC) and NCDMF have implemented various rules and policies in an attempt to reduce the impacts of abandoned pots, pot loss, and the catch/mortality associated with unattended crab pots. These rules and policies are summarized in Table 11.14.3.

Table 11.14.3 Various rules and policies implemented by the MFC and NCDMF in an attempt to reduce the impacts of abandoned pots, pot loss, and the catch/mortality associated with unattended crab pots.

Rule or process	Action date(s)	Description of rule or process
Process	2002-2006	Research on biodegradable panels in pots (NCDMF 2008)
Rule 03J .0301	7/1999, 9/2005	Allow the Fisheries Director to close any area to the use of pots in order to resolve user conflict, by proclamation with the prior consent of the MFC
Rules 3O .0302. (a) (3) and 3J .0302 (a)	7/1999	Limited individuals holding a RCGL to five pots and specified special marking requirements for pot buoys
Rule 03J .0301 (k)	2/2000	Required non-floating (sinking) line to be used to connect the pot to the buoy
Rule 03I .0105 (b)	7/1999	Shortened the required attendance period for pots from 10 to 7 days, and allows the Fisheries Director by proclamation to modify the attendance period for pots due to hurricanes, severe weather or other variable conditions
Rule 03I .0105 (b)	9/2005	Shortened the required attendance period for pots from 7 to 5 days
Process	ongoing	Marine Patrol implemented an expanded pot clean-up/removal initiative in 2003 during the NO POTTING period, and continues to document the number of abandoned pots collected during the pot clean-up period (Table 11.14.2).
Rule 03J .0301 (a) (1)	9/2005	Extended the NO POTTING period (Jan. 24-Feb. 7) by nine days (Jan. 15-Feb. 7) to allow additional time for pot clean-up efforts
Process	ongoing	Educate fisherman and the general public about efforts to remove abandoned gear and encourage them to notify Marine Patrol on locations of abandoned gear

IV. AUTHORITY

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION – POWERS AND DUTIES
15A NCAC 03J .0301	POTS

V. DISCUSSION

There are two components to this issue that need to be addressed separately: minimizing pot loss and reducing catch in lost pots. Factors affecting ghost fishing include number of pots lost, pot type, location where lost, and target-species behavior (Smolowitz 1978). Further reducing the pot attendance period from five to three days, and encouraging removal or requiring pots to be removed from the water prior to major storm events would help to reduce pot loss. Significant reductions in ghost fishing mortality in blue crab pots could be achieved by minimizing pot loss and by incorporating design features into pots to prevent or reduce ghost fishing.

Causes of Pot Loss and Mitigating Influences on Impact

Reducing spatial conflicts between crab pots in the water and other users may minimize actual pot loss. Incompatible gears being used in the same area contribute to pot loss. Large areas of North Carolina waters are fished by both trawlers and potters. Sometimes trawlers inadvertently tow across areas containing pots and either sever the buoys, or drag the pot away from the line. Pots that are caught by trawlers are usually returned to the water. However, the new location of the pot is unknown to the owner and, unless notified by law enforcement or other fishermen, the pot is seldom retrieved. Harvest seasons for crab trawling and potting would eliminate crab pot loss by crab trawls. However, negative interactions would still occur between shrimp trawlers and potters. Other spatial conflicts exist between competing potters, recreational users, and other fishing activities. Some of these problems could be solved by a combination of seasonal and area restrictions. Currently, some conflicts can be resolved by Rule 3J .0301 (j) User Conflicts, which was adopted by the Marine MFC in 1999 as recommended by the 1998 North Carolina Blue Crab FMP (McKenna et al. 1998).

Historically, large numbers of pot buoy lines have been severed by boat propellers. Another source of pot loss is abandonment. Fishermen cut the buoys off older pots or simply leave the gear in the water.

Storm events and abnormal water currents and tides also contribute to pot loss. In 1999, 111,247 crab pots were reported lost due to Hurricanes Dennis and Floyd (Table 11.14.1). The National Weather Service initiated a 10 day major storm warning timeframe in 2002. Requiring fishermen to remove their pots from the water prior to major storm events would eliminate this gear loss problem. Pots move and/or become partially buried by sand or mud in areas with heavy currents and tides. Two potential management options to solve this problem are to prohibit pots in these areas, and requiring extra weight or a larger diameter iron on the pots.

Lost pots most likely mud or sand-up after a certain period of time and catch rates would be reduced. This was observed in a couple of NCDMF survey pots that were lost for five or so weeks. After relocating the lost pots they had to be pulled from the mud with the aid of a boat. The mud line was above the entrance funnels; so the pots were no longer catching crabs and finfish. Fishermen have indicated that for a lost pot with a float attached the wave action on the float acts like a pile-driver and the continued movement of the float allows the pot to settle into the mud. It is not known what happens to pots that have their float lines cut. However, more than likely they too will mud-up, but at a slower rate. Pots lost during storms may incur damage, and pot damage could reduce catch efficiency and potential mortality; conversely, damage could also reduce escapement.

The magnitude of the potential impacts (positive or negative) is different for each individual ghost pot, and the overall impacts are difficult to discern and are debatable. In contrast to harming aquatic organisms, ghost pots may serve an artificial but beneficial role by providing a point of attachment for oysters, algae, tunicates, and other aquatic life, and thus aquatic habitat Pots with heavy marine fouling that restricts the funnel openings do not readily catch and entrap larger organisms. Winslow (2004) noted that in the Cape Fear River area estuaries, some pots became heavily fouled and the escape panels did not open when the degradable material broke. In some instances, the test pot was completely fouled and finfish and crabs could not enter the pot. Winslow (2004) also suggested that ghost pots equipped with escape panels have the potential to become habitat for juvenile finfish and crabs, as well as a hiding place for peeler crabs.

Mortality and Influence of Pot Design Features

The mortality caused by ghost pots is directly related to the durability of the pot and its retention capability. The use of vinyl-coated wire in crab pot construction has increased the life of crab pots. When lost, these pots do not degrade quickly, thereby increasing the potential for ghost fishing. The use of escape rings in hard crab pots significantly reduces ghost fishing mortality of sublegal blue crabs (Arcement and Guillory 1994). Since peeler pots are exempt from the escape ring requirement in North Carolina (Rule 03J .0303 (g)), this gear has a greater potential for ghost fishing mortality than hard crab pots.

Research conducted by High and Worlund (1978), suggests that the level of delayed mortality for crustaceans escaping from ghost pots may be high. Annual blue crab mortality has been estimated by studies in Louisiana (Guillory 1993) and North Carolina (NCDMF unpublished data 1993) (Table 11.14.4).

While data exist on the fate and quantity of blue crabs in ghost pots, little information is available on finfish bycatch since dead fish are quickly consumed by blue crabs, leaving only bones and fins [Guillory 1993 (Table 11.14.4); NCDMF unpublished data 1993].

A more recent (2002-2006) and expansive NCDMF (2008; Table 11.14.4) study was designed to evaluate hard crab pot catch rates, mortality, and escapement as though the pot was lost (i.e., a ghost pot) after the initial baiting when set in four coastal areas (i.e., Alligator River, Pamlico River, Bogue Sound, and Middle Sound (Figure 11.14.1). Ghost pots were checked weekly and the contents in each pot documented. Pot effort/duration due to gear damage and loss, crab and finfish catch, species composition, escapement, and mortality varied among and within areas seasonally and with pot condition. For all areas combined, the estimated yearly catch of legal blue crabs was 40.44 with an annual mortality rate of 19 crabs in a single ghost pot during this study time frame. Prior to this study, the statewide magnitude of blue crab escapement from ghost pots was not realized. Estimated annual escapement and mortality of blue crabs and finfish from ghost pots is shown in Table 11.14.4. If an estimated 100,000 pots are lost annually, annual ghost pot crab mortality (1,900,000 blue crabs; Table 11.14.5) is most likely high since pots were checked weekly and able to continue fishing for the entire study. Whereas, many lost pots are damaged and/or become mudded/sanded-up within several weeks; thus, restricting the entrance funnels and catch efficiency. To put this potential reduction in ghost pot catch efficiency in perspective, the catch from only the first four weeks of each ghost pot was used to estimate the short-term mortality per 100,000 pots lost annually (Table 11.14.5). Due to the initial baiting of the pot, approximately one-third of the annual mortality (6 crabs per pot) occurs within the first four week period after pot loss.

Table 11.14.4 Estimated annual percent escapement, mortality, or number of blue crabs and finfish per ghost for various areas and studies.

Percent escapement	Percent mortality	Annual mortality per ghost pot (number)	Annual catch per ghost pot (number)	Area	Reference
45	55	25 crabs	No data	Louisiana	Guillory 1993
64	36	11.5 legal crabs	No data	Pamlico River	NCDMF unpublished 1993
55	45	19 crabs	40.44 crabs	Four areas in North Carolina	NCDMF 2008
No data		8.6 fish	No data	Louisiana	Guillory 1993
No data		2.5 fish	No data	Four areas in North Carolina	NCDMF 2008

Table 11.14.5 Statewide annual mortality and mortality from only the first four weeks of each ghost pot to estimate the short-term mortality for number and pounds of blue crabs and for number of finfish, if an estimated 100,000 crab pots are lost annually in North Carolina (NCDMF 2008).

Assumed annual pot loss	Mortality per ghost pot (number)	Statewide annual mortality (number)	Statewide annual crab mortality (pounds*)
100,000	19 crabs annually	1,900,000	633,333*
100,000	2.5 finfish annually	249,000	No data
100,000	6 crabs annually based on four week catch rate	600,000	200,000*

* Poundage estimate using 3 crabs per pound.

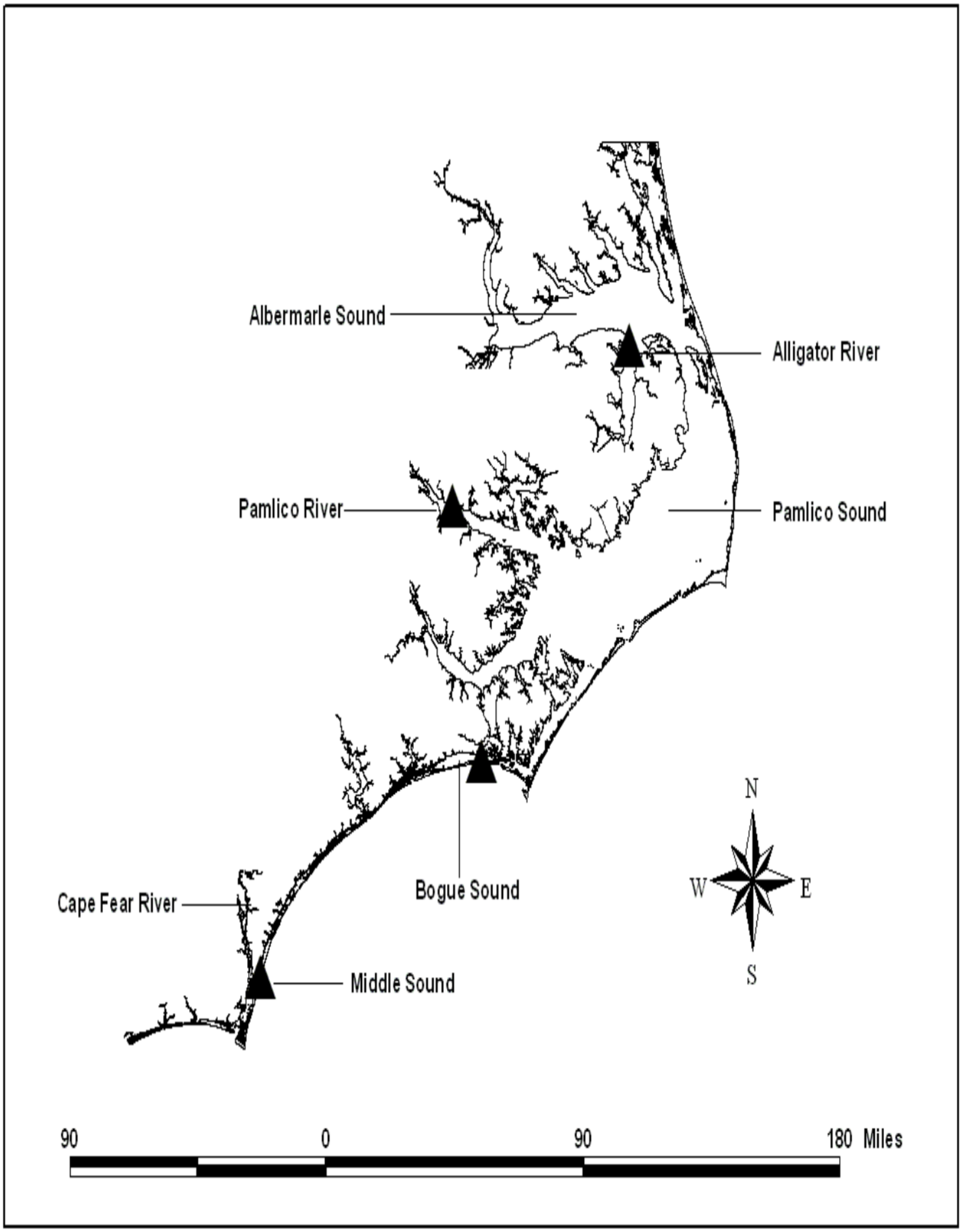

Figure 11.14.1 Locations of ghost and degradable test pots set in North Carolina, 2002 – 2006.

Pot Design Features to Reduce Mortality and Lost Pots

Significant reductions in ghost fishing mortality of blue crabs and finfish in blue crab pots could be achieved by incorporating design features into pots to prevent or reduce ghost fishing. Fishermen through increased catches would directly realize this benefit.

Pots may move easily and/or become partially buried by sand or mud in areas with heavy currents and tides. Options to reduce pot loss in areas with heavy currents and tides are to prohibit pots in these areas and require extra weight or a larger diameter iron on the pots.

Options to increase buoy visibility and reduce pot loss due to boat interactions include the use of full size buoys (5 inch by 11 inch) and/or reflective tape or paint on buoys. During a Pamlico River study designed to evaluate pot loss with full size (5 inch by 11 inch) and half size (5 inch by 5 inch) buoys over the course of a crabbing season, Hassell (2009) incurred an 11% pot loss with half floats verses 5% with full floats. Hassell (2007) evaluated the potential of reflective tape on pot buoys to reduce pot loss in Pamlico River, NC, and found a significant difference in pot loss between control pots (17% loss) and pot buoys with highly visible reflective tape on the top and end (7% loss).

When the buoy is separated from a pot, there is little chance of pot recovery. A method to help find lost pots by attaching a small float and twine with degradable jute material (time-release float) was designed and evaluated by Hassell (2007) in Pamlico River, NC. It was determined that a secondary time-release float was feasible. However, several modifications were recommended including a more durable degradable material and covering the material inside the pot with a fine mesh wire panel to keep crabs from picking at the material and causing pre-mature failure.

Hassell (2005) evaluated two internal opening escape panels per pot rigged with weights and floats that were designed to open when the pot was in any position except upright. The theory and functionality of these floated and weighted escapement panels is based on the premise that a lost pot will end up on its side or upside down; thus, allowing the escapement panel to open. The panels functioned as intended in all tests, except when the pot was turned on its left side where neither panel would open. However, to complicate the evaluation on comparable catchability, there was an unexplained significantly lower catch rate in test pots as compared to control pots.

Testing of Escapement Openings and Sites on Crab Pots

Escapement mechanisms were evaluated by the NCDMF in 1993 and tested under commercial conditions in 1995 (Hooker 1996). These devices discussed below included the lid closure strap, an escapement panel, and an escape ring, all of which were held in place by natural twine.

A. The lid closure strap was attached to a piece of natural twine located on top of the pot. In pots without a lip wire, the release of the strap would allow the top of the pot to open and all crabs to escape. All legal blue crabs (n=59) placed in test pots escaped in 48 hours (NCDMF unpublished data, 1993). Under commercial evaluation, fishermen reported that this device was cumbersome to work with and could be expensive to maintain since the strap was lost when the device degraded.
B. The escape ring was held in place with two hog rings on the bottom and a piece of natural twine at the top. An extra mesh had to be cut to allow legal crabs to escape. All legal blue crabs (n=70) placed in test pots escaped in 72 hours (NCDMF unpublished

data, 1993). Commercial fishermen testing this device felt that the hog rings interfered with the escapement of sublegal crabs through the escape ring (Hooker 1996). Additionally, fishermen were concerned with the inability of flounder and larger crabs to escape from this small opening when abandoned. Fishermen noted that blue crabs cut the string causing premature failure of the device.

C. Escapement panels were 4 1/2 inches by 3 inches made from 1/2 inch by 1 inch wire and were attached to the back of the pots. The bottom of the panel was held in place by three hog rings, while the top was secured at both corners and in the middle by twine. Fishermen preferred this larger device since it would allow larger crabs and flounder to escape from ghost pots (Hooker 1996).

Nobles et al. (2005) evaluated crab catch and finfish escapement in control pots and pots equipped with 2 unobstructed rectangular escapement openings in the upper pot chamber ranging in size from 1 x 8 to 1 1/2 x 10 inches, in 1/4 x 1 inch increments. Early test results showed that pots equipped only with the escape devices contained significant numbers of undersized crabs, indicating that the devices alone were not sufficient to allow small crabs to escape. Overall pots with escapement devices retained fewer crabs; however, the captured crabs were of a larger average size. Findings indicated that pots with the one inch escapement devices caught almost as many crabs as control pots, and allowed escapement of the majority of fishes evaluated within three days (i.e., flounder, white perch, spot), except for the thick bodied striped mullet. Increasing the size of the escapement openings did enhance escapement efficiency for finfish species; however, the one inch escapement devices would maintain crab catch while allowing significant finfish escapement.

NCDMF (2008) conducted several studies in Pamlico River and Albemarle Sound to evaluate the relative escapement efficiency of finfish and blue crabs from:

(1) standard (control) pots with two escape rings of 2 5/16 inch inside diameter, and/or
(2) test pots containing one of five various sized escapement openings that could be covered by a release panel.

The evaluation indicated that various finfish species in a variety of sizes can escape from, both, standard (control) crab pots and pots with escapement openings within a 24 hour period. White catfish, black drum, and white perch had the highest escapement rates, and southern flounder had the lowest rate. Overall escapement from the control pots was very good and much higher than expected for some species. Increasing the size of the escapement openings did appear to enhance escapement efficiency for finfish species.

Degradable Material Evaluation

Biodegradable panels and galvanic time release (GTR) devices are used in many pot fisheries to minimize ghost pot fishing mortality. Biodegradable material can easily be incorporated into trap designs to provide an exit port for animals captured in ghost pots. Examples of these devices include: untreated wooden slats in lobster traps; escape panels constructed of natural twine; the use of untreated wire in certain sections of the pot; corrodible pot-lid hooks; and pot-lid hooks held in place by untreated wire or natural twine. GTR devices are composed of an active metal cylinder functioning as an anode, joining together two stable metal eyelets, which function as cathodes. When immersed in salt water, conductivity produces galvanic corrosion of the anode. When the anode disintegrates, the eyelets separate and release. These devices can be constructed to meet predetermined release times (i.e., 50 days, 100 days, etc.). Tests conducted in Alaska and Canada have shown that these devices are very predictable [+ or - a couple of days (Paul et al. 1993; Boudreau 1991)]. However, GTR devices are usually constructed to specific salinity ranges, and a device designed for high salinity sites would take longer to degrade in lower salinity areas. With many fishermen moving their pots to different areas and salinity ranges, the major advantage of GTR devices, their predictability, would be negated. Depending on the desired release time, the cost of GTR's for fishermen could be high. For example, a device that would release after 30 days would have to be replaced seven times a year in North Carolina (assuming 200 fishing days per year). At approximately $3.00 per device the cost per pot per year would be $21.00. This would cost a person fishing 500 pots an extra $10,500 per year.

During 2002-2005, three different test periods were conducted simultaneously in four areas of coastal North Carolina (Figure 11.14.1) with varying salinities to determine the static degradation of several natural twines and non-coated steel wire (NCDMF 2008). Overall, there was a significant amount of variability in the time it took the various materials to degrade within, and between areas and tests. Degradable materials were tested with attachments on two potential crab pot escapement points (i.e., escapement panels and lid closure straps). Except for the cotton material test, lid strap attachment materials broke sooner in most cases. Minimum and maximum break time for the various materials and attachment points was highly variable. Numerous correlations were run with the various water quality parameters and materials. While some significant correlations were found with water temperature and dissolved oxygen these were most likely just a function of time. Winslow (2004) suggested that microbial activities, and the effect of light penetration should be examined in future degradable material studies. Although, none of the degradable materials had average break times within the critical four week period when one-third of the annual ghost pot mortality occurred (NCDMF 2008), based on these static evaluations, several potentially promising degradable materials were identified for continued testing by commercial crabbers (materials are contained in Table 11.14.6 in the section below on commercial evaluation of degradable materials).

Commercial Evaluation Degradable Materials and Escapement Openings

Promising degradable materials and crab pot escapement points (i.e., escapement panel openings and lid closure straps) identified during various studies were field tested by commercial crabbers (NCDMF 2008). In June 2005, seven crab potters in different geographic areas with varying salinity ranges were supplied with five test (plastic coated hex-mesh) crab pots and materials to use during their normal crabbing activities. Crabbers were asked to record fishing and material break dates, time required to replace device, and other observations on material use, escapement design function, and impact on catch rate.

In previous lid strap tests by NCDMF and others, the degradable material/lid strap device was attached to the top of the crab pot. Based on crabber concerns about the potential loss of the lid strap and pots during transport, we chose to try a different method of securing the lid strap. The pot lid closure strap was attached to the top of the crab pot as normal. However, instead of placing the strap hook on the wire mesh (normal), the strap hook was secured to a loop of degradable material to close the pot lid. Material length for the lid strap attachment loop ranged from 12 – 15 inches depending on the material diameter and point of attachment to the crab pot.

An approximately 2 inch vertical x 6 inch horizontal escapement opening (Figure 11.14.2) was made in the right rear wall of the upper pot chamber, one mesh above the pot partition. A functional 4.5 x 6 inch escapement panel, that covers the 2 x 6 inch escapement opening, was attached to the pot by a loosely fitting stainless steel hog ring at each bottom corner of the panel. The escape panel was secured in the closed position by attaching the selected test material at the top middle of the panel. Material length for attachment of the panel to the pot ranged from 5 to 7 inches depending on the material diameter.

Results from a NC study of degradable materials (Winslow 2004), on crab pots in areas of relatively low and high salinities, indicated that salinity did not seem to influence material degradation. Therefore, tests were not separated by salinity. It appears, from the frequency of material failure by crabber, that various environmental conditions and gear usage patterns may have a significant impact on material longevity. Thus, this effort resulted in a very useful evaluation that spanned a wide variety of areas and crabber use patterns. Minimum, maximum, and average days to break for each degradable material/escapement device, material/device repair time, and percentage of lost catch for functional devices are shown in Table 11.14.6.

For the lid strap escapement device materials, there was quite a bit of variability between the minimum and maximum days to break for all materials (Table 11.14.6). Average days to break were lowest for the sisal (light) and highest for the sisal (heavy) materials. Jute (heavy) had the highest minimum of 25 days to break; whereas, all other materials had an initial break date between two and ten days. However, the test durations, and small number of test replicates and breaks may not be sufficient to assess the relative longevity of the sisal (heavy) and jute (heavy) materials for the lid strap application. Material breakage for the lid strap device usually occurs as the crabber unhooks or hooks the lid strap. In cases where the lid strap material breaks when the pot is in the water, the lid of the pot may not open or open only slightly. Even when the lid strap material broke and the device opened, the average loss of catch was less than that for panel devices (Table 11.14.6).

For the panel escapement device materials, there was even more variability between the minimum and maximum days to break for the natural twine materials, as compared to the lid strap. Average days to break were lowest for the jute (light) material. The cotton material had the longest average failure rate and highest minimum of 72 days to break; whereas, all other natural twine materials had an initial break date between 2 to 22 days. However, for the cotton material, the test durations, and small number of test replicates and breaks (only 2) may not be sufficient to assess the relative longevity of this material for the panel application. The 14-gauge hog ring did not break during the study. Some crabbers reported the hog ring as rusty, but no significant degradation was noted. Compared to the lid strap device, crabbers reported significantly more occurrences where the panel device was functioning properly (open) after material failure (Table 11.14.6). During these instances when the panel device was open, the average loss of catch ranged from 83 to 100 percent.

An exit survey was conducted to determine the crabber's opinions of the various materials and escapement devices and to solicit input for improvements or new ideas. The escapement panel was the preferred device for durability and ease of maintenance. Most crabbers preferred the cotton or hog ring material for the panel device, due to the longevity of the materials and ease of use. The crabbers had significant problems with the lid strap device and the time consuming method of attaching the lid strap hook in the material loop while wearing heavy gloves. Frequency of material failure and variability by crabber, indicate that various environmental conditions and gear usage patterns may have a significant impact on material longevity. Depending on the escapement device/material, breakage and repair could result in a significant impediment to the routine speed and efficiency of commercial crab potting.

The cost of the natural twine materials is minimal; a 254 foot roll of heavy jute (9/64 inch) is about $2.65 and would be enough to rig about 508 pots with an escape panel (Table 11.14.7). Cost of a 5 x 6 ½ inch Top-Me escape panel with an incorporated escape ring is $0.50 ($250.00 for 500 pots) and a panel made from pot wire is likely cheaper. Hence, the cost for materials to a fishermen fishing 500 pots for 200 days per year and making five material changes would be approximately $263.25 for the first year and $13.25 for the twine in subsequent years.

However, this does not include material shipping, the time costs to cut the material, rig the pot, and on the water lost time to re-rig the escapement device, and lost catch.

Table 11.14.6 Minimum, maximum, and average days to break for each degradable material/escapement device, material/device repair time, and percentage of lost catch for functional escapement devices for the commercial crab pot field evaluation in North Carolina, 2005 (NCDMF 2008).

	Material – days to break					Percent loss of catch (when device functioned properly)			
Degradable material/ escapement device	Total breaks	Ave.	Min.	Max.	Repair time (minutes)	Total records	Ave.	Min.	Max.
Lid straps									
Sisal (light)-Lehigh #390/ Lid strap	11	28	4	58	1.25-10	2	80	80	80
Sisal (heavy) 5/64 inch Cordemex/ Lid strap	4	76	10	130	1-3	2	67	33	100
Jute (light)-Lehigh #530/ Lid strap	11	30	9	72	1-5	5	50	0	100
Jute (heavy) 9/64 inch Winne / Lid strap	5	41	25	73	2.25-10	0			
Cotton .062 inch/ Lid strap	23	37	2	87	1-10	4	79	50	100
Escape panels									
Sisal (light)-Lehigh #390/ Panel	13	41	5	106	1.25-10	2	100	100	100
Sisal (heavy) 5/64 Cordemex/ Panel	12	50	2	117	1-5	11	97	67	100
Jute (light)-Lehigh #530/ Panel	21	35	9	165	2-4	15	83	0	100
Jute (heavy) 9/64 inch Winne / Panel	14	46	22	107	2.25-10	7	100	100	100
Cotton .062 inch/ Panel	2	73	72	73	No data	1	100	100	100
Hog Ring 14ga./ Panel	None								

Table 11.14.7 Approximate cost of various degradable natural twines to rig escapement panels or lid straps on 500 crab pots (2011 prices) with 6 inches of material per panel and 12 inches for the lid strap.

			Number of pots that can be rigged per roll		Number of rolls needed to rig 500 pots		Total material cost to rig 500 pots	
Material	Material length per roll (feet)	Price per roll	Panel	Lid strap	Panel	Lid strap	Panel	Lid strap
Sisal (heavy) 5/64 inch	3000	$17.27	6000	3000	0.08	0.17	$1.44	$2.88
Jute (heavy) 9/64 inch	254	$2.65	508	254	0.98	1.97	$2.61	$5.22
Cotton 0.062 inch	4116	$13.25	8232	4116	0.06	0.12	$0.80	$1.61

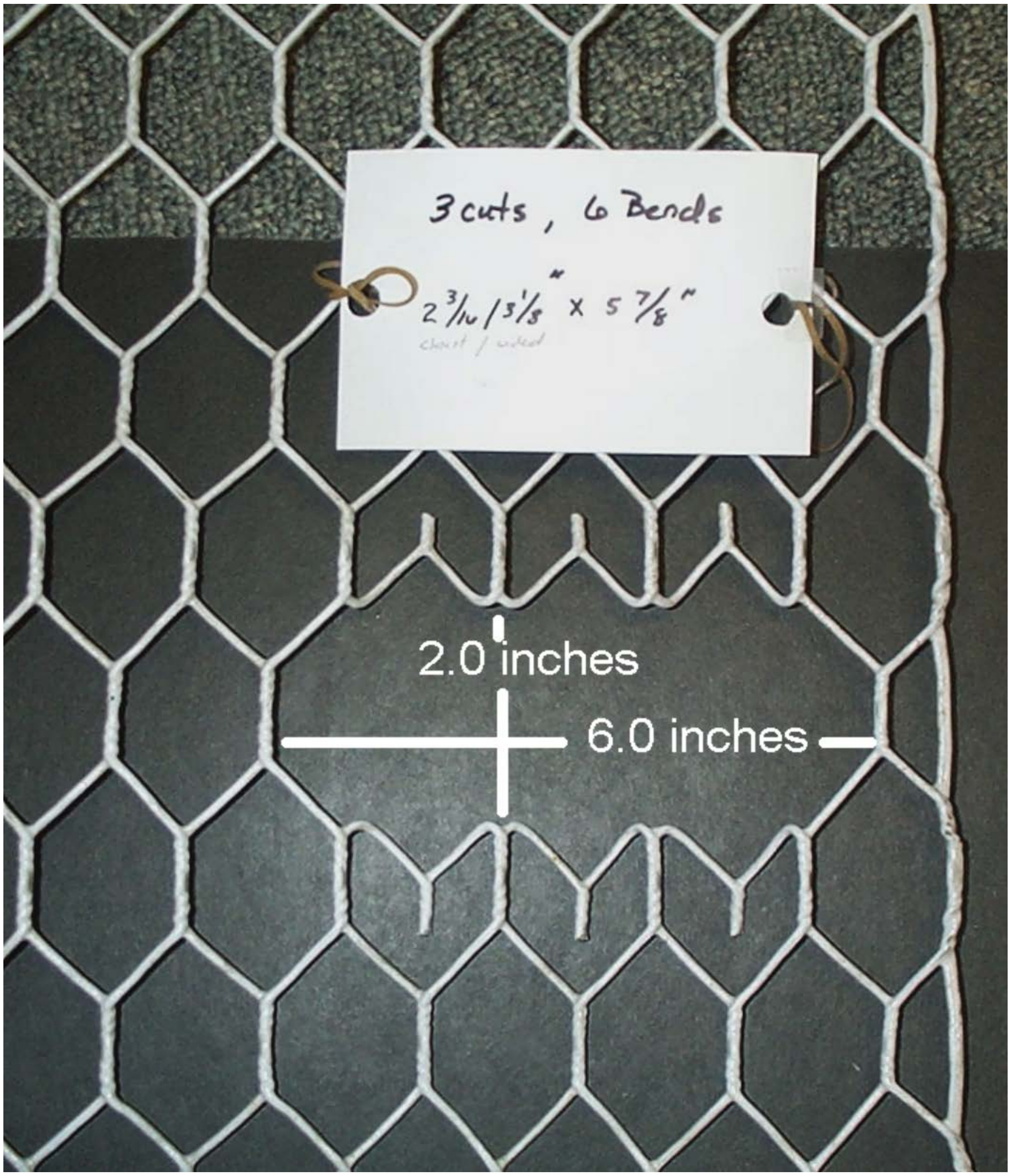

Figure 11.14.2 Crab pot escapement opening used in the commercial crab pot field evaluation of degradable materials and escapement devices in North Carolina, 2005 [horizontal orientation of a three bar cut opening, and six wire bends to make the opening; minimum 6.0 inch width (w) x 2.0 inch height (h); located one mesh above the lower pot partition in the right back corner of the upper pot chamber (opposite of the lid strap)]

VI. PROPOSED RULE(S)

No rules are proposed at this time.

VII. MANAGEMENT OPTIONS AND IMPACTS

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

A. <u>Options to minimize pot loss</u>:

1. Status quo
   + Pots collected during the clean up period have decreased significantly over time
   + No rules change
   - Continued problems with ghost pots (pot loss, mortality, spatial conflict)

2. Harvest seasons by gear type (pot and trawl)
   + Minimize interactions between crab trawlers and potters, thereby;
     a. Reducing pots lost to crab trawlers, and
     b. Reducing user conflicts
   + More efficient law enforcement (able to concentrate on fewer fisheries at a time).
   - Lost revenue for fishermen
   - Reduced flexibility for trawlers and potters

3. Area restrictions by gear type (pot and trawl)
   + Minimize interactions between crab trawlers and potters, thereby;
     a. Reducing pots lost to crab trawlers, and
     b. Reducing user conflicts
   + More efficient law enforcement (able to concentrate on fewer fisheries at a time).
   - Lost revenue for fishermen
   - Reduced flexibility for trawlers and potters

4. Require reflective tape or paint on crab pot buoys
   + Reduce ghost pots
   + Reduce user conflicts between boaters and potters
   - Increased economic burden on pot fishermen (might be offset by having to replace fewer pots)

5. Require the use of full size (5 inch X 11 inch vs. 5 inch x 5 inch) buoys on crab pots
   + Reduce ghost pots
   + Reduce user conflicts between boaters and potters
   - Increased economic burden on fishermen (might be offset by having to replace fewer pots)
   - Increase the number of ghost pots, because the increased buoyancy causes pots to move more readily during storms and periods of strong tides

6. Shorten the attendance period for crab pots
   + Reduce ghost pots
   + Reduce user conflicts
   + Reduce effort
   - Burden to fishermen

- Cause inefficiency during certain times of the year

7. Require pots to be removed from the water prior to major storm events
   + Reduce the number of ghost pots
   + Fishermen save money by not having to replace lost pots
   - Lost income due to days lost fishing

8. Prohibit pots in certain areas
   + Reduce the number of ghost pots
   + Reduce user conflicts
   - Lost income
   - Increase conflicts among potters

9. Structural weight modifications to pots
   + Reduce the number of ghost pots
   - Increased cost to fishermen

10. Encourage crab potters in areas of high pot loss to incorporate methods to reduce pot loss. Develop and provide information on potential methods to reduce pot loss
    + Reduce the number of ghost pots
    + Reduce pot replacement costs
    + Targets the problem to specific areas
    - Continued problem with ghost pot loss
    - Potential increase in cost to modify gear
    - No mechanism to ensure improved methods are implemented
    - Cost to produce educational materials

B. <u>Options to minimize ghost pot fishing mortality</u>:

1. No action
   + Pots collected during clean up period have decreased significantly over time
   + No new regulations
   - Continued problem with ghost pot fishing mortality

2. Require escape panels or devices on crab pots. Panel must be secured by a degradable material (method & material)
   + Reduce waste caused by ghost pots
   - Possible loss of legal catch due to premature failure of degradable material/panel
   - Cost and time to install and replace the devices

3. Require escape panels or devices on crab pots within certain high flow areas where pots are subject to move and the potential for loss is increased. Panel must be secured by a degradable material (method & material)
   + Reduces waste caused by ghost pots
   + Targets the problem to specific areas
   - Possible loss of legal catch due to premature failure of degradable material/panel
   - Cost and time to install and replace the devices
   - Places a higher burden on a particular segment of the fishery

4. Encourage crab potters in areas of high pot loss to incorporate escape panel designs in pots to reduce potential ghost fishing impacts. Develop and provide information on potential methods and materials to reduce ghost fishing impacts
   + Reduce the number of ghost pots
   + Reduce ghost fishing impacts
   + Pots collected during clean up period have decreased significantly over time
   + Reduce the need to regulate
   + Foster further innovative methods to reduce pot loss and ghost fishing impacts
   - Continued problem with ghost pot loss
   - Potential increase in cost to modify gear
   - No mechanism to ensure improved methods are implemented
   - Cost to produce educational materials

VIII. RECOMMENDATION

MFC selected management strategy
- Encourage crab potters in areas of high pot loss to incorporate methods to reduce pot loss. Develop and provide information on potential methods to reduce pot loss.
- Encourage crab potters in areas of high pot loss to incorporate escape panel designs in pots to reduce potential ghost fishing impacts. Develop and provide information on potential methods and materials to reduce ghost fishing impacts.

AC - Status quo for both minimizing pot loss and reducing ghost pot fishing mortality.

NCDMF- Encourage crab potters in areas of high pot loss to incorporate methods to reduce pot loss. Develop and provide information on potential methods to reduce pot loss.
- Encourage crab potters in areas of high pot loss to incorporate escape panel designs in pots to reduce potential ghost fishing impacts. Develop and provide information on potential methods and materials to reduce ghost fishing impacts.

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September 27, 2011
Revised: February 27, 2012

12.0 RECOMMENDED MANAGEMENT STRATEGIES AND RESEARCH RECOMMENDATIONS

12.1 MANAGEMENT STRATEGIES

The management strategies and research needs listed in this section are organized according to the General Problem Statements (Section 5.4) as recommended by the MFC. Each strategy is followed by a reference to the Principal Issues and Management Options from Section 11.0 indicated in parentheses. An overall discussion of the environmental factors is contained in Section 10.0 with recommended management strategies for habitat and water quality found in Subsection 10.4.

12.1.1 ENVIRONMENTAL FACTORS

MFC selected management strategy (Subsection 10.4)

Habitat

1. Identify and designate Strategic Habitat Areas (SHAs) that will enhance protection of the blue crab.
2. Identify, research, and designate additional areas as Primary Nursery Areas that may be important to blue crabs as well as other fisheries.
3. Continue to map blue crab spawning areas and evaluate any that need to adjust or expand the boundaries or restrictions of the crab spawning sanctuaries based on recent research.
4. Remap and monitor SAV in North Carolina to assess distribution and change over time.
5. Restore coastal wetlands to compensate for previous losses and enhance habitat and water quality conditions for the blue crab.
6. Work with CRC to revise shoreline stabilization rules to adequately protect riparian wetlands and shallow water habitat and significantly reduce the rate of shoreline hardening.
7. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV, wetland edge, and other habitat important to blue crab.
8. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.
9. Support oyster shell recycling and oyster sanctuary programs to provide areas of enhanced or restored shell bottom habitat.
10. Consider if prohibition of crab dredging is advisable.
11. Protect “recruitment bottlenecks”, like inlets for the blue crab, from trawling or other impacts including natural channel modification using hardened structures like groins and jetties.
12. Shallow areas where trawling is currently allowed should be re-examined to determine if additional restrictions are necessary.

Water Quality

1. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.
2. Increase on-site infiltration of stormwater through voluntary or regulatory measures.

3. Provide more incentives for low-impact development.
4. Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading.
5. Provide proper disposal of unwanted drugs, prevent the use of harmful JHA insecticides near-surface waters or in livestock feed, and develop technologies to treat wastewater for antibiotics and hormones.

12.1.2 STOCK PROTECTION

12.1.2.1 ISSUE: ADAPTIVE MANAGEMENT FRAMEWORK FOR THE NORTH CAROLINA BLUE CRAB STOCK

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MANAGEMENT OPTIONS

1. Status quo [Continue with the current female stock conservation management trigger as outlined in Rule 15A NCAC 03L .0201 SIZE LIMIT AND CULLING TOLERANCE (c) (1) (2)]
2. Implement some measure of effort control
3. Repeal the current female stock conservation management trigger as outlined in Rule 15A NCAC 03L .0201 SIZE LIMIT AND CULLING TOLERANCE (c) (1) (2)
4. Adopt adaptive management framework based on the Traffic Light Stock Assessment and the proposed moderate and elevated management levels for recruit, adult, and production stock characteristics

MFC selected management strategy (Section 11.1)

- Repeal the current female stock conservation management trigger.
- Continue existing sampling programs to maintain baseline information for the Traffic Light method.
- Adopt the adaptive management framework based on the Traffic Light Stock Assessment and the proposed moderate and elevated management levels for recruit abundance, adult abundance, and production characteristics with the proposed management measures shown in the table below. Initial management actions will only be implemented when either the adult abundance or production characteristics reach the management trigger of 50% red or greater for three consecutive years. The recruit abundance characteristic will be used as a supplement to further direct conservation management actions, if deemed necessary.

Note: All adaptive management measures would be implemented through proclamation authority.

Characteristic	Moderate management level	Elevated management level
Adult abundance	A1. Increase in minimum size limit for male and immature female crabs	A4. Closure of the fishery (season and/or gear)
	A2. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 5%) and/or implement gear modifications to reduce sublegal catch	A5. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 1%) and/or implement gear modifications to reduce sublegal catch
	A3. Eliminate harvest of v-apron immature hard crab females	A6. Time restrictions
Recruit abundance	R1. Establish a seasonal size limit on peeler crabs	R4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots in specific areas
	R2. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	R5. Expand existing and/or designate new crab spawning sanctuaries
	R3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	R6. Closure of the fishery (season and/or gear)
		R7. Gear modifications in the crab trawl fishery
Production	P1. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	P4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots for specific areas
	P2. Minimum and/or maximum size limit for mature female crabs	P5. Reduce peeler harvest (no white line peelers and/or peeler size limit)
	P3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	P6. Expand existing and/or designate new crab spawning sanctuaries
		P7. Closure of the fishery (season and/or gear)

12.1.3 USER CONFLICTS

12.1.3.1 ISSUE: CRAB POT LIMIT IN SOUTHERN BOGUE SOUND

MANAGEMENT OPTIONS
1. Status quo
2. Establish a 75 pot per vessel limit from the Emerald Isle Bridge to Marker #65A
3. Establish a 75 to100 pot per vessel limit from the Emerald Isle Bridge to Marker #65A from March through June

MFC selected management strategy (Section 11.2)

- Status quo, continue with no crab pot limit in this area.

12.1.3.2 ISSUE: CONSIDER ALLOWING NON-POT AREAS IN PUNGO RIVER AREA TO BE REDESIGNATED AS OPEN TO POTS

MANAGEMENT OPTIONS
1. Status quo
2. Modify rule to allow for all or selected non-pot areas to be opened by proclamation

MFC selected management strategy (Section 11.3)
- Open the non-pot (long haul net) areas all the time by rule in the Pungo River and keep status quo in the Long Point area on the Pamlico River.

12.1.4 CLARIFICATION OF RULES

12.1.4.1 ISSUE: INCORPORATE THE LOWER BROAD CREEK CLOSURE TO CRAB POT AREA INTO RULE

MANAGEMENT OPTIONS
1. Status quo
2. Modify rule to include lower Broad Creek area that is closed to potting June 1 through November 30

MFC selected management strategy (Section 11.4)
- Modify the rule to include the lower Broad Creek area that is closed to crab pots from June 1 through November 30.

12.1.4.2 ISSUE: CLARIFY CRAB DREDGING RESTRICTIONS

MANAGEMENT OPTIONS
1. Status quo
2. Amend Rule 15A NCAC 03L .0203 to conform to current harvest management
3. Apply a strict interpretation of Rule 15A NCAC 03L .0203 to taking crabs with dredges

MFC selected management strategy (Section 11.5)
- Amend the rule to match the harvest management provisions.

12.1.4.3 ISSUE: INCORPORATE THE PAMLICO SOUND CRAB TRAWLING PROCLAMATION INTO RULE 15A NCAC 03L .0202

MANAGEMENT OPTIONS
1. Status quo
2. Modify Rule 15A NCAC 03L .0202 CRAB TRAWLING to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four-inch mesh crab trawl line)
3. Remove the Fisheries Director’s proclamation authority to increase the minimum trawl mesh length to no more than four inches to take hard crabs

MFC selected management strategy (Section 11.6)
- Modify Rule 15A NCAC 03L .0202 to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four inch mesh crab trawl line), and retain the Director’s proclamation authority to restrict crab trawl mesh size.

12.1.4.4 ISSUE: EXPLORE OPTIONS FOR ESCAPE RING EXEMPTIONS IN HARD CRAB POTS TO HARVEST PEELER CRABS

MANAGEMENT OPTIONS
1. Status quo
2. Add these supplemental specifications to the existing proclamation authority outlined in the rule and develop criteria for escape ring exemptions for taking peeler crabs
3. Redefine criteria for exempting escape rings in crab pots from the 1½-inch pot mesh size to unbaited pots and pots baited with a male crab
4. Repeal the Fisheries Director's proclamation authority that allows for exempting the escape ring requirement in order to allow the harvest of peeler crabs

MFC selected management strategy (Section 11.7)
- Amend the current rule to redefine criteria for exempting escape rings in crab pots from the 1½-inch pot mesh size to unbaited pots and pots baited with a male crab.
- Repeal the proclamation authority that allows for exempting the escape ring requirement in order to allow the harvest of peeler crabs.

12.1.4.5 ISSUE: CONVERT CRAB POT ESCAPE RING PROCLAMATION EXEMPTIONS FOR MATURE FEMALES INTO RULE

MANAGEMENT OPTIONS
1. Status quo
2. Place exempted escape ring area delineations into rule as they are written now in proclamation
3. Place exempted escape ring area delineations into rule and clearly define the boundaries.

MFC selected management strategy (Section 11.8)
- Adopt the no trawl line along the Outer Banks in Pamlico Sound as the new boundary in Pamlico Sound, and the Newport River boundaries as delineated in the proposed rule as new boundaries for the area where closure of escape rings to take small mature females is allowed.

12.1.4.6 ISSUE: CORRECT PEELER TRAWL EXCEPTION RULE

MANAGEMENT OPTIONS
1. Status quo
2. Modify Rule 15A NCAC 03J .0104 (b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation

MFC selected management strategy (Section 11.9)
- Modify Rule 15A NCAC 03J .0104 (b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation.

12.1.4.7 ISSUE: BLUE CRAB SIZE LIMIT AND CULLING TOLERANCE

MANAGEMENT OPTIONS

1. Status quo
2. Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs

MFC selected management strategy (Section 11.10)

- Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs.

12.1.5 HARVEST PRACTICES

12.1.5.1 ISSUE: ALLOW FLOATING CRAB POT LINES IN AREAS WHERE OBSTRUCTIONS EXIST

MANAGEMENT OPTIONS

1. Status quo
2. Modify rule to describe specific configurations of line deemed within the "non-floating line" interpretation
3. Modify rules to delineate areas in which floating lines could be used
4. Modify rule to replace non-floating language with line that "does not float at the surface"

MFC selected management strategy (Section 11.11)

- Status quo, continue with non-floating line in crab pots.

12.1.5.2 ISSUE: DIAMONDBACK TERRAPIN INTERACTIONS WITH THE BLUE CRAB FISHERY

MANAGEMENT OPTIONS

1. Status quo. Take no regulatory action
2. Require terrapin excluders and/or modifications to crab pots (hard and/or peeler) fished within a specified distance of shore during the spring, within specified areas
3. Require terrapin excluders in all recreational crab pots, statewide
4. Require the use of terrapin excluders on all crab pots (hard and peeler) fished within 6 feet of water depth during April through October
5. Close specific areas to pots based on timing of increased interactions with terrapins
6. Require that all commercial pots used in waters less than 150 feet wide at low tide or in any man-made lagoon must be fitted with Bycatch Reduction Devices (BRD) designed to exclude diamondback terrapins. These devices may be either rectangular or diamond shaped and no longer than 6 inches wide or 2 inches high. These devices should be attached across the opening at the narrow end of each funnel entrance
7. Require the use of terrapin excluders on all crab pots (hard and peeler) in specified areas only

MFC selected management strategy (Section 11.12)

- Establish:
  1. Proclamation authority for requiring terrapin excluder devices in crab pots; and
  2. A framework for developing proclamation use criteria and terrapin excluder specifications which may extend until after adoption of the amendment.

- The recommendation is contingent on:
  a. Consultation with the Crustacean AC on developing criteria; and
  b. No use of the proclamation authority until criteria are approved by the MFC.

12.1.5.3 ISSUE: MULTIPLE POTS TO A SINGLE BUOY

MANAGEMENT OPTIONS
1. Status quo
2. Allow multiple pots on a line in the Atlantic Ocean (define maximum number of pots per line)
3. Allow multiple pots on a line in all waters open to potting (define maximum number of pots per buoy)
4. Proclamation authority for multiple pots on a line (areas, means, methods, etc.)

MFC selected management strategy (Section 11.13)
- Status quo, do not allow multiple pots to a single buoy.

12.1.5.4 ISSUE: POT LOSS AND GHOST POT BYCATCH MORTALITY

MANAGEMENT OPTIONS
A. <u>Options to minimize pot loss</u>:

1. Status quo
2. Harvest seasons by gear type (pot and trawl)
3. Area restrictions by gear type (pot and trawl)
4. Require reflective tape or paint on crab pot buoys
5. Require the use of full size (5 inch X 11 inch vs. 5 inch x 5 inch) buoys on crab pots
6. Shorten the attendance period for crab pots
7. Require pots to be removed from the water prior to major storm events
8. Prohibit pots in certain areas
9. Structural weight modifications to pots
10. Encourage crab potters in areas of high pot loss to incorporate methods to reduce pot loss. Develop and provide information on potential methods to reduce pot loss

B. <u>Options to minimize ghost pot fishing mortality</u>:

1. No action
2. Require escape panels or devices on crab pots. Panel must be secured by a degradable material (method & material)
3. Require escape panels or devices on crab pots within certain high flow areas where pots are subject to move and the potential for loss is increased. Panel must be secured by a degradable material (method & material)
4. Encourage crab potters in areas of high pot loss to incorporate escape panel designs in pots to reduce potential ghost fishing impacts. Develop and provide information on potential methods and materials to reduce ghost fishing impacts

MFC selected management strategy (Section 11.14)
- Encourage crab potters in areas of high pot loss to incorporate methods to reduce pot loss. Develop and provide information on potential methods to reduce pot loss.
- Encourage crab potters in areas of high pot loss to incorporate escape panel designs in pots to reduce potential ghost fishing impacts. Develop and provide information on

potential methods and materials to reduce ghost fishing impacts.

12.2 RESEARCH RECOMMENDATIONS

- Continue to support research to determine the status of protected species (e.g., migration patterns, habitat utilization) along the North Carolina coast to better anticipate and prevent interactions.
- Support research on blue crab fishery interactions with protected species (e.g., identifying any seasonal or spatial peaks in potential for interactions).
- Support gear modification research and testing that could reduce protected species interactions.
- Continue socioeconomic surveys of blue crab harvesters and include wholesale and retail benefits, the entire support industry for this fishery including suppliers, picking houses, and restaurants..
- Update Recreational Commercial Gear License (RCGL) survey.
- Continue survey and compile data of recreational crabbers not possessing a RCGL license.
- Determine the economic effects of imported crabmeat, including the mixture of imported meat with local crabmeat, on processing and demand.
- Determine the costs associated with crab processing. Identify the factors and their relative importance in predicting processor closures.
- Research the changing demographics of the commercial blue crab fishery.
- Continue research on the impacts of endocrine disrupting chemicals (EDCs) on the various life stages of the blue crabs and way to reduce introduction of EDCs into estuarine waters.
- Assess the impact of winter inlet deepening dredge activities on the overwintering female blue crabs and their habitat.
- Determine the spatial and biological characteristics of SAV beds that maximize their ecological value to the blue crab for restoration or conservation purposes.
- Identify, research, and map shallow detrital areas important to blue crabs.
- Additional research is needed on the extent, causes, and impacts of hypoxia and anoxia on blue crab behavior and population abundance in North Carolina’s estuarine waters.
- Conduct research on the water quality impacts of crab pot zincs, bait discard, and alternative crab baits in the pot fishery.
- Develop methods to expand sampling effort to more accurately assess the status of the blue crab stock and its fisheries.
- Continue research on blue crab discards in the shrimp trawl fishery.
- Expand research state wide on the use of terrapin excluder devices in crab pots
- Implement outreach programs to inform state agencies, the public, and the commercial and recreational fishing industries about issues relating to protected species and fishery management.
- Continue gear development research to minimize species interactions.
- Continue existing programs that have been used to monitor North Carolina’s blue crab stock to maintain baseline data
- Identify key environmental factors that significantly impact North Carolina’s blue crab stock and investigate assessment methods that can account for these environmental factors
- Conduct a study of the selectivity of the gear used in the Juvenile Anadromous Trawl Survey (Program 100) to evaluate the size at which blue crabs are fully-selected to the

survey gear; the results of such a study could help determine whether the survey data could be used to develop a reliable index of blue crab recruitment for the Albemarle region; no such index is currently available

- Expand spatial coverage of the Estuarine Trawl Survey (Program 120) to include shallow-water habitat in Albemarle Sound; sampling in shallow-water habitat is intended to target juvenile blue crabs so that a recruitment index for the Albemarle Sound could be developed
- Expand temporal coverage of the Estuarine Trawl Survey (Program 120) beyond May and June sampling; additional sampling later in the blue crab's growing season would provide more information on within-year changes in growth, mortality, and abundance; at a minimum, recommend addition of September sampling in order to capture the fall settlement peak
- Expand spatial coverage of Pamlico Sound Survey (Program 195) to include deepwater habitat in Albemarle Sound and the Southern Region; expanding the sampling region of adult blue crab habitat would allow for a more spatially-comprehensive adult index; additionally, there would be increased confidence in comparison of adult abundance trends among regions since all would derive from the same sampling methodology
- Implement a statewide survey with the primary goal of monitoring the abundance of blue crabs in the entire state; such a survey would need to be stratified by water depth to ensure capture of all stages of the blue crabs life cycle and standardized among North Carolina waters
- Implement monitoring of megalopal settlement near the ocean inlets could potentially add a predictive function to the blue crab stock assessments in the future; Forward et al. (2004) detected a positive, linear relationship between megalopal abundance and commercial landings of hard blue crabs for both the local estuarine area and the entire state of North Carolina when a two-year time lag was implemented (Forward et al. 2004); such monitoring is critical to track larval ingress peaks and the effect of natural forces, such as tropical storms and prevailing winds, on ingress.
- Continue surveys of recreational harvest and effort to improve characterization of the recreational fishery for blue crabs
- Identify programs outside the NCDMF that collect data of potential use to the stock assessment of North Carolina's blue crabs
- Perform in-depth analysis of available data; consider standardization techniques to account for gear and other effects in development of indices; explore utility of spatial analysis in assessing the blue crab stock

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14.0 APPENDICES

14.1 SUMMARY OF ACTIONS TAKEN IN 1998

Section 5.5 of the Fishery Reform Act of 1997 specifically requires that the Marine Fisheries Commission "adopt a Fishery Management Plan (FMP) for the blue crab fishery" by January 1, 1999. <u>The plan was adopted by the Marine Fisheries Commission on December 11, 1998</u>.

Actions taken as a result of the recommendations outlined in the 1998 Blue Crab Fishery Management Plan (BCFMP - McKenna et al. 1998) are summarized below by section (see underlined text). Much of the funded research listed herein was conducted through the Fishery Resources Grant Program (FRG-year-project code-project number) or the Blue Crab Research Program (BCRP). Both grant programs are funded by the NC General Assembly and administered by the NC Sea Grant College Program.

10. PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

10.1 ENVIRONMENTAL ISSUES

10.1.1 HABITAT (BCFMP 1998; page 29)

Recommended Management Strategy

The N.C. Marine Fisheries Commission (MFC), N.C. Coastal Resources Commission (CRC), and N.C. Environmental Management Commission (EMC) should adopt rules to protect blue crab critical habitats as outlined in the Coastal Habitat Protection Plans (CHPP), as those plans are prepared and approved. <u>No Plans have been completed and approved</u>.

The MFC and Division of Marine Fisheries (NCDMF) should continue to comment on activities that may impact aquatic habitats and work with permitting agencies to minimize impacts and promote restoration. <u>Ongoing by NCDMF Staff and MFC Habitat/Water Quality Committee</u>.

Research must be conducted to investigate the impacts of trawling on various habitats. <u>See "Funded Research" below</u>.

<u>Funded Research:</u>

"Study Utilization of Oyster Shell Planting Sites by Shrimp, Fishes, and Crabs." FRG-96-FEG-104. Hunter Lenihan.

"The Biological and Economic Value of Restored Intertidal Oyster Reef Habitat to the Nursery Function of the Estuary." FRG-97-EP-06. Jonathan H. Grabowski.

"The Biological and Economic Value of Restored Intertidal Oyster Reef Habitat to the Nursery Function of the Estuary." FRG-98-EP-16. Jonathan Grabowski.

"Shrimp and Crab Trawling Impacts on Estuarine Soft-Bottom Organisms." FRG-98-EP-21. William Henry Daniels.

"A Comparison of Restored vs. Natural Oyster Reefs: Assessing Whether Restoring Oyster Reef Habitat Returns the Biological Functions and Economic Value Provided by Natural Reefs to the Estuary." FRG-00-EP-03. Jonathan Grabowski.

"Potential Impacts of Bottom Trawling on Water Column Productivity and Sediment Transport Processes." FRG-01-EP-04. Henry Daniels.

10.1.2 WATER QUALITY (BCFMP 1998; page 30)

Recommended Management Strategy

The MFC and DMF should continue to comment on activities that may impact estuarine water quality and work with permitting agencies to minimize impacts. Ongoing.
Water quality standards should be based on the assimilative capacity of, and impacts to, the entire system. Standards are not based on assimilative capacity and impacts.
Several plans for water quality management have recommended strategies that need to be implemented to improve water quality. Many strategies have not been implemented.

Funded Research:
"Effects of Anoxia on the Value of Bottom Habitat for Fisheries Production in the Neuse River Estuary." FRG-98-EP-04. Elizabeth Thomson.

"Blue Crab Trophic Dynamics Project: Use of Stable Isotopes as Bio-Indicators of Anthropogenic Sources" BCRP-01-BIOL-06 and 02-BIOL-01. Steve Rebach and John Bucci.

"Impact of Salinity on Tolerance of Crustaceans to Nitrogenous Waste." BCRP-03-BIOL-07. Dell Newman.

10.2 WASTEFUL or DAMAGING FISHING PRACTICES

10.2.1 SPAWNING STOCK MANAGEMENT (BCFMP 1998; page 31-32)

Recommended Management Strategy

Strengthening of spawning sanctuary rules should be accomplished by prohibiting all commercial gears, except attended gill nets (Action 4). Existing rule was modified as follows:

15A NCAC 3L .0205 CRAB SPAWNING SANCTUARIES (MFC 2003; page 60)

(a) It is unlawful to set or use ~~a trawl net~~ trawls, pots, and mechanical methods for oysters or clams or take crabs with the use of commercial fishing equipment from the crab spawning sanctuaries described in 15A NCAC 3R .0110 from March 1 through August 31.

Action 2: Survey sanctuary areas to determine functionality.

Funded Research:
NCDMF conducted a trawl survey of Oregon Inlet Sanctuary, 1999-2001 (trawl may not be an efficient sample gear in this habitat).

"Mapping of Geographic Features and their Attributes and Marking of Hazards In and Between the Ocracoke and Hatteras Inlet Blue Crab Sanctuaries." FRG-98-FEG-31. Eugene Ballance.

"Reproductive Potential and Migratory Movements of Mature Female Blue Crabs." BCRP-01-BIOL-05. Dan Rittschof, Earl Chadwick, Robert Cahoon, Lloyd Culpepper, Ray Golden, Anthony Sawyer, Dr. Richard Forward.

"Blue Crab Sampling in the Vicinity of the Hatteras and Ocracoke Spawning Sanctuaries Using Crab Pots." BCRP-01-POP-04 and 02-POP-03. Eugene Ballance.

"Field Assessment of Spawning Sanctuaries and Possible Migration Corridors for the Blue Crab Spawning Stock in North Carolina." BCRP-01-POP-08. David Eggleston, Sean McKenna, Henry Daniels, Martin Posey, and Budd George.

“Tagging of Adult Female Blue Crabs to Study Migration Toward and Use of Spawning Sanctuaries.” FRG-01-EP-06. Robin Doxey.

“Small Scale Movements and Protection of Brooding Female Blue Crabs Within a Spawning Sanctuary.” BCRP 03-BIOL-02. Thomas Wolcott and Eugene Ballance.

10.2.2 GHOST POTS (BCFMP 1998; page 33)

Recommended Management Strategy

Sinking lines should be required on all crab (hard and peeler) pots. This restriction would not only reduce the number of new ghost pots each year but should significantly reduce conflicts. Existing rule was modified to add new language as follows**:**

15A NCAC 3J .0301 POTS (MFC 2003; pages 38-40)

(k) It is unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating.

Recommended Management Strategy

Biodegradable panels will be considered for all hard and peeler crab pots, once necessary research is completed. Additional research was initiated in 2002 through the NCDMF Hurricane Crab Grant.

Conduct research on reflective tape for crab pot buoys. No research to date.

10.2.3 CRAB POT ESCAPE RING (BCFMP 1998; page 34)

Recommended Management Strategies

Data support the utility of escape rings as a viable management tool. The MFC should continue to require escape rings in hard crab pots. No changes were recommended.

Develop criteria for using proclamation authority to close or not require escape rings for mature females and peeler crab harvest. Criteria have not been developed by NCDMF.

10.2.4 CRAB TRAWL BYCATCH (BCFMP 1998; page 35)

Recommended Management Strategy

To minimize waste in this fishery, a 4 inch or 4.5 inch stretched mesh crab trawl should be considered in all coastal waters where crab trawling is allowed (Action 1). No changes were implemented.

Funded Research:

“Crab Trawl Tailbag Testing.” FRG-98-FEG-10. Terry Hannah.

Recommended Management Strategy

Additionally, area restrictions need to be put in place during the summer months to prohibit trawling in areas that serve as critical habitat for the blue crab. Trawling is currently prohibited in many areas of the State. No new critical habitat areas have been identified for protection.

Funded Research:

“Study Utilization of Oyster Shell Planting Sites by Shrimp, Fishes, and Crabs.” FRG-96-FEG-104. Hunter Lenihan.

“The Biological and Economic Value of Restored Intertidal Oyster Reef Habitat to the Nursery Function of the Estuary.” FRG-97-EP-06. Jonathan H. Grabowski.

"The Biological and Economic Value of Restored Intertidal Oyster Reef Habitat to the Nursery Function of the Estuary." FRG-98-EP-16. Jonathan Grabowski.

"A Comparison of Restored vs. Natural Oyster Reefs: Assessing Whether Restoring Oyster Reef Habitat Returns the Biological Functions and Economic Value Provided by Natural Reefs to the Estuary." FRG-00-EP-03. Jonathan Grabowski.

"Use of Turtle Excluder Devices (TEDs) in Crab Trawl Fishery." FRG-02-FEG-21. Pamlico County School System.

Action 8: NCDMF should recommend a maximum allowable bycatch of crabs for shrimp trawls. To reduce directed effort for crabs by shrimp trawlers, the NCDMF analyzed shrimp trawl bycatch data and recommended a maximum allowable bycatch of crabs per trip. Existing rule was modified to add a new section (f) as follows:

15A NCAC 3J .0104 TRAWL NETS (MFC 2003; pages 26-27)

(f) It is unlawful to use shrimp trawls for the taking of blue crabs in internal waters, except that it shall be permissible to take or possess blue crabs incidental to shrimp trawling in accordance with the following limitations:

(1) For individuals using shrimp trawls authorized by a Recreational Commercial Gear License, 50 blue crabs, not to exceed 100 blue crabs if two or more Recreational Commercial Gear License holders are on board.

(2) For commercial operations, crabs may be taken incidental to lawful shrimp trawl operations provided that the weight of the crabs shall not exceed:

(A) 50 percent of the total weight of the combined crab and shrimp catch; or

(B) 300 pounds, whichever is greater.

(3) The Fisheries Director may, by proclamation, close any area to trawling for specific time periods in order to secure compliance of this Paragraph.

Action 3: Collect fishery dependent data from the peeler crab and shrimp trawl fisheries.

Action 4: Conduct tailbag mesh size studies in Pamlico Sound (work to be conducted during 1998 and 1999 through a grant funded by the Fisheries Resource Grant Program).

Action 5: Investigate the economic and social impacts of the crab trawl fishery).

Action 6: Separate hard and peeler crab trawl landings on trip tickets.

Action 7: Establish definitions for peeler and hard crab trawls and allow only these gears to direct for blue crab harvest

No actions, research, or recommendations have been initiated for Action items 3-7.

10.2.5 WHITE LINE PEELER HARVEST (BCFMP 1998; page 36)

Recommended Management Strategy

Prohibiting the baiting of peeler pots, except with live, legal male blue crabs would minimize the harvest of "green" and "white line" peelers in the peeler pot fishery, contribute to optimum yield of the resource, and have minimal impact on the majority of North Carolina's crab shedding operations. To address the minimum size limit exemption problem in the hard crab pot fishery, peelers should be culled from the catch were taken, and the possession of male "white line" peelers should be prohibited during June through September.

Existing rule was modified as follows:

15A NCAC 3L .0201 SIZE LIMIT AND CULLING TOLERANCE (MFC 2003; page 59)

(a) It is unlawful to possess blue crabs less than five inches from tip of spike to tip of spike except mature females, soft <u>and</u> peeler crabs <u>and from March 1 through October 31, male crabs to be used as peeler bait</u>. A tolerance of not more than 10 percent by number in any container shall be allowed.

(b) All crabs less than legal size, except mature female and soft crabs, shall be immediately returned to the waters from which taken. Peeler crabs shall be separated <u>where taken</u> ~~from the entire catch~~ and placed in a separate container ~~before reaching shore or dock~~. Those peeler crabs not separated ~~before reaching shore or dock~~ shall be deemed hard crabs and are not exempt from the size restrictions specified in Paragraph (a) of this Rule.

<u>Two new rules were implemented as follows</u>:

15A NCAC 3L .0206 PEELER CRABS (MFC 2003; page 61)

(a) It is unlawful to bait peeler pots, except with male blue crabs. Male blue crabs to be used as peeler bait and less than the legal size must be kept in a separate container, and may not be landed or sold.

(b) It is unlawful to possess male white line peelers from June 1 through September 1.

Action 4: Determine shedding mortality rates by peeler stage, area, and season.

Action 5: Determine the importance of “white line” peelers to the economics of the fishery and examine related enforcement issues.

Action 6: Develop and implement more effective shedding practices to minimize mortality.

<u>Funded Research</u>:

“Crab Shedding in Closed Recirculating Aquaculture Systems.” FRG-97-AM-08. Norman Garry Culpepper.

“Assessing the Impact of Pesticide Use and Water Quality on the Blue Crab Survival in Soft Crab Shedding Operations.” FRG-99-EP-16. Damian Shea.

“Development of a Simple Field Test to Assess the Health of Blue Crabs (Callinectes sapidus).” FRG-99-AM-01. Robin Doxey, and Edward D. Noga.

“Examine Mortality Rate in Crab Shedding Operations.” FRG-00-AM-08. Donna Rose.

“Mortality and CPUE of the Blue Crab in North Carolina's Soft Shell Crab Industry.” FRG-01-FEG-03. Juan Chavez.

“Comparison of Mortality Rates Among Male Peelers.” BCRP-01-SHED-01. Dell Newman.

10.2.6 CRAB POT FINFISH BYCATCH (BCFMP 1998; page 37)

Recommended Management Strategy

No regulatory action should be taken at this time. Before this issue can be addressed, baseline information must be collected on the composition, quantity, and fate of unmarketable finfish bycatch in the crab pot (hard and peeler) fishery, by season and area.

<u>Funded Research</u>:

“Bycatch in the Crab Pot Fishery.” FRG-99-FEG-45. Robin Doxey.

10.2.7 SMALL PEELER/ SOFT CRAB HARVEST (BCFMP 1998; pages 37-38)

Recommended Management Strategy

Currently, there is not sufficient information to indicate that there is a need to curtail the harvest of small peeler/soft crabs in an effort to protect the spawning stock. A minimum size limit would have a severe economic impact on the existing fishery practices and markets; therefore, no rule change is recommended. No regulatory changes were initiated (recommended).

Action 2: Develop more effective shedding practices to minimize mortality.
Action 3: Examine the economic and biological issues involved and quantify the results.

Funded Research:

"Crab Shedding in Closed Recirculating Aquaculture Systems." FRG-97-AM-08. Norman Garry Culpepper.

"Assessing the Impact of Pesticide Use and Water Quality on the Blue Crab Survival in Soft Crab Shedding Operations." FRG-99-EP-16. Damian Shea.

"Development of a Simple Field Test to Assess the Health of Blue Crabs (Callinectes sapidus)." FRG-99-AM-01. Robin Doxey, and Edward D. Noga.

"Examine Mortality Rate in Crab Shedding Operations." FRG-00-AM-08. Donna Rose.

"Mortality and CPUE of the Blue Crab in North Carolina's Soft Shell Crab Industry." FRG-01-FEG-03. Juan Chavez.

"Comparison of Mortality Rates Among Male Peelers." BCRP-01-SHED-01. Dell Newman.

"Eliminating Bycatch in Peeler Pots." BCRP-02-STOK-04 and 03-STOK-01 Sam Marshall

10.2.8 DIAMONDBACK TERRAPIN BYCATCH and MORTALITY in CRAB POTS (BCFMP 1998; page 38)

Recommended Management Strategy

Additional research on potential options is warranted before regulatory action is taken on this issue. No regulatory changes were initiated.

Funded Research:

"Turtle Friendly Crab Pots." FRG-00-FEG-21. Joseph Benevides.

"Trying to Solve a Bycatch and Mortality Problem: Can We Exclude Diamondback Terrapins (Malaclemys terrapin) from Crab Pots Without Compromising Blue Crab (Callinectes sapidus) Catch." FRG-00-FEG-23. Larry Crowder.

"Evaluating the Efficiency and Necessity of Requiring Bycatch Reduction Devices on Pots in the Peeler Crab Fishery: Quantifying and Characterizing the Spatial and Temporal Overlap of Activities Between Diamondback Terrapins (*Malaclemys terrapin*) and the Commercial Fishery for Peeler Blue Crabs (*Callinectes sapidus*)." FRG-03-FEG-18. Robert Cahoon and Kristen Hart.

10.2.9 WHITE BELLY CRAB HARVEST (BCFMP 1998; page 39)

Recommended Management Strategy

No regulatory action should be taken on this issue at this time. No regulatory changes were initiated (recommended).
The crab industry should voluntarily reduce the harvest of white belly crabs or reduce the incentive for harvesting this low quality product. Information on the economics of this product should be collected and summarized and used in industry education efforts.

Funded Research:
"Pilot project to maximize the market potential of "white belly" crabs." FRG-99-FEG-17. Mark Hooper.

"Economic Implications of the Harvest of "White Belly" Blue Crabs." FRG-01-FEG-13. Mark Hooper.

"Economic Feasibility of Fattening Up White Belly Crabs." BCRP-01-BIOL-01. Willy Phillips.

"Feasibility and Economics of Holding and/or Selling White Belly Crabs." BCRP-01-ECON-04 and 02-ECON-03. Christopher Matthews, Russ Howell, and Gerry Howell.

10.3 COMPETITION and CONFLICT WITH OTHER USERS

10.3.1 CONFLICT (BCFMP 1998; page 40)

Recommended Management Strategy

The N.C. General Assembly needs to provide the Marine Patrol with statutory authority to deal with theft. G.S. 113-268 "Injuring, destroying, stealing, or stealing from nets, seines, buoys, pots, etc." was modified by inserting "steal" in subsection (c), effective Dec. 1, 1998.
The MFC needs to change the unattended pot rule from the existing 10 day period to seven days. Existing rule was modified as follows and Item 3 was added to deal with unforeseen events:

15A NCAC 3I .0105 LEAVING DEVICES UNATTENDED (MFC 2003; pages 10-11)

(b) It is unlawful to leave pots in any coastal fishing waters for more than ~~**ten**~~ seven consecutive days, when such pots are not being employed in fishing operations, except upon a timely and sufficient showing of hardship as defined in Subparagraph (b)(2) of this Rule or as otherwise provided by General Statute.
- (3) The Fisheries Director may, by proclamation, modify the seven day requirement, if necessary due to hurricanes, severe weather or other variable conditions.

Recommended Management Strategy

Modify existing crab pot areas using depth as the boundary instead of distance from shore. Crustacean Committee has recommended using the 6 foot depth contour to the MFC. The MFC has issued a subject matter notice for rule making (Jan. 2001).
Make it unlawful to use or set pots in any navigation channel marked by State or Federal agencies and in areas identified by the MFC. Existing rule was modified as follows:

15A NCAC 3J .0301 POTS (MFC 2003; pages 38-40)

(b) It is unlawful to use pots:
- (1) in any navigation channel ~~maintained and~~ marked by State or Federal agencies; or
- (2) in any turning basin maintained and marked by the North Carolina Ferry Division.

Recommended Management Strategy

Establish management areas. Five Regional Stakeholder Committees were established by the MFC in 1999 to assist with effort management deliberations. These groups were disbanded

after recommendations on effort management were submitted to the MFC. Currently, there are no formal management areas to address crab resource issues.
Consider gear licenses or permits. Licenses and permits were considered and recommendations were made in conjunction with various open access and limited entry options that were explored during 1999 and 2000. However, no gear licenses or permits were implemented.
Consider a pot tagging system. Tagging was considered and recommendations were made in conjunction with various open access and limited entry options that were explored during 1999 and 2000. However, a pot tagging system was not implemented.
Develop guidelines to mediate user conflicts. Item (j) User Conflicts was added to the existing rules for POTS (see below).

15A NCAC 3J .0301 POTS (MFC 2003; pages 38-40)

(j) User Conflicts:
- (1) The Fisheries Director may, with the prior consent of the Marine Fisheries Commission, by proclamation close any area to the use of pots in order to resolve user conflict. The Fisheries Director shall hold a public meeting in the affected area before issuance of such proclamation.
- (2) Any person(s) desiring to close any area to the use of pots may make such request in writing addressed to the Director of the Division of Marine Fisheries. Such requests shall contain the following information:
  - (A) A map of the proposed closed area including an inset vicinity map showing the location of the proposed closed area with detail sufficient to permit on-site identification and location;
  - (B) Identification of the user conflicts causing a need for closing the area to the use of pots;
  - (C) Recommended method for resolving user conflicts; and
  - (D) Name and address of the person(s) requesting the closed area.
- (3) Person(s) making the requests to close an area shall present their request at the public meeting.
- (4) The Fisheries Director shall deny the request or submit a proposed proclamation granting the request to the Marine Fisheries Commission for their approval.
- (5) Proclamations issued closing or opening areas to the use of pots under Paragraph (j) of this Rule shall suspend appropriate rules or portions of rules under 15A NCAC 3R .0107 as specified in the proclamation. The provisions of 15A NCAC 3I .0102 terminating suspension of a rule as of the next Marine Fisheries Commission meeting and requiring review by the Marine Fisheries Commission at the next meeting shall not apply to proclamations issued under Paragraph (j) of this Rule.

Recommended Management Strategy

Support the establishment of boating safety courses and boat operator licenses by the Wildlife Resources Commission (WRC). The MFC has not initiated any action on this recommendation.
Re-examine the times when pots must be moved into designated crab pot areas. Crustacean Committee has recommended a time frame shift to the existing rule (1 May- 31 Oct.) to 1 June - 30 Nov. There will not be an increase or decrease in the total time the area is closed to crab potting. The MFC has issued a subject matter notice for rule making (Jan. 2001). Also, the Crustacean Committee has recommended a proposal to the MFC to open designated long haul areas to crab potting by proclamation. The MFC has issued a subject matter notice for rule making (Jan. 2001).

10.3.2 POTS IN INLAND WATERS (BCFMP 1998; page 41)

Recommended Management Strategy

The MFC and Wildlife Resources Commission (WRC) should work together to identify Inland Waters with historical crabbing activity and low recreational pressure. See WRC resolution below. The identification of inland waters that might be reclassified has not been initiated. Commercial crab potting should continue to be allowed in these selected waters. Historically, commercial crab potting was allowed in Inland Waters with a WRC Special Device License. This activity was prohibited by the WRC (see resolution below). Allowed crab pot use is noted in the resolution and a special device license is not required. Additionally, the commissions should work together to standardize rules for the crab fishery. The two commissions have not addressed standardized rules for the crab fishery.

RESOLUTION CONCERNING THE USE OF CRAB POTS IN INLAND WATERS

THAT WHEREAS, the Wildlife Resources Commission is responsible for managing the fishery resources of the inland waters of North Carolina, including the harvest of those resources by hook-and-line as well as special fishing devices;

AND WHEREAS, the use of crab pots in many inland waters presents a barrier to navigation and interferes with hook-and-line fishing;

AND WHEREAS, historically the use of crab pots has been restricted to joint and coastal waters where commercial fishing is controlled by the Marine Fisheries Commission;

AND WHEREAS, the Wildlife Resources Commission believes the continuation of this historical practice is in the best interests of the aquatic resources and the anglers who pursue those resources;

NOW, THEREFORE BE IT RESOLVED, that the North Carolina Wildlife Resources Commission meeting in official session on October 23, 1998 does hereby adopt the rule prohibiting the use of crab pots in inland waters, except that adjoining landowners may continue to set two crab pots that are attached to their property as prescribed in 15A NCAC 10C .0404(e);

AND BE IT FURTHER RESOLVED, that the staff of the Wildlife Resources Commission shall work with the staff of the Division of Marine Fisheries to identify specific inland waters that have blue crab populations in fishable numbers but lack substantial populations of inland sport fishes for the purpose of reclassifying such waters as either joint or coastal fishing waters.

10.4.2 RECREATIONAL COMMERCIAL GEAR LICENSE (RCGL) and EXEMPTION (BCFMP 1998; pages 47-48)

Recommended Management Strategy

The specific number of pots allowed for RCGL-holders will be five per person or vessel. A new section of SUBCHAPTER 15A NCAC 3O was added to address rules associated with the "new" Recreational Commercial Gear License. Authorized gear types specific to the crab fishery are contained in the following rule.

SECTION .0300 - RECREATIONAL COMMERCIAL GEAR LICENSES
15A NCAC 3O .0302 AUTHORIZED GEAR (MFC 2003; pages 102-103)

(a) The following are the only commercial fishing gear authorized (including restrictions) for use under a valid Recreational Commercial Gear License:…

(3) With or without a vessel, five eel, fish, shrimp, or crab pots in any combination, except only two pots of the five may be eel pots. Peeler pots are not authorized for recreational purposes;

(4) One multiple hook or multiple bait trotline up to 100 feet in length;

Recommended Management Strategy

Individuals (not possessing a RCGL) setting crab pots from privately owned shore or a pier will be limited to one pot per person and will be required to follow all gear marking requirements imposed on RCGL-holders. <u>Existing rule on "NON-COMMERCIAL USE OF POTS" was significantly modified and resulted in the following rule</u>.

15A NCAC 3J .0302 RECREATIONAL USE OF POTS (MFC 2003; page 40)

(a) It is unlawful to use pots for recreational purposes unless each pot is marked by attaching one floating buoy, any shade of hot pink in color, which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. The owner shall always be identified on the buoy using engraved buoys or by attaching engraved metal or plastic tags to the buoy. Such identification shall include the owner's last name and initials and if a vessel is used, one of the following:

(1) Gear owner's current motor boat registration number, or

(2) Owner's U.S. vessel documentation name.

(b) It is unlawful for a person to use more than one crab pot attached to the shore along privately owned land or to a privately owned pier without possessing a valid Recreational Commercial Gear License.

Recommended Management Strategy

Crab trawls should not be considered as a gear for RCGL-holders. <u>Crab trawl was not allowed as an authorized gear type in Rule 3O .0302 AUTHORIZED GEAR (MFC 2003; pages 102-103)</u>.

Buoys for all recreational pots shall be hot pink and engraved with the full name of the fisher. NCDMF shall select a buoy shape for recreational gear. <u>Marking and identification of recreational pots was addressed in the modification of Rule 3J .0302 (a) RECREATIONAL USE OF POTS (see rule above)</u>. <u>NCDMF did not recommend a buoy shape for recreational gear</u>. <u>Also, a new rule was added to define the marking requirements for recreational trotlines (see below).</u>

15A NCAC 3J .0305 TROTLINES (MULTIPLE HOOK OR MULTIPLE BAIT)
(MFC 2003; page 41)

It is unlawful to use multiple hook or multiple bait trotlines for recreational purposes unless such trotlines are marked by attaching to them at each end one floating buoy, any shade of hot pink in color, which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. The owner shall always be identified on the buoy by using an engraved buoy or by attaching engraved metal or plastic tags to the buoy. Such identification shall include owner's last name and initials and if a vessel is used, one of the following:

(A) Gear owner's current motor boat registration number, or

(B) Owner's U.S. vessel documentation name.

Recommended Management Strategy

Define collapsible crab traps as non-commercial gear, and a RCGL would not be required. <u>A definition for collapsible crab traps was added to the section of Rule 15A NCAC 3I .0101 DEFINITIONS (MFC 2003; page 2), which lists exceptions to those gears considered as commercial fishing equipment and gear</u>.

15A NCAC 3I .0101 DEFINITIONS (MFC 2003; pages 2–8)

(b) The following additional terms are hereby defined:

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

(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;

Recommended Management Strategy

Existing non-commercial catch limits will apply to the recreational harvest of blue crabs. The current limit is 50 legal crabs per person per day, not to exceed 100 per vessel per day. <u>Recreational harvest limits did not change and are contained in Rule 15A NCAC 3K .0105 HARVEST OF CRABS AND SHELLFISH (MFC 2003; pages 48-49).</u>

10.5 INSUFFICIENT ASSESSMENT DATA (BCFMP 1998; page 49)

Recommended Management Strategy

The MFC and NCDMF should prioritize research needs and implement actions to accomplish the identified research and data needs. <u>Many of the research needs were prioritized in BCFMP (1998) Sections 10.6.4, 10.6.5, 10.6.6, and 10.6.7. These research needs have been targeted by the commercial fishing and academic communities through FRG's, BCRP, and other grant programs</u>.

<u>Funded Research</u>:

"Development of Two Simple Devices to Increase the Accuracy of Catch Per Unit Effort (CPUE) Data." FRG-98-FEG-08. Mark Hooper.

"The role of trawl discards in sustaining blue-crab fishery production." FRG-99-EP-07. Galen Johnson.

"Stock assessment of the blue crab (Callinectes sapidus) in North Carolina." FRG-99-FEG-10. David B. Eggleston, Joseph E. Hightower, and Eric G. Johnson.

"Population Dynamics and Stock Assessment of the Blue Crab (Callinectes sapidus) in North Carolina." FRG-00-FEG-11. David Eggleston.

"The Seasonal Food Habits of Striped Bass (Morone saxatilis) in the Albemarle." FRG-00-EP-14. Wesley Patrick.

"Survey of Catch/Effort Data from the Recreational Blue Crab Fishery." BCRP 01-POP-03. Jimmy Nobles, Lisa and Kim Nobles, Jeff Johnson, and Hans Vogelsong.

"Pilot Project to Improve the Accuracy of Catch Per Unit Effort (CPUE) Calculations in the Blue Crab Pot Fishery." BCRP-01-POP-06. Mark Hooper, and Royal Hooper.

"A New Method for the Evaluation of Spatial and Temporal Dispersal Patterns of Blue

Crab (*Callinectes spp.*) Larvae in the Cape Fear River Plume." BCRP 01-BIOL-03. Ami Wilbur.

"Blue Crab (*Callinectes sapidus*) Culture for Stock Enhancement." BCRP 01-STOK-01. Joanne Harcke.

"Blue Crab Stock Enhancement Potential: Field Releases and Pond-Rearing." BCRP 01-STOK-03. G. Todd Kellison.

"Blue Crab Stock Enhancement Potential: Further Progress in Field Releases and Pond-Rearing." BCRP 02-STOK-02. G. Todd Kellison and David Eggleston.

"Artificial Manipulation of Critical Habitat for Alewife and Blue Crab in Pamlico Sound, North Carolina." FRG-02-EP-17 Roger Rulifson and Tommy Midgette.

"Blue Crab Attraction to Animal Processing Wastes: Chemoreception and Bait Potential." BCRP 02-BIOL-03. Daniel Rittschof and Joshua Osterberg.

"Migration and Reproductive Potential of Female Blue Crabs." BCRP 02-BIOL-04, Dan Rittschof.

"Pheromones from Male Crabs: Basic Properties and Bait Potential." BCRP 02-BIOL-05. Dell Newman.

"Evidence for Functional Sperm Limitation in NC Blue Crabs." BCRP 02-BIOL-07 and 03-BIOL-06. Donna Wolcott and Thomas Wolcott.

"High School Students and the Blue Crab: An Educational Outreach Program to Quantify Annual Recruitment Success." BCRP 02-POP-04. David Eggleston.

"Building the Pot Counter Network to Improve Calculation of CPUE (Catch Per Unit Effort) in the NC Crab Pot Fishery." BCRP 02-POP-06. Mark Hooper.

"Survey of Catch/Effort Data of Blue Crabs from the NC Coastal and Estuarine Landowners." BCRP 02-ECON-01. Hans Vogelsong and Jeffery Johnson.

"Trip Log and Socio-Economic Survey of North Carolina Commercial and Recreational Crab Potters." BCRP 02-ECON-02. Robin Doxey.

"Refinement of a Field Test to Assess the Health of Blue Crabs." BCRP 03-BIOL-01. Edward Noga.

"Origin and Movement Patterns of Tar-Hens and Tar-Jimmys." BCRP 03-BIOL-04. Dan Rittschof.

"Fishing Baits from Poultry Production Wastes." BCRP 03-BIOL-05 Daniel Rittschof and Joshua Osterberg.

"A Dynamic View of North Carolina Blue Crab Stock Abundance and Distribution Generated from Fishery Dependent Data." BCRP 03-POP-02. Mark Hooper.

"Investigation of the Relationship Between Effort and Landings in the North Carolina Commercial Blue Crab (*Callinectes sapidus*) Pot Fishery." BCRP 03-POP-04. Teresa Thorpe, David Beresoff, and Mark Hooper.

"Crab Pot Cleaning Technique to Replace the Use of Toxic Chlorine." FRG-03-FEG-06. Willy Phillips.

"Crab Pot Edge Guards." FRG-03-FEG-14. Edward Etheridge.

10.5 INSUFFICIENT ASSESSMENT DATA (continued) (BCFMP 1998; page 49)

Recommended Management Strategy

Licenses and/or permits should be implemented to identify participants and quantify activities and gear usage in the blue crab fisheries. Licenses and permits for various activities were discussed in concert with several of the limited entry and open access effort management proposals. The MFC decided not to implement an effort management strategy for the crab fisheries; so additional licenses and permits for harvest or gear use were not pursued. Blue crab shedding was defined and a permit was implemented to identify individual blue crab shedding operations. The two new rules are presented below.

15A NCAC 3I .0101 DEFINITIONS (MFC 2003; page 8)

(b) The following additional terms are hereby defined:

(50) Blue Crab Shedding. Shedding is defined as the process whereby a blue crab emerges soft from its former hard exoskeleton. A shedding operation is any operation that holds peeler crabs in a controlled environment. A controlled environment provides and maintains throughout the shedding process one or more of the following: predator protection, food, water circulation, salinity or temperature controls utilizing proven technology not found in the natural environment. A shedding operation does not include transporting peeler crabs to a permitted shedding operation.

15A NCAC 3O .0503 PERMIT CONDITIONS; SPECIFIC (MFC 2003; page 117)

(c) Blue Crab Shedding Permit: It is unlawful to possess more than 50 blue crabs in a shedding operation without first obtaining a Blue Crab Shedding Permit from the Division of Marine Fisheries.

10.4 INCREASING FISHING EFFORT (BCFMP 1998; pages 42-47)

10.4.1 EFFORT MANAGEMENT

Recommended Management Strategy

It is likely that none of the traditional open-access management alternatives (for example seasons, time, and area restrictions) can significantly control or reduce the overall effort in the crab fishery without severely restricting individual landings or traditional fishing patterns. ******Therefore, some type of effort management system is needed to control and/or reduce effort in the crab fishery. ******No specific strategy for a continued open access or limited entry system to manage effort in the crab fishery is proposed at this time. The legislated time frame to develop the blue crab FMP did not allow for an effort management system to be fully developed for this fishery. ******Therefore, the crab licenses and license moratorium should be extended for one more year (until 1 July 2000) to allow for the development of an effort management system. ******Any option to reduce effort should provide an appropriate means to allow flexibility within the fishing community (future holders of the limited SCFL); minimize exclusive privileges and avoid monopolies; control or reduce effort in the crab fishery; and make management of the crab fishery more efficient and effective.

The License moratorium and Crab License was scheduled to expire June 30, 1999. The expiration of this moratorium and the Crab License would allow anyone with an Endorsement to Sell License to purchase a Standard or Retired Commercial Fishing License and be eligible to participate in the crab fishery. The moratorium on new licenses and provisions of the Crab License had allowed only a limited number of license holders (3639 in Oct. 2000) to participate in the crab fishery. Once the moratorium and license expired, approximately 8830 (cap for year 2000) licensees would be eligible to participate in the crab fishery at any level of effort they chose. This increase would potentially more than double the number of participants. Therefore, a segment of the industry was concerned that increased participation, fishing effort, and gear use would escalate to the point that the resource and the economics of the fishery may collapse or would suffer from over capitalization.

Action 3:
Crustacean and Blue Crab Advisory committees charged to evaluate effort management options. Final recommendation to MFC by 1 May 1999.
MFC to make a final recommendation on effort mgmt. for the crab fishery to the N.C. General Assembly by 1 July 1999 (General Assembly has the authority to limit entry).

In order to achieve "Action 3", "Action 2" which was an "ongoing discussion of options" was implemented. Activity under "Action 2" are summarized below:

1. Effort Management Workshop held in January 1999. Five open access and 5 limited entry options evaluated. Three open and 3 limited considered viable.
2. Two open access and 2 limited entry effort management options for the crab pot fishery presented at 5 public meetings in the coastal area (March 1999).
3. License moratorium and Crab License scheduled to expire on June 30, 1999. An Interim Crab License ("Action 1") was established by the N.C. General Assembly until October 1, 2000. This extension of the Crab License was granted to allow the industry, MFC, and NCDMF an opportunity to continue work on an effort management plan for the crab pot fishery.
4. To accomplish this plan the MFC established five regional crab pot management areas. A stakeholder advisory committee of commercial fishermen, dealers, recreational fishermen and boaters was appointed for each region. Due to the lack of consensus reached during prior effort management discussions, the need to allow new entrants into this fishery, and a desire to control overall pot numbers, the MFC directed these regional committees to assist in drafting an effort management plan for this fishery and to consider: 1) regional differences in the fishery; 2) market stability; and 3) also allow those involved to maintain operations similar to existing levels, while allowing flexibility for the entire fishing community to participate in the pot fishery.
5. MFC decided to pursue only open access options (Sept. 10, 1999).
6. The open access effort management plan considered for the crab pot fishery, included combining 3 elements of open access management into one system of management. These are (1) management areas, (2) gear restrictions (regional pot limits), and (3) a permit system to participate in the fishery.
7. Some of the committees identified a need to reduce effort in some areas and recommended pot limits. However, generally the Stakeholder Committees did not expect effort to increase significantly when the Crab License expired, and did not feel that pot limits were necessary, unless the primary purpose was to protect the blue crab

population. Therefore, after almost 2 years of discussion, the MFC decided not to implement an effort management strategy for the crab pot fishery.

Literature Cited:

McKenna, S., L.T. Henry, and S. Diaby. 1998. North Carolina Fishery Management Plan – Blue Crab (BCFMP). NC. Dept. of Environ. and Nat. Res., Div. Mar. Fish., Morehead City. 73p. + Appendices

MFC (North Carolina Marine Fisheries Commission). 2003. North Carolina Fisheries Rules for Coastal Waters 2003. NC Div. Mar. Fish., Morehead City, NC. 297p

14.2 TIMELINE FOR AMENDMENT 2 OF THE BLUE CRAB FISHERY MANAGEMENT PLAN

BLUE CRAB FMP TIMELINE

Task	Timeline
Orient AC and Discuss Issues, Goal and Objectives	February 2011
Present Goal and Objectives and Timeline to MFC	February 2011
Obtain MFC input on Issues	May 2011
Draft/Revise and Review Informational Sections and Issue Papers in the FMP and Establish DMF/AC Positions	October 2010 to May 2011
Obtain MFC Approval for Review of FMP	August 2011
Public and Committee Review of FMP	August/September 2011
Present Revised FMP to MFC for Selection of Preferred Management Options	November 2011
Review of FMP by DENR and JLCSA [Note JLCSA typically does not meet during a session]	January/March 2012
Procedural Approval of FMP and Approval of Notice of Text for Rules by MFC	May 2012
Direct Rules through APA Process	September/October 2012
Final FMP and Rule Approval by MFC	November/December 2012
Selected Management Measures Effective Date	April 1, 2013

Initial Timeline Approval by Director Date: 1/25/11 LBD
Presented to MFC Date: ____________________

Timeline Revision Approved by Director Date: ____________________
Presented to MFC Date: ____________________
Revision(s) and Reason:

Timeline Revision Approved by Director Date: ____________________
Presented to MFC Date: ____________________
Revision(s) and Reason:

Timeline Revision Approved by Director Date: ____________________
Presented to MFC Date: ____________________
Revision(s) and Reason:

REVISED BLUE CRAB FMP TIMELINE (REVISIONS UNDERLINED)

Task	Timeline
Orient AC and Discuss Issues, Goal and Objectives	February 2011
Present Goal and Objectives and Timeline to MFC	February 2011
Obtain MFC input on Issues	May 2011
Draft/Revise and Review Informational Sections and Issue Papers in the FMP and Establish DMF/AC Positions	January to August 2011
Obtain MFC Approval for Review of FMP	November 2011
Public and Committee Review of FMP	November /December 2011
Present Revised FMP to MFC for Selection of Preferred Management Options	January 2012
Review of FMP by DENR and JLCSA [Note JLCSA typically does not meet during a session]	February/March 2012
Procedural Approval of FMP and Approval of Notice of Text for Rules by MFC	May 2012
Direct Rules through APA Process	September/October 2012
Final FMP and Rule Approval by MFC	November/December 2012
Selected Management Measures Effective Date	April 2013

Initial Timeline Approval by Director Date: ____________________
Presented to MFC Date: ____________________

Timeline Revision Approved by Director Date: 5/11/11 [signature]
Presented to MFC Date: ____________________
Revision(s) and Reason: MFC Approval for Review of FMP moved back from August 2011 to November 2011, to allow more time for thorough review of potential FMP issues.

Timeline Revision Approved by Director Date: ____________________
Presented to MFC Date: ____________________
Revision(s) and Reason:

Timeline Revision Approved by Director Date: ____________________
Presented to MFC Date: ____________________
Revision(s) and Reason:

14.3 COMMERCIAL BLUE CRAB POT MANAGEMENT MEASURES FOR VARIOUS STATES IN 2011.
[underlined text denotes a change from NCDMF (2004) summary]

	Harvest restrictions				Gear restrictions			Size limits (inches)						
State	Season	Catch limits	Time	Days	Pots (max.)	Escape rings/ Degradable panel	Buoys	Hard	Soft	Peeler	Culling Tolerance	Sponge crab protection	Effort Mgmt.	Pot Attendance
NEW JERSEY	Delaware Bay Apr. 6-Dec. 4 Other waters Mar. 15-Nov. 30	None	4am-9pm Bay, 24-hrs Other waters	None	600 Delaware Bay 400 Other waters	None Terrapin Excluder some areas. Degradable panel	Reflective I.D. Sink Line	4.75 4.5 Non egg bearing female	3.5	3	Zero	A	Yes	3 days
DELAWARE	Mar. 1-Nov. 30	None	1 hr before sunrise-sunset	None	200 500/vessel	None	I.D. Color coded	5	3.5	3	5% by number	A	Yes	3 days
MARYLAND (MD) [1, 2, and 3]	Males Apr. 1- Dec. 15 Mature female[1] Apr. 1- Nov. 10	Mature female[2]	½ hr before sunrise - 7 ½ hrs after sunrise	Prohibited either Sun. or Mon	50 up to 900/vessel w/ 2 crew	1 (2-3/16 in) 1 (2-5/16 in) may close for peelers	I.D.	5 [3] Apr. 1-July 14	3.5	3.25 [3] Separated from catch	5 hard crabs/ bushel or 13/barrel 10 peelers	A	Yes Effective 6/98	None
VIRGINIA	Mar.17-Nov.30 Mature females prohibited Nov. 21-30	Mar.17-May 31, 51 bushels or 17 barrels/ vessel	6am-2pm Mar.17-Apr. 30 5am-1pm May-Aug.	Mon.-Sat. except peeler pots	425 bay 255 tributaries and Potomac tribs. into VA 210 peeler	Seaside Eastern Shore 1 (2-3/16 in) 1 (2-5/16 in)/ Bay & Tribs. 2 (2-3/8 in)	I.D.	5	3.5	3.25 Mar. 17-Jul. 15 3.5 Jul. 16-Nov. 30	10 hard crabs/ bushel or 35/barrel 10 peelers/bushel or 5% in other containers	B and C Baywide Sanctuary at 35 ft. contour May 1-Sept. 15	Yes	None
NORTH CAROLINA (NC)	No pots Jan. 15-Feb. 7 May open areas cleaned of pots	None	1 hr. before sunrise- 1 hr. after sunset	None	None 150 in Newport River only	2 (2-5/16 in) may close in two areas	I.D. Sink Line	5 6.75[4]	None	None[4] Separated. White-lines no sale	10% by number/container	C	Comm. License Cap	5 days
SOUTH CAROLINA	None	None	5am-9pm Apr. 1-Sept 15 6am-7pm Sept 15-Mar. 31	None	None	2 (2-3/8 in) Jun. 1- Mar. 14 Peeler pot bait not to exceed 3".	I.D. with colors	5[5]	5[5]	None with peeler permit	Zero	A and D	None	5 days
GEORGIA	None	None	None	None	200 includes peeler pots	2 (2-3/8 in)	I.D. No green	5	5	3	Zero	A and D	Yes	None
FLORIDA	10 day closure for derelict trap removal	None	1 hr before sunrise-1 hr. after sunset	None	600 inshore 400 offshore 100 non-transfer 400 peeler	3 (2-3/8 in) Degradable panel	I.D.	5[5]	5	None Separated from catch	5% by number/ container except bait	A	Yes Effective 2007-08	None
ALABAMA	Periodic derelict trap removal with no set closure period	None	1 hr before sunrise-sunset	None	None	None	½ white	5[5] Bait Dealer exempt	None Separate from catch	None Separated from catch	Zero Exemption bait and work box	None	None	None
MISSISSIPPI	Possible 10 – 30 day closure for abandoned trap removal	None	½ hr before sunrise – ½ hr after sunset	None	None	None	I.D. on trap tag or color code Sink line	5[5]	None	None Separated from catch	Zero	A	None	None
LOUISIANA	Possible 10 day closure for abandoned trap removal	None	½ hr before sunrise – ½ hr after sunset	None	None	2 (2-5/16 in) Can be closed Apr.-Jun. Sept.-Oct.	I.D. on metal trap tag/plastic bait cov. Sink line	5[5]	None	None Separated from catch	10% by number in 50 crab random sample	A 2% by number tolerance in work box only	None	None
TEXAS	No pots 10-30 days in Feb.-Mar.	None	½ hr before sunrise – ½ hr after sunset	None	200	4 (2-3/8 in) 2 in each chamber Degradable panel	White gear tag – I.D.	5[5]	5	5	5% by number in separate container for bait only	A	Yes Effective 9/98	30 day gear tag

[1] MD – prohibit mature female harvest June 1-15. [2] MD – bushel limits by license level and season. [3] MD – Split season size limits: 5 ¼ for hard male and 3 ½ peeler crabs, July 15 – Dec. 15.
[4] NC – Maximum size limit Sept. – April-30: 6 ¾ for mature female and 5 ¼ female peeler crabs (based on survey results). [5] Includes 5 inch size limit for mature females.
A = Unlawful to take, sell, or possess sponge crabs. B = Prohibit brown/black sponge with tolerance. C = Crab sanctuary to protect females. D = May sell or possess sponge crabs, taken legally in another state.

14.4 EFFORT MANAGEMENT MEASURES F0R COMMERCIAL BLUE CRAB POT FISHERY FOR VARIOUS STATES IN 2011 [underlined text denotes a change from NCDMF (2004) summary]

			Crab License								
State	Commercial License Required	Crew License	Individual License	License Cap	Trap Permit	Pot Limit (maximum)	Transferable	Use or Lose Provision	Soft-shell Dealer License	Soft-shell Shedding License	Apprenticeship Program
NEW JERSEY	Yes	None	Yes	Yes (312)	None	600 Delaware Bay 400 Other waters	Yes Only family	None	None	None	None
DELAWARE	Yes	None	Yes 50 pot increments	Yes Previous licensee (219)	None	200	Yes Family or Designee	None	None	None	None
MARYLAND	Yes Limited Entry effective 6/98	None	Yes	Yes Tied to Comm. License	None	50 up to 900/vessel with 2 crew	Yes with criteria	None	None	None	Yes with criteria
VIRGINIA	Yes	None	Yes 85, 127, 170, 255, or 425 pots	Yes Moratorium (1999-present)	Peeler and Hard	425 bay 255 tributaries and Potomac tribs. into VA 210 peeler	Yes	None	None	Yes	None
NORTH CAROLINA	Yes Comm. License cap	None	None Ended Oct. 2000	N/A Comm. License cap	None	None 150 only in Newport River	N/A	None	None	None Free permit required	None
SOUTH CAROLINA	Yes	None	Yes $25/50 pots $1/pot over 50 pots	None	None	None	No	None	Yes Peeler Crab License	Yes	None
GEORGIA	Yes	Yes	Yes 50 pot Increments	Yes (138) Begin reduction to 100 starting May 1, 2013	$2/pot	200/includes Peeler pots	Yes with boat or family	2 years	Yes	None	None
FLORDIA	Yes	Vessel license covers crew	Yes Landings Criteria	Yes Moratorium	Yes $0.50 per trap	Per endorsement 600 inshore 400 offshore 100 non-transfer 400 peeler	Yes	Yes Annual documented landings	None	Yes Under VS Endorsement	None
ALABAMA	Yes	None	Yes	None	None	None	No	None	None	None	None
MISSISSIPPI	Yes	None	Vessel	None	None	None	Yes	None	None	None	None
LOUISIANA	Yes	None	Yes	None	None	None	No	None	None	Yes	None
TEXAS	Yes	None	Yes	Yes Eligibility criteria	None	200	Yes	None	None	None	None

14.5 RECREATIONAL BLUE CRAB POT MANAGEMENT MEASURES FOR VARIOUS STATES IN 2011.
[underlined text denotes a change from NCDMF (2004) summary]

			Harvest restrictions				Gear restrictions			Size limit (inches)				
State	License	License Exemption	Season	Daily catch limits	Time	Days	Pots (max)	Escape rings/ Degrade panel	Buoys	Hard	Soft	Peeler	Culling Tolerance	Effort Mgmt.
NEW JERSEY	Yes Rec. Crab Pot License		Delaware Bay Apr. 6-Dec. 4 Other waters Mar. 15-Nov. 30	1 bushel	None	None	2	None Terrapin excluder some areas Degradable panel	Reflective I.D. Sink line	4.5* Prohibit sponge	3.5	3	Zero	None
DELAWARE	Yes Rec. Fish. License		March 1- Nov.30	1 bushel	None	None	2	None. Terrapin excluder in all tidal waters	I.D. white	5 Prohibit sponge	3.5	3	5% by number	None
MARYLAND Ches. Bay & tributaries.	Yes [1]	Yes [1]	Apr. 1 – Dec 15	Max. 1 bushel & 2 dozen peeler/ soft with license [1]	Variable ½ hr before sunrise – sunset	None	2 Shoreline land owners only	1 (2-3/16 in) 1 (2-5/16 in) Turtle excluder	I.D.	5** Prohibit all females	3.5 Female allowed	3.25*** No females	Zero	None
VIRGINIA	Yes Crab Pot Lic. for more than 2 pots	2 pots 1 bushel and 24 peelers daily limit	2 pots Mar. 17 – Nov. 30 5 pots Jun. 1 - Sept. 15	1 bushel hard crabs and 24 peelers	5 pots 5am – 1pm Jun. – Aug. 6am – 2pm Sept. 1-15	Mon. – Sat. with 5 pot license	5	Bay/tidal 2 (2-3/8 in) Seaside 1 (2-3/16 in) 1 (2-5/16 in)	I.D. Marked with the letter "R"	5	3.5	3.25 Mar. 17-Jul. 15 3.5 Jul. 16-Nov. 30	10 hard crabs/ bushel or 35/barrel 10 peelers/bushel or 5% in other containers	None
NORTH CAROLINA	Yes Rec. Comm. Gear License	One pot/person on privately owned shore/pier	None	50 crabs, not to exceed 100/vessel	1 hr before sunrise – 1 hr after sunset	None	5	2 (2-5/16 in) May close in two areas	I.D. Hot Pink Sink line	5	None	None	10% by number/container	None
SOUTH CAROLINA	Yes Rec. Fish. License		None	None	None	None	2	None	I.D. Yellow	5*	5*	5	Zero	None
GEORGIA	Yes Rec. Fish. License		None	1 bushel 2 bushels/ vessel	None	None	6	2 (2-3/8 in)	I.D. Bright green	5 Prohibit sponge	5	3	Zero	None
FLORDIA	Yes Rec. Fish. License		10 day closure for derelict trap removal	10 gallons/ person	1 hr before sunrise- 1 hr after sunset	None	5	3 (2-3/8 in) Degradable panel	Marked with the letter "R"	None* Prohibit sponge	None	None	N/A	None
ALABAMA	Yes Rec. Fish. License		None	None	None	None	5	None	Orange, marked with letter "R"	5	None	None	Zero One gallon of crabs exemption for bait w/ rec. shrimp lic.	None
MISSISSIPPI	Yes Crab Trap License	Ages <16/>65 and disabled persons	Possible 10 – 30 day closure for abandoned trap removal	None	½ hr before sunrise – ½ hr after sunset	None	6 per household or vessel	None	I.D. Sink line	5* Prohibit sponge	None	None	Zero	None
LOUISIANA	Yes Crab Trap License		Possible 10 day closure for abandoned trap removal	12 doz. per day per person	½ hr before sunrise – ½ hr after sunset	None	10	2 (2-5/16 in) Rings can be closed April-June, Sept.-Oct.	I.D. on trap tag	None	None	None	N/A	None
TEXAS	Yes Rec. Fish. Lic. & Saltwater Stamp		No pots 10 – 30 days in Feb. – March	None	½ hr before sunrise – ½ hr after sunset	None	6	4 (2-3/8 in) 2 in each chamber Degradable panel	White with color stripe Gear tag- I.D.	5* Prohibit sponge	5	5	5% by number in separate container for bait only	None

***** Includes mature female
****** Maryland minimum carapace width 5.25 effective July 15 until end of season. ******* Minimum carapace width 3.5 effective July 15 until end of season.

1 Maryland license is not required for crab pots unless potter takes more than 2 doz. male hard crabs/ 1 doz. male peelers or soft crabs. With Noncommercial Crabbing License can take 1 bushel male hard crabs/ 2 doz. male peelers or soft crabs.

14.6 OVERVIEW OF THE RECOMMENDATIONS RECEIVED DURING PUBLIC REVIEW OF THE DRAFT AMENDMENT 2 TO THE BLUE CRAB FISHERY MANAGEMENT PLAN

		Recommendations (Other AC recommendations for this issue on next page)			
Section	**Issue**	**Blue Crab AC**	**NCDMF**	**Inland (12/5/11)**	**Northeast (12/6/11)**
11.1	Adaptive management framework for the North Carolina blue crab stock	(1) Repeal the current female stock conservation management trigger. (2) Leave management of the sanctuaries as they are now. (3) Eliminate the harvest of female crabs carrying sponge but allow no more than a 3% culling tolerance by number 8/22/11 (yes-unanimous). (4) Support the principle behind the adaptive management system as opposed to the system that is currently in place (9/19/2011, yes 7 no-1). (5) Improve data collection and consider fishery dependent and independent data to apply to the stoplight method (9/19/2011 yes-7 no-1). (6) Prohibit the harvest of v-apron immature hard crab females 5-inches or greater (9/19/2011 yes-7 no-1).	Option 1: Repeal the current female stock conservation management trigger. <u>Continue existing sampling programs to maintain baseline information for the Traffic Light method.</u> <u>Adopt adaptive management framework based on the Traffic Light Stock Assessment and the proposed moderate and elevated management levels for recruit, adult, and production stock characteristics. Note: All regulations from the management levels would be through proclamation.</u> <u>Option 2: NCDMF would like further public input to consider the recommendation in Option 1 with the addition of prohibition on sponge crab harvest in rule</u>. 9/28/11	Support the NCDMF Adaptive Management recommendations (Options 1 and 2). (yes-6, unanimous)	Repeal the current female stock conservation management trigger (yes-3, abstain-1) Support the principle behind the adaptive management system as opposed to the system that is currently in place (multiple survey indicators rather than one), but do not support using adaptive management for stock protection and the measures recommended (yes-2, abstain-2) Support leaving management of the sanctuaries as they are (yes-4, unanimous) <u>*Support leaving the sponge crab season opened*</u> (yes-3, abstain-1) Improve data collection and consider fishery dependent and independent data (yes-3, no-1) Prohibit the harvest of v-apron immature hard crab females 5-inches or greater (yes-4, unanimous)

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14.6 OVERVIEW OF THE RECOMMENDATIONS RECEIVED DURING PUBLIC REVIEW OF THE DRAFT AMENDMENT 2 TO THE BLUE CRAB FISHERY MANAGEMENT PLAN

		Recommendations				
Section	**Issue**	**Southeast (12/8/11)**	**Crustacean (12/12/11)**	**Central (12/13/11)**	**Habitat and Water Quality (12/15/11)**	**Public Comments Received Outside of Meetings**
11.1	Adaptive management framework for the North Carolina blue crab stock	Support adaptive management *<u>with input from the user groups on measures to implement once a threshold has been met</u>* and include independent and dependent data in stoplight approach. (yes-6, unanimous)	*<u>In order for the recruit abundance to trigger management changes it must be combined with either the adult or production characteristic that is also showing a similar level (yes-5, no-1)</u>*. Adopt the AC adaptive management recommendations (yes-3, no-2)	*<u>Do not support the prohibition on the taking of sponge crabs</u>* (yes-3, no-2, abstain-2) Repeal the current female stock conservation management trigger (yes-6, unanimous) Prohibit the harvest of v-apron immature hard crab females 5-inches or greater *<u>and keep within the 10% culling tolerance</u>* (yes-6, unanimous) Support the AC Adaptive Management recommendations 2, 4, and 5 (yes-4, no-1, abstain-1)	*<u>Thank staff for their effort but will not take a position on this issue because they feel they do not have the proper expertise</u>* (yes-5, abstain-1)	Eliminate harvest of female sponge and immature v-apron crabs. <u>Making bigger sanctuaries closed year round will put crabbers closer together</u>. <u>Too many pots are being set.</u> <u>Put a moratorium on (female) sook and sally crabs we might have more crabs in the future</u>. <u>Red fish are eating all of the crabs. We need to change the rules on red fish so that other species will survive</u>. <u>Stop allowing female sponge crabs to be possessed and sold</u>. <u>Limit season on peelers-allowing more to reach maturity and spawn</u>. <u>The existing population of blue crab in the Neuse River has been greatly reduced due both overfishing and to the pollution of the river. Request that the NCDMF consider a reduction in the number of crab pots allowed on the Neuse River to allow the blue crab population to recover</u>. <u>Some type of pot limit needs to be considered.</u>

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14.6 OVERVIEW OF THE RECOMMENDATIONS RECEIVED DURING PUBLIC REVIEW OF THE DRAFT AMENDMENT 2 TO THE BLUE CRAB FISHERY MANAGEMENT PLAN

		Recommendations (Other AC recommendations for these issues on next page)			
Section	**Issue**	**Blue Crab AC**	**NCDMF**	**Inland (12/5/11)**	**Northeast (12/6/11)**
11.2	Crab pot limit for southern Bogue Sound	Status quo - continue with no crab pot limit in this area 4/11/11 (yes 6; abstain - 3)	Same as AC. 9/28/11	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support AC/NCDMF recommendation (yes-3, abstain-1)
11.3	Consider allowing non-pot areas in the Pungo river area rivers to be redesignated as open to pots	Open the haul net areas all the time by rule in the Pungo River and keep status quo in the Long Point area on the Pamlico River. 5/23/2011 (yes-unanimous)	Same as AC. 9/28/11	Support the AC/NCDMF recommendations (yes-6, unanimous)	Open all non-pot area in the Pungo River *<u>and Long Point</u>* by rule (yes-3, abstain-1)
11.4	Incorporate the lower Broad Creek closure of pot area into rule	Modify the rule to include the lower Broad Creek area that is closed to crab pots from June 1 through November 30. 5/2/11 (yes-unanimous)	Same as AC. 9/28/11	Support the AC/NCDMF recommendation (yes-6, unanimous)	No recommendation
11.5	Clarify crab dredging restrictions	Amend the rule to match harvest management. 5/2/11 (yes-unanimous)	Same as AC.9/28/11	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support AC/NCDMF recommendation (yes-3, abstain-1)
11.6	Incorporate the Pamlico Sound crab trawling proclamation into rule 15A NCAC 03L .0202	Modify Rule 15A NCAC 03L .0202 CRAB TRAWLING to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four inch mesh crab trawl line)(5/2/11; yes-unanimous) [keep Director proc authority as is 9/19/2011 (2 in favor, 2 against, and 4 abstaining)]	Same as AC. 9/28/11.	Support the AC/NCDMF recommendation(yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-3, abstain-1)

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14.6 OVERVIEW OF THE RECOMMENDATIONS RECEIVED DURING PUBLIC REVIEW OF THE DRAFT AMENDMENT 2 TO THE BLUE CRAB FISHERY MANAGEMENT PLAN

		Recommendations				
Section	**Issue**	**Southeast (12/8/11)**	**Crustacean (12/12/11)**	**Central (12/13/11)**	**Habitat and Water Quality (12/15/11)**	**Public Comments Received Outside of Meetings**
11.2	Crab pot limit for southern Bogue Sound	Establish a 75 to 100 pot limit from the Emerald Isle Bridge to Marker 65A from March through June and ask the NCDMF or MFC to develop a strategy to deal with these situation. (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	Support the AC/NCDMF recommendation (yes-3, no-1, abstain-2)	No recommendation	None
11.3	Consider allowing non-pot areas in the Pungo river area rivers to be redesignated as open to pots	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	<u>*Status quo - leave the areas closed to pots in the Pamlico and Pungo rivers*</u> (yes-5, no-1)	No recommendation	None
11.4	Incorporate the lower Broad Creek closure of pot area into rule	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	Support the AC/NCDMF recommendation (yes-6, unanimous)	No recommendation	None
11.5	Clarify crab dredging restrictions	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	Support the AC/NCDMF recommendation (yes-6, unanimous)	No recommendation	None
11.6	Incorporate the Pamlico Sound crab trawling proclamation into rule 15A NCAC 03L .0202	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	Support the AC/NCDMF recommendation (yes-4, no-2)	No recommendation	None

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14.6 OVERVIEW OF THE RECOMMENDATIONS RECEIVED DURING PUBLIC REVIEW OF THE DRAFT AMENDMENT 2 TO THE BLUE CRAB FISHERY MANAGEMENT PLAN

		Recommendations (Other AC recommendations for these issues on next page)			
Section	**Issue**	**Blue Crab AC**	**NCDMF**	**Inland (12/5/11)**	**Northeast (12/6/11)**
11.7	Explore options for escape ring exemptions in hard crab pots to harvest peeler crabs	Endorse clarification of rule language to use bait to define escape ring requirements in a crab pot. Repeal the proclamation authority that allows for exempting the escape ring requirements in order to allow the harvest of peeler crabs. 7/25/11 (yes-unanimous)	Same as AC. (9/28/11)	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support AC/NCDMF recommendation (yes-4, unanimous)
11.8	Convert crab pot escape ring proclamation exemptions for mature females into rule	Adopt <u>the four inch mesh crab trawl line as the new boundary in Pamlico Sound,</u> and the Newport River boundaries as delineated in the proposed rule as the new boundaries for the area where closure of escape rings to take small mature females is allowed. 6/13/2011 (yes-unanimous)	Adopt the <u>no trawl line along the Outer Banks in Pamlico Sound as the new boundary in Pamlico Sound,</u> and the Newport River boundaries as delineated in the proposed rule as the new boundaries where the closure of escape rings to take small mature females is allowed.9/28/11	Support the NCDMF recommendation (yes-6, unanimous)	Support the AC recommendation (yes-4, unanimous) *<u>The NEAC elected to make no recommendation for the boundaries in the Newport River</u>*.
11.9	Correction of peeler trawl exception rule	Modify Rule 15A NCAC 03J .0104 (b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation (9/19/2011 unanimous).	Same as AC. 9/28/11	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-4, unanimous)

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		Recommendations				
Section	**Issue**	**Southeast (12/8/11)**	**Crustacean (12/12/11)**	**Central (12/13/11)**	**Habitat and Water Quality (12/15/11)**	**Public Comments Received Outside of Meetings**
11.7	Explore options for escape ring exemptions in hard crab pots to harvest peeler crabs	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	Support the AC/NCDMF recommdation (yes-5, abstain-1)	No recommendation	None
11.8	Convert crab pot escape ring proclamation exemptions for mature females into rule	Support NCDMF recommendation (yes-6, unanimous)	Support the AC recommendation (yes 4, no-1)	Support the AC recommendation (yes-5, no-1)	No recommendation	None
11.9	Correction of peeler trawl exception rule	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	Support the AC/NCDMF recommendation (yes-5, abstain-1)	No recommendation	None

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		Recommendations (Other AC recommendations for these issues on next page)			
Section	**Issue**	**Blue Crab AC**	**NCDMF**	**Inland (12/5/11)**	**Northeast (12/6/11)**
11.10	Blue crab size limit and culling tolerance	Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs 4/4/11 (yes-unanimous)	Same as AC. 9/28/11	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-4, unanimous)
11.11	Allow floating crab pot lines in areas where obstructions exist	Status quo - continue with non-floating line in crab pots 5/2/11 (yes-unanimous)	Same as AC.9/28/11	Support the AC/NCDMF recommdendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-4, unanimous)
11.12	Diamondback terrapins interactions with the blue crab fishery in North Carolina	Establish (1) proclamation authority for requiring terrapin excluder devices in crab pots and (2) a framework for developing proclamation use criteria and excluder specifications which may extend until after adoption of the amendment. The recommendation is contingent on (1) consultation with the Crustacean AC on developing criteria, (2) no use of the proclamation authority until criteria are approved by the MFC and (3) <u>a size of 2-inches by 6-inches for terrapin excluder devices to allow blue crab catch</u> (7/25/11 yes-unanimous; revised on 9/19/2011 by consensus; revised by consensus on 10/3/11)	Establish (1) proclamation authority for requiring terrapin excluder devices in crab pots and (2) a framework for developing proclamation use criteria and excluder specifications which may extend until after adoption of the amendment. The recommendation is contingent on (1) consultation with the Crustacean AC on developing criteria and (2) no use of the proclamation authority until criteria are approved by the MFC. 9/28/11	Support the AC recommendation (yes-4, no-2)	Support the AC recommendation (yes-4, unanimous)

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		Recommendations				
Section	**Issue**	**Southeast (12/8/11)**	**Crustacean (12/12/11)**	**Central (12/13/11)**	**Habitat and Water Quality (12/15/11)**	**Public Comments Received Outside of Meetings**
11.10	Blue crab size limit and culling tolerance	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	Support the AC/NCDMF recommendation (yes-6, unanimous)	No recommendation	None
11.11	Allow floating crab pot lines in areas where obstructions exist	Support the AC/NCDMF recommendation (yes-6, unanimous)	Support the AC/NCDMF recommendation (yes-5, unanimous)	Support the AC/NCDMF recommendation (yes-6, unanimous)	No recommendation	None
11.12	Diamondback terrapins interactions with the blue crab fishery in North Carolina	<u>*Status quo with additional research needed on terrapin excluder devices in crab pots*</u> (yes-6, unanimous)	Accept this as a work in process and <u>*to insure proclamation authority is in keeping with appropriate terrapin habitat*</u> (yes-4, no-1)	<u>*Status quo*</u> (yes-5,no-1)	Support the NCDMF recommendation (yes-5, abstain-1)	<u>*Against putting terrapin excluder devices in crab pots*</u>. Terrapin excluder devices should only be used in areas where terrapins are known to exist. The NC Wildlife Resources Commission supported the NCDMF recommendations in a formal letter to the MFC. 1/24/12

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		Recommendations (Other AC recommendations for these issues on next page)			
Section	**Issue**	**Blue Crab AC**	**NCDMF**	**Inland (12/5/11)**	**Northeast (12/6/11)**
11.13	Multiple pots attached to a single buoy	Allow proclamation authority for multiple pots on a line, not to exceed 2 pot to a buoy. 6/13/2011 (4-yes; 1-no; 2-abstained); Added 2 pot limit on 10/3/11 (Unanimous - 6)	Status quo do not allow multiple pots to a single buoy. 9/28/11	Support the NCDMF recommendation (yes-6, unanimous)	Support the NCDMF recommendation (yes-4, unanimous)
11.14	Pot loss and ghost pot bycatch mortality	Status quo for both minimizing pot loss and reducing ghost pot fishing mortality. 10/3/11 (Unanimous - 7)	Encourage crab potters in areas of high pot loss to incorporate methods to reduce pot loss. Develop and provide information on potential methods to reduce pot loss. Encourage crab potters in areas of high pot loss to incorporate escape panel designs in pots to reduce potential ghost fishing impacts. Develop and provide information on potential methods and materials to reduce ghost fishing impacts. (9/28/11)	Support the NCDMF recommendation (yes-6, unanimous)	Support the AC recommendation (yes-4, unanimous)

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		Recommendations				
Section	**Issue**	**Southeast (12/8/11)**	**Crustacean (12/12/11)**	**Central (12/13/11)**	**Habitat and Water Quality (12/15/11)**	**Public Comments Received Outside of Meetings**
11.13	Multiple pots attached to a single buoy	Support the NCDMF recommendation (yes-6, unanimous)	Support the NCDMF recommendation (yes-4, no-1)	Support the NCDMF recommendation (yes-4, abstain-2)	No recommendation	None
11.14	Pot loss and ghost pot bycatch mortality	Support the AC recommendation (yes-6, unanimous)	Support the NCDMF recommendation (yes-5, unanimous)	Support the NCDMF recommendation (yes-6, unanimous)	Support the AC recommendation (yes-6, unanimous)	<u>*Require crab pots to be fished within 3 days (not 5) to reduce by catch waste.*</u>

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Section	**Issue**	**Blue Crab AC**	**NCDMF**	**Inland (12/5/11)**	**Northeast (12/6/11)**
10.5	Environmental Factors Section	Support all management recommendations except numbers 10, 11, and 12 in the habitat recommendations (Section 10.4) and number 6 (Section 10,5) in the research recommendations. 10/3/11 5-yes 1-no	Approve all the management recommendations.9/28/11	Support NCDMF recommendation(yes-6, unanimous)	No recommendation
12.2	Research recommendations	Approve the research recommendations 10/3/11	Same as AC. 9/28/11	Support AC/NCDMF recommendation (yes-6, unanimous)	No recommendation
	Other	None	None	None	None

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		Recommendations				
Section	**Issue**	**Southeast (12/8/11)**	**Crustacean (12/12/11)**	**Central (12/13/11)**	**Habitat and Water Quality (12/15/11)**	**Public Comments Received Outside of Meetings**
10.5	Environmental Factors Section	None	No recommendation, tabled the discussion.	Support the AC habitat management recommendations (yes-3, no-2; one member left the meeting before the vote) Support the AC water quality management recommendations (yes-4, no-1; One member left the meeting before the vote)	Approved of the habitat management recommendations #1-9 (yes-7, unanimous) *<u>Combined and modified the habitat management recommendations #10 and #12 to the following: Periodically evaluate the effects of crab dredging and trawling on immediate and adjacent habitat and Protect blue crab recruitment at inlets from adverse impacts, such as channel modification using hardened structures like groins and jetties</u>* (yes-6, no-1) Approve the water quality management recommendations #1-4 and *<u>modify #5 to: Provide proper disposal of unwanted pharmaceuticals and prevent discharge of Endocrine Disrupting Chemicals into surface waters</u>* (yes-7, unanimous) Support the AC recommendation for the environmental factors research recommendations (yes-7, unanimous)	None
12.2	Research recommendations	Support NCDMF research recommendations (yes-6, unanimous)	No recommendation, tabled the discussion.	Support all 31 research recommendations with woring changes to #4 to read: Continue socioeconomic surveys of blue crab harvesters and include wholesale and retail benefits, the entire support industry for this fishery including suppliers, picking houses, and restaurants.	*<u>Support #22 in the research recommendations</u>* (yes-6, unanimous) *<u>No position on any other research recommendations</u>* .	None
	Other	None	None	None	None	*<u>Increase the cull ring size by at least 1/16" or by 1/8" to reduce the catch of sublegal crabs.</u>* *<u>Encourage the use of other methods like trot lines (not 100 ft) up to 1000 ft recreational & 200 ft commercial.</u>* *<u>Eliminate all dragging & dredging methods of fishing which destroys grass/breeding grounds and kills many species including crabs while dragging.</u>* *<u>Request that a rule be established that limits the placement of crab pots within "X" number of feet of any existing structures located in the Neuse river. Another option would be to limit the placement of crab pots that impede the enjoyment of the river by other users of the Neuse river.</u>* *<u>Request the area located on the Neuse River between Camp Don Lee and Dawson's Creek be designated as a closed area for crabbing.</u>*

* *<u>Recommendations or comments from committees and public beyond the ones provided by the AC or NCDMF in italics and underlined.</u>*

** <u>Items underlined in AC or NCDMF recommendations to show variation between the two.</u>

*** **Items in the AC and NCDMF recommendation indicate changes after the public comment period.**

14.7 PUBLIC COMMENTS FROM THE REGIONAL AND STANDING ADVISORY COMMITTEE MEETINGS ON THE DRAFT AMENDMENT 2 OF THE BLUE CRAB FISHERY MANAGEMENT PLAN

Inland Advisory Committee 12-5-11

Diamondback terrapins:

- A member of the public supported the adoption of measures to help conserve diamondback terrapins in NC.

Research recommendations:

- A member of the public emphasized the need for funding to address the Research Recommendations.

Northeast Advisory Committee 12-6-11

Traffic light assessment and adaptive management:

- The numbers did not match what they were seeing in the fishery and that recruitment numbers shouldn't be low if they were seeing more crabs than they ever had before as was the case in their 2008 catches.

- The crabbers were extremely concerned about the survey data that were used in the Traffic Light.

- The NCDMF surveys are not conducted in such a way that would allow them to capture crabs in numbers that would represent what the fishery is seeing and how many crabs there are in the population. Specific sampling concerns were: the type of net, the frequency of sampling, water quality, time of year and number of stations used
- The crabbers did not support using these surveys as input and wanted to see additional data collected and also wanted to incorporate the use of the dependent trip ticket data.

- If the surveys were insufficient, NCDMF should not consider increased restrictions on the fishery.

- NCDMF needed to use the trip ticket data and that it better represented what the crabbers were seeing in the fishery.

- The data sources show production is up but that adult and recruitment is down and does not understand how that can be.

- Management is static and NCDMF needs to change to a full system management plan instead of by species. Monies need to be budgeted to collect the data that is needed and that the current lack of data is not helping the fishermen.

- The crabbers do not want rules and further restrictions put on them that are based on the lack of or poor data.

- A member of the public did not like the Director having proclamation authority to set restrictions on the fishery.

- Environmental factors were affecting the population more than harvest. Blue crabs were always moving and that the NCDMF surveys could not collect adequate data due to environmental influences.

- NCDMF needs to look at trip ticket landings and not just survey data. There is concern that the NCDMF independent survey data is being used to assess the population. The NCDMF data results should not be used to regulate the blue crab fishery and that crabbers would be put out of business on flawed data.

- A member of the public did not like the NCDMF independent surveys because they were not reliable and NCDMF should not include the option to close the commercial season in the management measures.

- The fishermen would likely lose the option to harvest sponge crabs and never get it back.

Hard pots for peeler crab harvest:

- Many crabbers have expressed an interest in being able to use hard crab pots to harvest peelers and that supporting this option would allow the fishermen to do that.

Diamondback terrapins:

- A member of the public would like to see status quo.

- This species has been on the concerned species list for 15 years. He further stated that there is no need to implement statewide restrictions since the terrapin is only found in near shore, higher saline waters.

- It was a short time period when these terrapins interact with the blue crab fishery and that the blue crab AC decided it was a better move to be proactive rather than wait for the Federal Government to make the decisions for them.

- A member of the public recommended that any restrictions relative to terrapins should be area specific.

- Supported diamondback terrapin excluder devices for all recreational pots.

Pot loss and ghost pot mortality:

- Signs should be put up at boat ramps to inform the recreational boating public about crab pots and buoys would be helpful in reducing crab pot loss.

Southeast Advisory Committee 12-8-11

Crab pot limit in southern Bogue Sound:

- During the spring there are fishermen who set a large number of pots in the area and the crab population is depleted for 2- 3 months.

Options for escape ring exemption in hard crab pots used to harvest peelers:

- A pot limit in this area would be beneficial because it would eliminate the duplication of gear for harvesting hard crabs and peelers.
- One fisherman in this area stated that the pot limit would not affect his operations much.

Diamondback terrapins:

- Crabbing effort has declined in areas where terrapins occur, and if populations are declining there may be other causes.
- Any changes in crabbing that may come about would decrease available data on terrapins because crabbers would move away from the areas to avoid restrictions.
- Mandatory use of excluders or area closures would put some crabbers out of business as these areas are challenging to fish anyhow.
- Resources spent changing these rules is a misappropriation of funds and he would rather see the money put into research on terrapins.
- A member of the public questioned whether there is a concern about terrapins an there is no need to go further without sufficient data.
- If excluders are required, there is no way of knowing whether they help.
- Crabbers don't want to catch turtles and avoid high concentrations in May and June when they see the most turtles. They are released alive.
- A member of the public stated in the six years he has been crabbing he is seeing more turtles. He felt that the experiment with excluders without testable results will only hinder crabbers fishing in high salinity areas
- A 2"X6" excluder would eliminate the stone crabs, whelks and flounder from the catch, which are important in the southern part of the State.
- Excluders would reduce the size of blue crabs that are harvested.
- Would like to see better information on the population size of terrapins.
- This began as a recommendation to require excluders on recreational crab pots and has morphed into proclamation authority for pots statewide.
- If recreational pots were required to have excluders, then pots attached to docks should have to be identified.
- An alternative to excluders; that would be to place a cup upside down on the pot to trap air so that any terrapin that is caught could breathe until it was released.
- The wording for proclamation authority in the proposal should be amended to allow for devices to enhance turtle survival and to restrict any requirement for excluders or other devices to areas that have known terrapin concentrations.

Multiple pots to a single buoy:

- A member of the public expressed concern about the loss of an entire string of pots.

- A crabber said it would not affect their operation.

Crustacean Advisory Committee 12-12-11

Adaptive management:

- A member of the public preferred regional management for blue crabs. Different water bodies have different characteristics.

Diamondback terrapins:

- The recommendation from the wildlife committee was only for recreational crab pots and enforcement would be difficult because these pots do not have ownership identification. The AC/NCDMF recommendations include commercial and recreational crab pots. There are specific areas with terrapins. Terrapins have a very small home range and stay in small areas. We should specify use of these excluder devices to only known areas where terrapins occur, not from state line to state line.

- There is no trouble with terrapins if pots are actively fished.

Multiple pots to a single buoy:

- There are concerns for multiple pots per buoy in inside waters where boaters have no idea that pots are in the area.

- There is also a concern about lines crossing and more gear could be lost if the buoy is cut from the pots

Pot loss:

- A crabber said he uses sinking line which is a pain but he does not lose pots. Shorter pots work well. It sands up but it will not move.

Central AC Advisory Committee 12-13-11

Adaptive management:

- Sponge crab harvest has supported the Outer Banks crabbers a lot. If sponge crab harvest is eliminated it will hurt fishermen in some areas and push them to other areas to be in conflict with other crabbers.

Pot limit in southern Bogue Sound:

- A member of the public talked with 6-7 crabber sin this area and only 2 waivered on a 75 pot limit, all agreed a 100 pot limit would help crabbers in this area.

- There are 2 populations of crabs in this area, they come in the spring and move back in the fall.

Non-pot areas in Pungo/Pamlico:

- There are more ways to catch crabs than with a pot.

Escape ring closures for mature females:

- Other areas of the state should be allowed to close their cull rings to harvest small mature females. This is a statewide issue and should be addressed statewide.

- The no trawl line supported by the NCDMF recommendation is the more appropriate line.

Diamondback terrapins:

- The request was originally for recreational pots not for commercial pots and the problem is lack of identification on pots attached to the shore or structure. Terrapins have a very small range off the shoreline and research has no idea about the population size of terrapins.

- Excluder devices would also hurt stone crab fishermen.

- Diamondback terrapins occur along Ocracoke close to shore in the spring in shallow waters. Captures in pots rarely occur because the pots are usually set out beyond the terrapin’s range. It is overkill to require terrapin excluder devices.

Habitat and Water Quality Advisory Committee 12-15-11

No public comment received.

14.8 THE MARINE FISHERIES COMMISSION DRAFT PROPOSED RULE CHANGES

ISSUE 11.1 ADAPTIVE MANAGEMENT FRAMEWORK FOR THE NORTH CAROLINA BLUE CRAB STOCK

MFC Preferred Rule Change:

15A NCAC 03L .0201 **~~SIZE LIMIT AND CULLING TOLERANCE~~ CRAB HARVEST RESTRICTIONS**

(a) It is unlawful to possess blue crabs less than five inches from tip of spike to tip of spike except mature females, soft and peeler crabs and from March 1 through October 31, and male crabs to be used as peeler ~~bait.~~ bait, except the Fisheries Director may, by proclamation, further restrict the harvest of blue crabs as provided in Paragraph (e) of this Rule. A culling tolerance of not more than 10 percent by number in any container shall be ~~allowed.~~allowed, except the Fisheries Director may, by proclamation, further restrict the harvest of blue crabs as provided in Paragraph (e) of this Rule.

(b) All crabs not of legal size, except mature female and soft crabs shall be immediately returned to the waters from which taken. Peeler crabs shall be separated where taken and placed in a separate container. White-line peeler crabs shall be separated from pink and red-line peeler crabs where taken and placed in a separate container. A culling tolerance of not more than five percent by number shall be allowed for white-line peelers in the pink and red-line peeler container. Those peeler crabs not separated shall be deemed hard crabs and are not exempt from the size restrictions specified in Paragraph (a) of this Rule.

~~(c) The Director, may by proclamation, impose the following restrictions when the sum of the carapace widths of mature female blue crabs collected during the September cruise of the Division of Marine Fisheries Pamlico Sound Fishery Independent Trawl Survey divided by the total number of tows (adjusted catch per effort) falls below the lower 90 percent confidence limit for two consecutive years (spawner index):~~

~~(1) It is unlawful to possess mature female blue crabs greater than 6¾ inches from tip of spike to tip of spike from September 1 through April 30. A culling tolerance of not more than five percent by number in any container shall be allowed.~~

~~(2) It is unlawful to possess female peeler crabs greater than 5¼ inches from tip of spike to tip of spike from September 1 through April 30.~~

(c) It is unlawful to:

(1) sell white-line peelers;

(2) possess white-line peelers unless they are to be used in the harvester's permitted blue crab shedding operation, except the Fisheries Director may, by proclamation, further restrict the harvest of blue crabs as provided in Paragraph (e) of this Rule; and

(3) possess male white line peelers from June 1 through September 1, except the Fisheries Director may, by proclamation, further restrict the harvest of blue crabs as provided in Paragraph (e) of this Rule.

(d) 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, except the Fisheries Director may, by proclamation, further restrict the harvest of blue crabs as provided in Paragraph (e) of this Rule.

(e) In order to comply with management measures adopted in the North Carolina Blue Crab Fishery Management Plan, the Fisheries Director may, by proclamation, close the harvest of blue crabs and take the following actions for commercial and recreational blue crab harvest:

(1) Specify size;

(2) Specify seasons;

(3) Specify areas:

(4) Specify quantity;

(5) Specify means and methods;

(6) Specify culling tolerance;

(7) Specify time periods; and

(8) Specify limitations on harvest based on sex, reproductive stage, or peeler stage.

History Note: *Authority G.S. 113-134; 113-182; ~~113-221;~~ 113-221.1; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. April 1, 1997; July 1, 1993;

Temporary Amendment Eff. July 1, 1999;
Amended Eff. April 1, 2013 September 1, 2005; August 1, 2000.

15A NCAC 03L .0203 CRAB DREDGING

(a) It is unlawful to take crabs with dredges except:

(1) From January 1 through March 1 in the area of Pamlico Sound described in 15A NCAC 03R .0109.

(2) Crabs may be taken incidental to lawful oyster dredging operations provided the weight of the crabs shall not exceed:
(A) 50 percent of the total weight of the combined oyster and crab catch; or
(B) 500 pounds, whichever is less.

(3) The Fisheries Director may, by proclamation authority established in 15A NCAC 03L .0201, further restrict the use of dredges to take crabs.

(b) It is unlawful to take crabs with dredges between sunset and sunrise and between sunset on any Saturday and sunrise on the following Monday, except in the Atlantic Ocean.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. April 1, 2013; May 1, 1997.

15A NCAC 03L .0204 CRAB POTS

It is unlawful to take crabs with pots except as provided in 15A NCAC 03J .0301 and .0302. The Fisheries Director may, by proclamation authority established in 15A NCAC 03L .0201, further restrict the use of pots to take crabs.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991.
Amended Eff. April 1, 2013

15A NCAC 03L .0205 CRAB SPAWNING SANCTUARIES

(a) It is unlawful to set or use trawls, pots, and mechanical methods for oysters or clams or take crabs with the use of commercial fishing equipment from the crab spawning sanctuaries described in 15A NCAC 3R .0110 from March 1 through August 31.

(b) ~~From September 1 through February 28, the~~ The Fisheries Director may, by proclamation, ~~close the~~ extend the restrictions in crab spawning sanctuaries implemented in Paragraph (a) of this Rule, designate additional areas as crab spawning sanctuaries and may impose any or all of the following ~~restrictions:~~ restrictions in crab spawning sanctuaries:

~~(1) specify number of days;~~
~~(2)~~(1) specify areas;
~~(3)~~(2) specify means and methods ~~which may be employed in the taking~~;
~~(4)~~(3) specify time periods; and
~~(5)~~(4) specify crab harvest limits ~~limit the quantity~~.

History Note: Authority G.S. 113-134; 113-182; ~~113-221;~~ 113-221.1; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. May 1, 1997;
Temporary Amendment Eff. October 2, 1999;
Amended Eff. April 1, 2013; April 1, 2001.

15A NCAC 03L .0206 PEELER CRABS

~~(a) It is unlawful to bait peeler pots, except with male blue crabs. Male blue crabs to be used as peeler bait and less than the legal size shall be kept in a separate container, and may not be landed or sold.~~
~~(b) It is unlawful to possess male white line peelers from June 1 through September 1.~~
~~(c) It is unlawful to sell white-line peelers.~~
~~(d) It is unlawful to possess white-line peelers unless they are to be used by the harvester in the harvester's permitted blue crab shedding operation.~~
~~(e) Peeler crabs shall be separated where taken and placed in a separate container.~~

History Note: *Authority G.S. 113-134; 113-182; 143B-289.52;*
Temporary Adoption Eff. July 1, 1999;
Eff. August 1, 2000;
Amended Eff. September 1, 2005.
Repealed Eff. April 1, 2013

15A NCAC 03L .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. October 1, 2008.
Repealed Eff. April 1, 2013

15A NCAC 03J .0301 POTS

(a) It is unlawful to use pots except during time periods and in areas specified herein:

(1) In Coastal Fishing Waters from December 1 through May 31, ~~except that~~ except:

(A) ~~All~~ All pots shall be removed from internal waters from January 15 through February 7. Fish pots upstream of U.S. 17 Bridge across Chowan River and upstream of a line across the mouth of Roanoke, Cashie, Middle and Eastmost Rivers to the Highway 258 Bridge are exempt from the January 15 through February 7 removal requirement. The Fisheries Director may, by proclamation, reopen various waters to the use of pots after January 19 if it is determined that such waters are free of ~~pots.~~ pots; and

(B) The Fisheries Director may, by proclamation authority established in 15A NCAC 03L .0201, restrict the use of crab pots from December 1 through May 31.

(2) From June 1 through November 30, north and east of the Highway 58 Bridge at Emerald Isle:

(A) In areas described in 15A NCAC 03R ~~.0107(a);~~ .0107(a), except the Fisheries Director may, by proclamation authority established in 15A NCAC 03L .0201, further restrict the use of crab pots in these areas; and

(B) To allow for the variable spatial distribution of crustacea and finfish, the Fisheries Director may, by proclamation, specify time periods for or designate the areas described in 15A NCAC 03R .0107(b); or any part thereof, for the use of pots.

(3) From May 1 through November 30 in the Atlantic Ocean and west and south of the Highway 58 Bridge at Emerald Isle in areas and during time periods designated by the Fisheries Director by proclamation.

(b) It is unlawful to use pots:

(1) in any navigation channel marked by State or Federal agencies; or

(2) in any turning basin maintained and marked by the North Carolina Ferry Division.

(c) It is unlawful to use pots in a commercial fishing operation unless each pot is marked by attaching a floating buoy which shall be of solid foam or other solid buoyant material and no less than five inches in diameter and no less than five inches in length. Buoys may be of any color except yellow or hot pink or any combination of colors that include yellow or hot pink. The owner shall always be identified on the attached buoy by using engraved buoys or by engraved metal or plastic tags attached to the buoy. Such identification shall include one of the following:

(1) gear owner's current motorboat registration number; or

(2) gear owner's U.S. vessel documentation name; or

(3) gear owner's last name and initials.

(d) Pots attached to shore or a pier shall be exempt from Subparagraphs (a)(2) and (a)(3) of this Rule.

(e) It is unlawful to use shrimp pots with mesh lengths smaller than one and one-fourth inches stretch or five-eights inch bar.

(f) It is unlawful to use eel pots with mesh sizes smaller than one inch by one-half inch unless such pots contain an escape panel that is at least four inches square with a mesh size of 1 inch by one-half inch located in the outside panel of the upper chamber of rectangular pots and in the rear portion of cylindrical pots, except that not more than two eel pots per fishing operation with a mesh of any size may be used to take eels for bait.

(g) It is unlawful to use crab pots in coastal fishing waters unless each pot contains no less than two unobstructed escape rings that are at least 2 5/16 inches inside diameter and located in the opposite outside panels of the upper chamber of the pot. Peeler pots with a mesh size less than 1 1/2 inches shall be exempt from the escape ring requirement. The Fisheries Director may, by proclamation, exempt the escape ring requirement in order to allow the harvest of peeler crabs or mature female crabs and may impose any or all of the following restrictions:

(1) Specify areas, and
(2) Specify time.

(h) It is unlawful to use more than 150 pots per vessel in Newport River.

(i) It is unlawful to remove crab pots from the water or remove crabs from crab pots between one hour after sunset and one hour before sunrise.

(j) User Conflicts:

(1) In order to address user conflicts, the Fisheries Director may by proclamation impose any or all of the following restrictions:
   (A) Specify time period;
   (B) Specify areas; and
   (C) Specify means and methods.

   The Fisheries Director shall hold a public meeting in the affected area before issuance of such proclamation.
(2) Any person(s) desiring user conflict resolution may make such request in writing addressed to the Director of the Division of Marine Fisheries. Such requests shall contain the following information:
   (A) A map of the affected area including an inset vicinity map showing the location of the area with detail sufficient to permit on-site identification and location;
   (B) Identification of the user conflict causing a need for user conflict resolution;
   (C) Recommended solution for resolving user conflict; and
   (D) Name and address of the person(s) requesting user conflict resolution.
(3) Upon the requestor's demonstration of a user conflict to the Fisheries Director and within 90 days of the receipt of the information required in Subparagraph (j)(2) of this Rule, the Fisheries Director shall issue a public notice of intent to address a user conflict. A public meeting shall be held in the area of the user conflict. The requestor shall present his or her request at the public meeting, and other parties affected may participate.
(4) The Fisheries Director shall deny the request or submit a proclamation that addresses the results of the public meeting to the Marine Fisheries Commission for their approval.
(5) Proclamations issued under Subparagraph (j)(1) of this Rule shall suspend appropriate rules or portions of rules under 15A NCAC 03R .0107 as specified in the proclamation. The provisions of 15A NCAC 03I .0102 terminating suspension of a rule as of the next Marine Fisheries Commission meeting and requiring review by the Marine Fisheries Commission at the next meeting shall not apply to proclamations issued under Subparagraph (j)(1) of this Rule.

(k) It is unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating.

(l) It is unlawful to use pots with leads or leaders to take shrimp. For the purpose of this Rule, leads or leaders are defined as any fixed or stationary net or device used to direct fish into any gear used to capture fish. Any device with leads or leaders used to capture fish is not a pot.

History Note: Authority G. S. 113-134; 113-173; 113-182; ~~113-221;~~ 113-221.1; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. August 1, 1998; May 1, 1997; March 1, 1996; March 1, 1994; October 1, 1992; September 1, 1991;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000;
Temporary Amendment Eff. September 1, 2000;
Amended Eff. April 1, 2013; September 1, 2005; August 1, 2004; August 1, 2002.

ISSUE 11.3 CONSIDER ALLOWING NON-POT AREAS IN PUNGO RIVER AREA TO BE REDESIGNATE AS OPEN TO POTS

MFC Preferred Rule Change:

15A NCAC 03R .0107 DESIGNATED POT AREAS

(a) The pot areas referenced in 15A NCAC 03J .0301(a)(2)(A) are delineated in the following coastal fishing waters:

(1) In Albemarle and Currituck sounds and tributaries.

(2) In Roanoke Sound and tributaries.

(3) In Croatan Sound and tributaries.

(4) In Pamlico Sound and tributaries, except areas further described in Subparagraphs (a)(5), (a)(7), and (a)(8) of this Rule. Pots shall not be set within the following area described by lines:

(A) Striking Bay - beginning on shore at a point 35° 23.7003' N - 76° 26.6951' W; running southeasterly to shore at a point 35° 23.3580' N - 76° 26.3777' W; running easterly along shore to Long Point to a point 35° 23.3380' N - 76° 26.2540' W; running southeasterly to Drum Point to a point 35° 22.4830' N - 76° 25.1930' W; running southerly along shore to Point of Narrows to a point 35° 21.9240' N - 76° 25.4080' W; running northwesterly near Marker "2" to a point 35° 22.4166' N - 76° 26.4833' W; running westerly to a point 35° 22.3833' N - 76° 27.0000' W; running northerly to Short Point to a point 35° 23.3831' N - 76° 26.9922' W; running northerly along shore to a point 35° 23.5000' N - 76° 26.9666' W; running northeasterly to the beginning point.

(5) In the Pamlico River and its tributaries west of a line beginning on Willow Point at a point 35° 22.3741' N - 76° 28.6905' W; running southerly to Pamlico Point to a point 35° 18.5882' N - 76° 28.9625' W; pots may be used within an area bound by the shoreline to the depth of six feet, except areas listed in Paragraph (b) of this Rule that may be opened to the use of pots by proclamation and except pots shall not be set within the following areas described by lines:

~~(A) Lupton Point - beginning on Lupton Point at a point 35° 25.6012' N - 76° 31.9641' W; running northwesterly to a point 35° 25.7333' N - 76° 32.1500' W; running southerly along the six foot depth to a point 35° 25.2833' N - 76° 32.3000' W; running northeasterly to shore to a point 35° 25.3389' N - 76° 31.9592' W; running northerly along shore to the beginning point.~~

~~(B) Green Point - beginning on shore at a point 35° 26.6478' N - 76° 33.5008' W; running westerly to a point 35° 26.5833' N - 76° 33.8333' W; running southeasterly along the six foot depth to a point 35° 26.0833' N - 76° 33.2167' W; running northerly to shore to a point 35° 26.4216' N - 76° 33.2856' W; running northwesterly along the shore to the beginning point.~~

~~(C) July Point - beginning on shore at a point 35° 27.3667' N - 76° 33.3500' W; running northeasterly to a point 35° 27.5166' N - 76° 33.3000' W; running westerly along the six foot depth to a point 35° 27.3000' N - 76° 33.8833' W; running easterly to the beginning point.~~

~~(D) Manley Point - beginning on shore at a point 35° 28.0171' N - 76° 33.3144' W; running northwesterly to a point 35° 28.1500' N - 76° 33.7167' W; running southeasterly along the six foot depth to a point 35° 27.6667' N - 76° 33.2000' W; running northwesterly to the beginning point.~~

~~(E) Durants Point - beginning on shore east of Durants Point at a point 35° 30.4660' N - 76° 33.4513' W; running northwesterly to a point 35° 30.7666' N - 76° 33.6500' W; running easterly along the six foot depth to a point 35° 30.8347' N - 76° 32.6529' W; running southwesterly to shore to a point 35° 30.4400' N - 76° 32.7897' W; running westerly along shore to the beginning point.~~

~~(F) Lower Dowry Point - beginning on shore west of Lower Dowry Creek at a point 35° 32.4334' N - 76° 35.6647' W; running southwesterly to a point 35° 32.2333' N - 76° 35.8500' W; running easterly along the six foot depth to a point 35° 32.1166' N - 76° 35.1166' W; running northerly to shore to a point 35° 32.4740' N - 76° 35.1017' W; running westerly along shore to the Inland/Coastal line on the east shore of Lower Dowry Creek; running westerly along the Inland/Coastal line to the west shore of Lower Dowry Creek; running westerly along shore to the beginning point.~~

~~(G) Schrams Beach - beginning on shore at a point 35° 27.2222' N - 76° 36.4662' W; running northeasterly to a point 35° 27.2988' N - 76° 36.2600' W; running southerly along the six foot depth to a point 35° 26.9000' N - 76° 36.1500' W; running northwesterly to shore to~~

~~a point 35° 27.0418' N - 76° 36.3767' W; running northerly along shore to the beginning point.~~

~~(H)~~ ~~Grassy Point - beginning on shore at a point 35° 25.8333' N - 76° 35.6167' W; running northeasterly to a point 35° 25.9846' N - 76° 35.4654' W; running southerly along the six foot depth to a point 35° 25.7333' N - 76° 34.7667' W; running westerly to shore to a point 35° 25.6787' N - 76° 35.4654' W; running northwesterly along shore to the beginning point.~~

~~(I)~~(A) Long Point - beginning on shore at a point 35° 22.4833' N - 76° 43.4167' W; running northwesterly to a point 35° 22.6500' N - 76° 43.4333' W; running easterly along the six foot depth to a point 35° 22.7333' N - 76° 42.7333' W; running to shore to a point 35° 22.4000' N - 76° 43.0833' W; running westerly along shore to the beginning point~~.~~

~~(J)~~(B) Pamlico River Mainstream Channel - beginning at a point 250 yards north of Marker "7" at a point 35° 27.2953' N - 76° 55.1351' W; running westerly to a point near Marker "8" at a point 35° 27.4217' N - 76° 56.0917' W; running westerly along the north side of the marked channel to a point 100 yards north of Marker "9" at a point 35° 27.7472' N - 76° 57.5392' W; running westerly along the north side of the marked channel to a point near Marker "16", north of Whichard's Beach at a point 35° 30.4750' N - 77° 01.2217' W; running southwesterly across the channel to a point 35° 30.4373' N - 77° 01.2614' W; running southeasterly along the south side of the marked channel at a distance of 100 yards from the north side of the marked channel to a point near Marker "7" at a point 35° 27.1722' N - 76° 55.1380' W; running northerly to the beginning point.

~~(K)~~(C) Chocowinity Bay Channel - beginning at a point near the Wildlife Resources Commission (WRC) red marker in Chocowinity Bay at a point 35° 29.5501' N - 77° 01.4335' W; running easterly to the south side of the marked navigation channel in Pamlico River, at a point 35° 29.0408' N - 76° 59.5437' W; running southeasterly to a point 35° 28.9236' N - 76° 59.3109' W; running westerly to the WRC green buoy in Chocowinity Bay at a point 35° 29.5004' N - 77° 01.4339' W; running northerly to the beginning point.

~~(L)~~(D) Whichards Beach Channel - beginning on shore at a point 35° 30.2364' N - 77° 01.3679' W; running easterly to the south side of the marked navigation channel in Pamlico River at a point 35° 30.1952' N - 77° 01.0252' W; running southeasterly to a point 35° 30.1373' N - 77° 00.9685' W; running westerly to shore at a point 35° 30.2002' N - 77° 01.4518' W, running northeasterly to the beginning point.

~~(M)~~(E) Broad Creek Channel - beginning near Marker "3" in Broad Creek at a point 35° 29.0733' N - 76° 57.2417' W; running southwesterly near Marker "1" at a point 35° 28.8591' N - 76° 57.3823' W; running southerly to the marked navigation channel in Pamlico River at a point 35° 27.8083' N - 76° 57.6250' W; running southeasterly to a point 35° 27.7344' N - 76° 57.4822' W; running northerly to the six foot depth at a point 35° 28.5779' N - 76° 57.2924' W; running northerly to the six foot depth at a point 35° 28.7781' N - 76° 57.3508' W; running northerly along the six foot depth to a point near Marker "4" at a point 35° 29.0933' N - 76° 57.1967' W; running southwesterly to the beginning point.

~~(N)~~(F) Blounts Bay - from June 1 through September 15, on the south side of Pamlico River beginning near Marker "7" at a point 35° 27.1722' N - 76° 55.1381' W; running westerly and along the south side of the marked navigation channel to a point near Marker "9" at a point 35° 27.7070' N - 76° 57.5739' W; running northwesterly along the south side of the marked channel to the intersection of the Chocowinity Bay Channel at a point 35° 28.9236' N - 76° 59.3109' W; running westerly along the south side of the Chocowinity Bay Channel to a point 35° 29.0206' N - 76° 59.6678' W; running southerly to the eight foot depth at a point 35° 28.6667' N - 76° 59.6667' W; running southeasterly along the eight foot depth to a point 35° 27.0833' N - 76° 55.1667' W; running northerly to the beginning point.

(6) In the Pamlico River and its tributaries west of a line beginning on Willow Point at a point 35° 22.3741' N - 76° 28.6905' W; running southerly to Pamlico Point to a point 35° 18.5882' N - 76° 28.9625' W; pots may be used within an area bound by the shoreline to the depth of six feet, except areas listed in Paragraph (b) of this Rule that may be opened to the use of pots by proclamation and except; pots may be set within the following areas described by lines:

~~(A) Durants Point - beginning on Durants Point at a point 35° 30.5197' N - 76° 35.1521' W; running northwesterly to a point 35° 31.1333' N - 76° 35.5833' W; running northeasterly 200 yards south of Marker "10" to a point 35° 31.2032' N - 76° 35.5558' W; running easterly parallel to the marked navigation channel at a distance of 200 yards to a point southwest of Marker "12" to a point 35° 31.1492' N - 76° 33.8997' W; running southeasterly to shore to a point 35° 30.4660' N - 76° 33.4513' W; running westerly along shore to the beginning point.~~

~~(B) South shore, upper Pungo River - beginning on shore west of Durants Point at a point 35° 30.4400' N - 76° 32.7897' W; running northeasterly to a point southeast of Marker "14" to a point 35° 31.0833' N - 76° 32.5667' W; running easterly parallel to the marked navigation channel at a distance of 200 yards to the shore south of Wilkerson Creek to a point 35° 33.0493' N - 76° 27.2752' W; running southerly and westerly along the shoreline and following the Inland/Coastal lines of Horse Island, Tarklin, Scranton, and Smith Creeks to the beginning point.~~

~~(C) North shore, upper Pungo River - beginning on shore east of Lower Dowry Creek at a point 35° 32.4740' N - 76° 35.1017' W; running southerly to a point 35° 31.5167' N - 76° 35.1000' W; running easterly parallel to the marked navigation channel at a distance of 200 yards to the north shore of Wilkerson Creek to a point 35° 33.2339' N - 76° 27.5449' W; running northwesterly along the shoreline to the east end of the US 264 bridge; running westerly along the bridge and following the Inland/Coastal line to the western shore; running southerly and westerly along the shoreline and following the Inland/Coastal lines of Crooked Creek and Upper Dowry Creek to the beginning point.~~

~~(D) Tooleys Point - beginning at the "Breakwater" 200 yards northeast of Beacon "6", at a point 35° 31.7833' N - 76° 36.8500' W; running southeasterly to a point 200 yards from Marker "4" at a point 35° 31.5167' N - 76° 36.3500' W; running easterly to a point 35° 31.4667' N - 76° 35.9833' W; running northerly near Beacon "1" to a point 35° 32.1100' N - 76° 35.9817' W; running northeasterly to shore to a point 35° 32.4334' N - 76° 35.6647' W; running westerly and along the shoreline of Battalina and Tooley Creeks; running along the river shore to the "Breakwater" to a point 35° 31.9908' N - 76° 36.6105' W; running southwesterly along the "Breakwater" to the beginning point.~~

(A) Durant’s Point and South Shore, upper Pungo River – beginning on Durant’s Point at a point 35° 30.5197’ N – 76° 35.1521’ W; running northwesterly to a point 35° 31.1333’ N – 76° 35.5833’ W; running northeasterly 200 yards south of Marker “10” to a point 35° 31.2032’ N – 76° 35.5558’ W; running easterly parallel to the marked navigation channel at a distance of 200 yards to the shore south of Wilkerson Creek to a point 35° 33.0493’ N – 76° 27.2752’ W; running southerly and westerly along the shoreline and following the Inland/Coastal lines of Horse Island, Tarklin, Scranton, and Smith Creeks to the beginning point.

(B) Tooley’s Point and North Shore, upper Pungo River – beginning at the “Breakwater” 200 yards northeast of Beacon “6”, at a point 35° 31.7833’ N – 76° 36.8500’ W; running southeasterly to a point 200 yards from Marker “4” at a point 35° 31.5167’ N – 76° 36.3500’ W; running easterly parallel to the marked navigation channel at a distance of 200 yards to the north shore of Wilkerson Creek to a point 35° 33.2339’ N - 76° 27.5449’ W; running northwesterly along the shoreline to the east end of the US 264 bridge; running westerly along the south side of the bridge and following the Inland/Coastal line to the western shore; running southerly and westerly along the shoreline and following the Inland/Coastal lines of Upper Dowry Creek and Lower Dowry Creek; running westerly and along the shoreline of Battalina and Tooley Creeks; running along the river shore to the “Breakwater” to a point 35° 31.9908’ N – 76° 36.6105’ W; running southwesterly along the “Breakwater” to the beginning point.

~~(E)~~(C) Pungo Creek - beginning on Windmill Point at a point 35° 30.7444' N - 76° 38.2869' W; running northeasterly to a point 200 yards west of Marker "3" to a point 35° 31.3500' N - 76° 36.6167' W; running northwesterly to the "Breakwater" to a point 35° 31.6296' N - 76° 37.1201' W; running westerly along the "Breakwater" to shore to a point 35° 31.5653' N - 76° 37.3832' W; running westerly along shore and into Pungo Creek following the shoreline and the Inland/Coastal lines of Vale, Scott, and Smith creeks to the north end of the NC 92 bridge over Pungo Creek; running southerly along the bridge and following the Inland/Coastal line to the southern shore; running easterly along shore to the beginning point.

~~(F)~~(D) Upper Pamlico - in coastal fishing waters west of a line beginning on the north shore of Gum Point at a point 35° 25.1699' N - 76° 45.5251' W; running southwesterly to a point on the south shore of Pamlico River to a point 35° 23.4453' N - 76° 46.4346' W, except as described in Part (a)(5)(J) through (N) of this Rule.

~~(G)~~(E) North Side Pamlico - beginning on the north shore of Gum Point at a point 35° 25.1699' N - 76° 45.5251' W; running southwesterly 500 yards from shore to a point 35° 24.9339' N - 76° 45.6495' W; running easterly parallel to the shoreline at a distance of 500 yards near Adams Point to a point 35° 23.3949' N - 76° 35.8089' W; running northerly to shore at a point 35° 23.1754' N - 76° 35.9619' W; running westerly along shore to the beginning point.

~~(H)~~(F) South Creek - in coastal fishing waters of South Creek and tributaries west of a line beginning on Hickory Point at a point 35° 21.7385' N - 76° 41.5907' W; running southerly to Fork Point to a point 35° 20.7534' N - 76° 41.7870' W.

(7) In Bay River west of a line beginning on Bay Point at a point 35° 11.0750' N - 76° 31.6080' W; running southerly to Maw Point to a point 35° 09.0407' N - 76° 32.2348' W; pots may be used within an area bound by the shoreline to the depth of six feet, except areas listed in Paragraph (b) of this Rule that may be opened to the use of pots by proclamation, and pots shall not be set within the following areas described by lines:

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History Note: *Authority G.S. 113-134; 113-182; ~~113-221~~; 113-221.1; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. March 1, 1996; March 1, 1994; July 1, 1993; September 1, 1991;
Recodified from 15A NCAC 03R .0007 Eff. December 17, 1996;
Amended Eff. April 1, 2013; September 1, 2005; May 1, 1997; April 1, 1997.

ISSUE 11.4 INCORPORATE THE LOWER BROAD CREEK CLOSURE OF POT AREA INTO RULE

MFC Preferred Rule Change:

15A NCAC 03R .0107 DESIGNATED POT AREAS

(a) The pot areas referenced in 15A NCAC 03J .0301(a)(2)(A) are delineated in the following coastal fishing waters:

(1) In Albemarle and Currituck sounds and tributaries.
(2) In Roanoke Sound and tributaries.
(3) In Croatan Sound and tributaries.
(4) In Pamlico Sound and tributaries, except areas further described in Subparagraphs (a)(5), (a)(7), and (a)(8) of this Rule. Pots shall not be set within the following area described by lines:

. . .

(8) In the Neuse River and Point of Marsh area south and west of a line beginning on Maw Point at a point 35° 09.0407' N – 76° 32.2348' W; running southeasterly near the Maw Point Shoal Marker "2" to a point ~~35° 08.1250' N - 76° 30.8532' W;~~ 35° 08.1250' N – 76° 30.8532' W; running southeasterly near the Neuse River Entrance Marker "NR" to a point 35° 06.6212' N – 76° 28.5383' W; running southeasterly to a point 35° 04.7670' N – 76° 25.7920' W; running southwesterly to shore to a point 35° 03.9387' N – 76° 27.0466' W; pots may be used in coastal fishing waters bound by the shoreline to the depth of six feet, except areas listed in Paragraph (b) of this Rule that may be opened to the use of pots by proclamation and except pots shall not be set within the following areas described by lines:

(A) Oriental - in that area including Greens Creek and tributaries downstream of the bridge on State Secondary Road 1308, and Whittaker Creek north of a line beginning on the west shore at the Whittaker Creek primary nursery area (PNA) line; running easterly along the Whittaker Creek PNA line to the east shore; running southerly to a point 35° 01.3833' N – 76° 40.9500' W; running westerly following the six foot depth to a point 35° 01.1666' N – 76° 41.8833' W; running southerly across the channel to a point 35° 01.1339' N – 76° 41.9589' W; running westerly to Windmill Point to the south shore of the Shop Gut Creek PNA line; running northerly along the Shop Gut Creek PNA line to the north shore of the Shop Gut Creek PNA line.

(B) Greens Creek - more than 75 yards from shore in the area beginning on the south shore of Greens Creek primary nursery area (PNA) line; following the PNA lines of Greens Creek and Kershaw Creek to the east shore of Kershaw Creek; running easterly along the shore of Greens Creek, and running along the shore of Smith Creek and its tributaries to the bridge on State Secondary Road 1308; running southwesterly along the bridge to the south shore of Greens Creek; running westerly along the shore to the beginning point.

(C) Dawson Creek - beginning on the west shore at a point 34° 59.5920' N – 76° 45.4620' W; running easterly along the bridge on State Secondary Road 1302 to shore at a point 34° 59.5800' N – 76° 45.4140' W; running northerly and easterly along the shore to the primary nursery area (PNA) line of the southeastern tributary; running northerly along the PNA line to shore; running northerly along shore to the PNA line of the unnamed northeastern tributary; running northwesterly along the PNA line to shore; running northwesterly along shore to the Inland/Coastal line on Tarklin Creek; running westerly along the Inland/Coastal line to shore; running southwesterly along shore to the Inland/Coastal line on Dawson Creek; running southerly along the Inland/Coastal line to the shore; running easterly and then southerly along shore to the beginning point.

(D) Wilkerson Point - beginning on the west side of the Minnesott Beach Yacht Basin Channel at a point 34° 58.2682' N – 76° 49.1903' W; running southerly to a point 34° 58.1403' N – 76° 49.2253' W; running easterly along the six foot depth to a point 34° 58.4000' N – 76° 46.5667' W; running northerly to shore to a point 34° 58.5333' N – 76° 46.6333' W; running westerly along shore to the beginning point.

(E) Beard Creek - beginning on shore west of Beard Creek at a point 35° 00.1902' N – 76° 52.2176' W; running southerly to a point 34° 59.8883' N – 76° 52.3594' W; running easterly along the six foot depth to a point 34° 59.4167' N – 76° 51.2333' W; running northeasterly to shore to a point 34° 59.5989' N – 76° 51.0781' W; running westerly along shore to the Beard Creek tributary primary nursery area (PNA) line; running northeasterly along the PNA line to the Inland/Coastal line in Beards Creek; running westerly along the Inland/Coastal line to the western shore; running southerly along shore to the beginning point.

(F) Clubfoot Creek - more than 50 yards from shore in the area south of a line beginning at a point ~~34° 54.9327' N - 76° 45.6506' W~~ 34° 54.9327' N – 76° 45.6506' W on the west shore; running northerly to a point ~~34° 55.1501' N - 76° 45.6221' W;~~ 34° 55.1501' N – 76° 45.6221' W; running northeasterly to a point ~~34° 55.1812' N - 76° 45.5172' W~~ 34° 55.1812' N – 76° 45.5172' W near Marker "5"; running northeasterly to a point ~~34° 55.2994' N - 76° 45.1180' W~~ 34° 55.2994' N – 76° 45.1180' W on the east shore and north of line beginning at a point on the west shore ~~34° 54.5424' N - 76° 45.7252' W;~~ 34° 54.5424' N – 76° 45.7252' W; running easterly to a point ~~34° 54.4853' N - 76° 45.4022' W~~ 34° 54.4853' N – 76° 45.4022' W on the east shore.

(G) Lower Broad Creek - beginning on the north shore at a point 35° 05.8314' N – 76° 35.3845' W; running southwesterly along the secondary nursery area line to the six foot depth at 35° 05.7321' N – 76° 35.5046' W; running southerly following the six foot depth near Marker "2A" to a point 35° 05.5442' N – 76° 35.2886' W; running northerly to a point 35° 05.7446' N – 76° 35.2980' W; running westerly along the shore to the point of beginning.

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History Note: *Authority G.S. 113-134; 113-182; ~~113-221;~~ 113-221.1; 143B-289.52;*

Eff. January 1, 1991;
Amended Eff. April 1, 2013; March 1, 1996; March 1, 1994; July 1, 1993; September 1, 1991;
Recodified from 15A NCAC 03R .0007 Eff. December 17, 1996;
Amended Eff. September 1, 2005; May 1, 1997; April 1, 1997.

ISSUE 11.5 CLARIFY CRAB DREDGING RESTRICTIONS

MFC Preferred Rule Change:

15A NCAC 03L .0203 CRAB DREDGING

(a) It is unlawful to take crabs with dredges except:

(1) From January 1 through March 1 in the area of Pamlico Sound described in 15A NCAC ~~03R .0109.~~ 03R .0109; and

(2) ~~Crabs may be taken incidental~~ Incidental to lawful oyster dredging operations in areas not subject to the exception in Subparagraph (a)(1) of this Rule provided the weight of the crabs shall not exceed:

(A) 50 percent of the total weight of the combined oyster and crab catch; or

(B) 500 pounds, whichever is less~~.~~; and

(b) It is unlawful to take crabs with dredges between sunset and sunrise and between sunset on any Saturday and sunrise on the following Monday, except in the Atlantic Ocean.

History Note: *Authority G.S. 113-134; 113-182; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. April 1, 2013; May 1, 1997.

ISSUE 11.6 INCORPORATE THE PAMLICO SOUND CRAB TRAWLING PROCLAMATION INTO RULE 15A NCAC 03L .0202

MFC Preferred Rule Change:

15A NCAC 03L .0202 CRAB TRAWLING

(a) It is unlawful to take or possess aboard a vessel crabs taken by trawl in internal waters except in areas and during such times as the Fisheries Director may specify by proclamation.

(b) It is unlawful to use ~~any crab~~ a trawl to take crabs that does not meet mesh length requirements, except as provided in 15A NCAC 03J .0104(f). The minimum mesh length to take hard crabs with a trawl is three inches, except:~~with a mesh length less than three inches for taking hard crabs, except that the Fisheries Director may, by proclamation, increase the minimum mesh length to no more than four inches, and specify areas for crab trawl mesh size use.~~

(1) The minimum mesh length is four inches in the area of western Pamlico Sound west of a line beginning at a point 35° 48.3693'N – 75° 43.7232'W on Roanoke Marshes Point; running easterly to a point 35° 48.3000'N – 75° 37.1167'W near Beacon "1" at the southern end of Roanoke Island; running southerly to a point 35° 30.7500'N - 75° 40.5667'W near the "S" Beacon at Long Shoal; running southwesterly to a point 35° 12.6167'N – 76° 04.3833'W near the "BL" Beacon on Bluff Shoal; running westerly to a point 35° 08.1000'N – 76° 17.5000'W near the "BI" Beacon at Brant Island Shoal; running southwesterly to a point 35° 04 .6167' N – 76° 27.8000'W on Point of Marsh; and

(2) The Fisheries Director may, by proclamation, specify areas other than the area described in Sub-item (b)(1) of this Rule for trawl mesh length use and increase the minimum trawl mesh length to no more than four inches to take hard crabs.

(c) It is unlawful to use ~~trawls~~ a trawl with a mesh length less than two inches or with a combined total headrope length exceeding 25 feet ~~for taking soft or "peeler"~~ to take soft or peeler crabs, except as provided in 15A NCAC 03J .0104(f).

History Note: *Authority G.S. 113-134; 113-182; ~~113-221~~; 113.221.1; 143B-289.52;*
Eff. February 1, 1991;
Amended Eff. April 1, 2013; September 1, 2005; August 1, 2004; March 1, 1994; September 1, 1991.

ISSUE 11.7 EXPLORE OPTIONS FOR ESCAPE RING EXEMPTIONS IN HARD CRAB POTS TO HARVEST PEELER CRABS

MFC Preferred Rule Change:

15A NCAC 03J .0301 POTS

(a) It is unlawful to use pots except during time periods and in areas specified herein:

(1) In Coastal Fishing Waters from December 1 through May 31, except that all pots shall be removed from internal waters from January 15 through February 7. Fish pots upstream of U.S. 17 Bridge across Chowan River and upstream of a line across the mouth of Roanoke, Cashie, Middle and Eastmost Rivers to the Highway 258 Bridge are exempt from the January 15 through February 7 removal requirement. The Fisheries Director may, by proclamation, reopen various waters to the use of pots after January 19 if it is determined that such waters are free of pots.

(2) From June 1 through November 30, north and east of the Highway 58 Bridge at Emerald Isle:

(A) In areas described in 15A NCAC 03R .0107(a);

(B) To allow for the variable spatial distribution of crustacea and finfish, the Fisheries Director may, by proclamation, specify time periods for or designate the areas described in 15A NCAC 03R .0107(b); or any part thereof, for the use of pots.

(3) From May 1 through November 30 in the Atlantic Ocean and west and south of the Highway 58 Bridge at Emerald Isle in areas and during time periods designated by the Fisheries Director by proclamation.

(b) It is unlawful to use pots:

(1) in any navigation channel marked by State or Federal agencies; or

(2) in any turning basin maintained and marked by the North Carolina Ferry Division.

(c) It is unlawful to use pots in a commercial fishing operation unless each pot is marked by attaching a floating buoy which shall be of solid foam or other solid buoyant material and no less than five inches in diameter and no less than five inches in length. Buoys may be of any color except yellow or hot pink or any combination of colors that include yellow or hot pink. The owner shall always be identified on the attached buoy by using engraved buoys or by engraved metal or plastic tags attached to the buoy. Such identification shall include one of the following:

(1) gear owner's current motorboat registration number; or

(2) gear owner's U.S. vessel documentation name; or

(3) gear owner's last name and initials.

(d) Pots attached to shore or a pier shall be exempt from Subparagraphs (a)(2) and (a)(3) of this Rule.

(e) It is unlawful to use shrimp pots with mesh lengths smaller than one and one-fourth inches stretch or five-eights inch bar.

(f) It is unlawful to use eel pots with mesh sizes smaller than one inch by one-half inch unless such pots contain an escape panel that is at least four inches square with a mesh size of 1 inch by one-half inch located in the outside panel of the upper chamber of rectangular pots and in the rear portion of cylindrical pots, except that not more than two eel pots per fishing operation with a mesh of any size may be used to take eels for bait.

(g) It is unlawful to use crab pots in coastal fishing waters unless each pot contains no less than two unobstructed escape rings that are at least 2 5/16 inches inside diameter and located in the opposite outside panels of the upper chamber of the pot. ~~Peeler pots with a mesh size less than 1 1/2 inches~~ Unbaited pots and pots baited with a male crab shall be exempt from the escape ring requirement. The Fisheries Director may, by proclamation, exempt the escape ring requirement in order to allow the harvest of ~~peeler crabs or~~ mature female crabs and may impose any or all of the following restrictions:

(1) Specify areas;~~,~~ and

(2) Specify time periods~~,~~.

(h) It is unlawful to use more than 150 crab pots per vessel in Newport River.

(i) It is unlawful to remove crab pots from the water or remove crabs from crab pots between one hour after sunset and one hour before sunrise.
(j) User Conflicts:
(1) In order to address user conflicts, the Fisheries Director may by proclamation impose any or all of the following restrictions:
(A) Specify time ~~period~~periods;
(B) Specify areas; and
(C) Specify means and methods.
The Fisheries Director shall hold a public meeting in the affected area before issuance of such proclamation.
(2) Any person(s) desiring user conflict resolution may make such request in writing addressed to the Director of the Division of Marine Fisheries. Such requests shall contain the following information:
(A) A map of the affected area including an inset vicinity map showing the location of the area with detail sufficient to permit on-site identification and location;
(B) Identification of the user conflict causing a need for user conflict resolution;
(C) Recommended solution for resolving user conflict; and
(D) Name and address of the person(s) requesting user conflict resolution.
(3) Upon the requestor's demonstration of a user conflict to the Fisheries Director and within 90 days of the receipt of the information required in Subparagraph (j)(2) of this Rule, the Fisheries Director shall issue a public notice of intent to address a user conflict. A public meeting shall be held in the area of the user conflict. The requestor shall present his or her request at the public meeting, and other parties affected may participate.
(4) The Fisheries Director shall deny the request or submit a proclamation that addresses the results of the public meeting to the Marine Fisheries Commission for their approval.
(5) Proclamations issued under Subparagraph (j)(1) of this Rule shall suspend appropriate rules or portions of rules under 15A NCAC 03R .0107 as specified in the proclamation. The provisions of 15A NCAC 03I .0102 terminating suspension of a rule as of the next Marine Fisheries Commission meeting and requiring review by the Marine Fisheries Commission at the next meeting shall not apply to proclamations issued under Subparagraph (j)(1) of this Rule.
(k) It is unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating.
(l) It is unlawful to use pots with leads or leaders to take shrimp. For the purpose of this Rule, leads or leaders are defined as any fixed or stationary net or device used to direct fish into any gear used to capture fish. Any device with leads or leaders used to capture fish is not a pot.

History Note: Authority G. S. 113-134; 113-173; 113-182; ~~113-221;~~113-221.1; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. August 1, 1998; May 1, 1997; March 1, 1996; March 1, 1994; October 1, 1992; September 1, 1991;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000;
Temporary Amendment Eff. September 1, 2000;
Amended Eff. April 1, 2013; September 1, 2005; August 1, 2004; August 1, 2002.

15A NCAC 03L .0206 PEELER CRABS
~~(a) It is unlawful to bait peeler pots, except with male blue crabs. Male blue crabs to be used as peeler bait and less than the legal size shall be kept in a separate container, and may not be landed or sold.~~
(a)~~(b)~~ It is unlawful to possess male white line peelers from June 1 through September 1.
(b)~~(c)~~ It is unlawful to sell white-line peelers.
(c)~~(d)~~ It is unlawful to possess white-line peelers unless they are to be used by the harvester in the harvester's permitted blue crab shedding operation.
~~(e) Peeler crabs shall be separated where taken and placed in a separate container.~~

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Temporary Adoption Eff. July 1, 1999;
Eff. August 1, 2000;

Amended Eff. April 1, 2013; September 1, 2005.

ISSUE 11.8 CONVERT CRAB POT ESCAPE RING PROCLAMATION EXEMPTIONS FOR MATURE FEMALES INTO RULE

MFC Preferred Rule Change:

15A NCAC 03J .0301 POTS

(a) It is unlawful to use pots except during time periods and in areas specified herein:

(1) In Coastal Fishing Waters from December 1 through May 31, except that all pots shall be removed from internal waters from January 15 through February 7. Fish pots upstream of U.S. 17 Bridge across Chowan River and upstream of a line across the mouth of Roanoke, Cashie, Middle and Eastmost Rivers to the Highway 258 Bridge are exempt from the January 15 through February 7 removal requirement. The Fisheries Director may, by proclamation, reopen various waters to the use of pots after January 19 if it is determined that such waters are free of pots.

(2) From June 1 through November 30, north and east of the Highway 58 Bridge at Emerald Isle:

(A) In areas described in 15A NCAC 03R .0107(a);

(B) To allow for the variable spatial distribution of crustacea and finfish, the Fisheries Director may, by proclamation, specify time periods for or designate the areas described in 15A NCAC 03R .0107(b); or any part thereof, for the use of pots.

(3) From May 1 through November 30 in the Atlantic Ocean and west and south of the Highway 58 Bridge at Emerald Isle in areas and during time periods designated by the Fisheries Director by proclamation.

(b) It is unlawful to use pots:

(1) in any navigation channel marked by State or Federal agencies; or

(2) in any turning basin maintained and marked by the North Carolina Ferry Division.

(c) It is unlawful to use pots in a commercial fishing operation unless each pot is marked by attaching a floating buoy which shall be of solid foam or other solid buoyant material and no less than five inches in diameter and no less than five inches in length. Buoys may be of any color except yellow or hot pink or any combination of colors that include yellow or hot pink. The owner shall always be identified on the attached buoy by using engraved buoys or by engraved metal or plastic tags attached to the buoy. Such identification shall include one of the following:

(1) gear owner's current motorboat registration number; or

(2) gear owner's U.S. vessel documentation name; or

(3) gear owner's last name and initials.

(d) Pots attached to shore or a pier shall be exempt from Subparagraphs (a)(2) and (a)(3) of this Rule.

(e) It is unlawful to use shrimp pots with mesh lengths smaller than one and one-fourth inches stretch or five-eights inch bar.

(f) It is unlawful to use eel pots with mesh sizes smaller than one inch by one-half inch unless such pots contain an escape panel that is at least four inches square with a mesh size of 1 inch by one-half inch located in the outside panel of the upper chamber of rectangular pots and in the rear portion of cylindrical pots, except that not more than two eel pots per fishing operation with a mesh of any size may be used to take eels for bait.

(g) It is unlawful to use crab pots in coastal fishing waters unless each pot contains no less than two unobstructed escape rings that are at least 2 5/16 inches inside diameter and located in the opposite outside panels of the upper chamber of the pot. ~~Peeler pots with a mesh size less than 1 1/2 inches~~ Pots set in areas and during time periods described in 15A NCAC 03R .0118 shall be exempt from the escape ring requirement. The Fisheries Director may, by proclamation, exempt the escape ring requirement in order to allow the harvest of peeler crabs or mature female crabs and may impose any or all of the following restrictions:

(1) Specify areas;~~, and~~

(2) Specify time periods; and~~.~~

(3) Specify means and methods.

(h) It is unlawful to use more than 150 pots per vessel in Newport River.

(i) It is unlawful to remove crab pots from the water or remove crabs from crab pots between one hour after sunset and one hour before sunrise.

(j) User Conflicts:

(1) In order to address user conflicts, the Fisheries Director may by proclamation impose any or all of the following restrictions:
(A) Specify time period;
(B) Specify areas; and
(C) Specify means and methods.
The Fisheries Director shall hold a public meeting in the affected area before issuance of such proclamation.
(2) Any person(s) desiring user conflict resolution may make such request in writing addressed to the Director of the Division of Marine Fisheries. Such requests shall contain the following information:
(A) A map of the affected area including an inset vicinity map showing the location of the area with detail sufficient to permit on-site identification and location;
(B) Identification of the user conflict causing a need for user conflict resolution;
(C) Recommended solution for resolving user conflict; and
(D) Name and address of the person(s) requesting user conflict resolution.
(3) Upon the requestor's demonstration of a user conflict to the Fisheries Director and within 90 days of the receipt of the information required in Subparagraph (j)(2) of this Rule, the Fisheries Director shall issue a public notice of intent to address a user conflict. A public meeting shall be held in the area of the user conflict. The requestor shall present his or her request at the public meeting, and other parties affected may participate.
(4) The Fisheries Director shall deny the request or submit a proclamation that addresses the results of the public meeting to the Marine Fisheries Commission for their approval.
(5) Proclamations issued under Subparagraph (j)(1) of this Rule shall suspend appropriate rules or portions of rules under 15A NCAC 03R .0107 as specified in the proclamation. The provisions of 15A NCAC 03I .0102 terminating suspension of a rule as of the next Marine Fisheries Commission meeting and requiring review by the Marine Fisheries Commission at the next meeting shall not apply to proclamations issued under Subparagraph (j)(1) of this Rule.

(k) It is unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating.
(l) It is unlawful to use pots with leads or leaders to take shrimp. For the purpose of this Rule, leads or leaders are defined as any fixed or stationary net or device used to direct fish into any gear used to capture fish. Any device with leads or leaders used to capture fish is not a pot.

History Note: Authority G. S. 113-134; 113-173; 113-182; ~~113-221;~~113-221.1 143B-289.52;
Eff. January 1, 1991;
Amended Eff. August 1, 1998; May 1, 1997; March 1, 1996; March 1, 1994; October 1, 1992; September 1, 1991;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000;
Temporary Amendment Eff. September 1, 2000;
Amended Eff. April 1, 2013; September 1, 2005; August 1, 2004; August 1, 2002.

15A NCAC 03R .0118 EXEMPTED CRAB POT ESCAPE RING AREAS

The areas referenced in 15A NCAC 03J .0301(g) are delineated in the following coastal fishing waters:

(1) In Pamlico Sound: within the area described by a line beginning at a point 35° 43.7457' N - 75° 30.7014' W on the south shore of Eagles Nest Bay on Pea Island; running westerly to a point 35° 42.9500' N - 75° 34.1500' W; running southerly to a point 35° 39.3500' N – 75° 34.4000' W; running southeasterly to a point 35° 35.8931' N - 75° 31.1514' W in Chicamacomico Channel near Beacon "ICC"; running southerly to a point 35° 28.5610' N - 75° 31.5825' W on Gull Island; running southwesterly to a point 35° 22.8671' N - 75° 33.5851' W in Avon Channel near Beacon "1AV"; running southwesterly to a point 35° 18.9603' N - 75° 36.0817' W in Cape Channel near Beacon "2"; running westerly to a point 35° 16.7588' N - 75° 44.2554' W in Rollinson Channel near Beacon "42RC"; running southwesterly to a point 35° 14.0337' N - 75° 45.9643' W southwest of Oliver Reef near the quick-flashing beacon; running westerly to a point 35° 09.3650' N – 76° 00.6377' W in Big Foot Slough Channel near Beacon "14BF"; running southwesterly to a point 35° 08.4523' N – 76° 02.6651'W in Nine Foot Shoal Channel near Beacon "9"; running westerly to

a point 35° 07.1000' N – 76° 06.9000' W; running southwesterly to a point 35° 01.4985' N – 76° 11.4353' W near Beacon "HL"; running southwesterly to a point 35° 00.2728' N - 76° 12.1903' W near Beacon "1CS"; running southerly to a point 34° 59.5027' N – 76° 12.3204' W in Wainwright Channel immediately east of the northern tip of Wainwright Island; running southwesterly to a point 34° 59.3610' N - 76° 12.6040' W on Wainwright Island; running easterly to a point at 34° 58.7853' N - 76° 09.8922' W on Core Banks; running easterly and northerly along the shoreline across the inlets following the COLREGS Demarcation line up the Outer Banks to the point of beginning.

(2) In Newport River, from April 1 through June 15, within the area described by a line beginning at a point 34° 49.5080' N – 76° 41.4440' W; running westerly along the south side of the Highway 101 Bridge over Core Creek to a point on the west shore 34° 49.5260' N – 76° 41.5130' W; running along the shoreline of Newport River and its tributaries to a point 34° 49.3050'N - 76° 44.2350'W; running westerly along the south side of the Highway 101 Bridge over Harlowe Canal to point on the west shore 34° 49.2980'N - 76° 44.2610'W; running along the shoreline of Newport River and its tributaries to a point 34° 45.2478'N - 76° 46.4479'W; running southerly along the Inland-Coastal Waters boundary line to a point 34° 45.1840'N - 76° 46.4488'W; running along the shoreline of Newport River and its tributaries to a point 34° 43.2520' N – 76° 41.6840' W; running easterly along the north side of the Highway 70 Bridge over Newport River to a point 34° 43.2840' N – 76° 41.2200' W; running along the shoreline of Newport River and its tributaries to a point 34° 43.3530' N – 76° 40.2080'W; running easterly across Gallant Channel to a point 34° 43.3521' N – 76° 40.0871' W; running along the shoreline of Newport River and its tributaries back to the point of beginning.

History Note: Authority G. S. 113-134; 113-182; 143B-289.52;
Eff. April 1, 2013;

ISSUE 11.9 CORRECTION OF PEELER TRAWL EXCEPTION RULE

MFC Preferred Rule Change:

15A NCAC 03J .0104 TRAWL NETS

(a) It is unlawful to possess aboard a vessel while using a trawl in internal waters more than 500 pounds of finfish from December 1 through February 28 and 1,000 pounds of finfish from March 1 through November 30.

(b) It is unlawful to use trawl nets:

(1) In internal coastal waters, from 9:00 p.m. on Friday through 5:00 p.m. on Sunday, except that in the areas listed in Subparagraph (b)(5) of this Rule, trawling is prohibited from December 1 through February 28 from one hour after sunset on Friday to one hour before sunrise on Monday~~.~~;

(2) For the taking of oysters;

(3) In Albemarle Sound, Currituck Sound, and their tributaries, west of a line beginning on the south shore of Long Point at a point 36° 02.4910' N - 75° 44.2140' W; running southerly to the north shore on Roanoke Island to a point 35° 56.3302' N - 75° 43.1409' W; running northwesterly to Caroon Point to a point 35° 57.2255' N - 75° 48.3324' W;

(4) In the areas described in 15A NCAC 03R .0106, except that the Fisheries Director may, by proclamation, open the area designated in Item ~~(6)~~ (1) of 15A NCAC 03R .0106 to peeler crab trawling;

(5) From December 1 through February 28 from one hour after sunset to one hour before sunrise in the following areas:

(A) In Pungo River, north of a line beginning on Currituck Point at a point 35° 24.5833' N-76° 32.3166' W; running southwesterly to Wades Point to a point 35° 23.3062' N-76° 34.5135' W;

(B) In Pamlico River, west of a line beginning on Wades Point at a point 35° 23.3062' N – 76° 34.5135' W; running southwesterly to Fulford Point to a point 35° 19.8667' N – 76° 35.9333' W;

(C) In Bay River, west of a line beginning on Bay Point at a point 35° 11.0858' N – 76° 31.6155' W; running southerly to Maw Point to a point 35° 09.0214' N – 76° 32.2593' W;

(D) In Neuse River, west of a line beginning on the Minnesott side of the Neuse River Ferry at a point 34° 57.9116' N – 76° 48.2240' W; running southerly to the Cherry Branch side of the Neuse River Ferry to a point 34° 56.3658' N – 76° 48.7110' W; and

(E) In New River, all waters upstream of the N.C. Highway 172 Bridge when opened by proclamation; and

(6) In designated pot areas opened to the use of pots by 15A NCAC 03J .0301(a)(2) and described in 15A NCAC 03R .0107(a)(5), (a)(6), (a)(7), (a)(8) and (a)(9) within an area bound by the shoreline to the depth of six feet.

(c) Minimum mesh sizes for shrimp and crab trawls are presented in 15A NCAC 03L .0103 and .0202.

(d) The Fisheries Director may, with prior consent of the Marine Fisheries Commission, by proclamation, require bycatch reduction devices or codend modifications in trawl nets to reduce the catch of finfish that do not meet size limits or are unmarketable as individual foodfish by reason of size.

(e) It is unlawful to use shrimp trawls for recreational purposes unless the trawl is marked by attaching to the codend (tailbag), one floating buoy, any shade of hot pink in color, which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. The owner shall always be identified on the buoy by using an engraved buoy or by attaching engraved metal or plastic tags to the buoy. Such identification shall include owner's last name and initials and if a vessel is used, one of the following:

(1) Gear owner's current motor boat registration number; or

(2) Owner's U.S. vessel documentation name.

(f) It is unlawful to use shrimp trawls for the taking of blue crabs in internal waters, except that it shall be permissible to take or possess blue crabs incidental to shrimp trawling in accordance with the following limitations:

(1) For individuals using shrimp trawls authorized by a Recreational Commercial Gear License, 50 blue crabs, not to exceed 100 blue crabs if two or more Recreational Commercial Gear License holders are on board.

(2) For commercial operations, crabs may be taken incidental to lawful shrimp trawl operations provided that the weight of the crabs shall not exceed:

(A) 50 percent of the total weight of the combined crab and shrimp catch; or

(B) 300 pounds, whichever is greater.

(g) The Fisheries Director may, by proclamation, close any area to trawling for specific time periods in order to secure compliance with this Rule.

History Note: *Authority G.S. 113-134; 113-173; 113-182; ~~113-221~~ 113-221.1; 143B-289.52;*
Eff. February 1, 1991;
Amended Eff. August 1, 1998; May 1, 1997; March 1, 1994; February 1, 1992;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. April 1, 2013; April 1, 2009; September 1, 2005; August 1, 2004; August 1, 2000.

ISSUE 11.10 BLUE CRAB SIZE LIMIT AND CULLING TOLERANCE

MFC Preferred Rule Change:

15A NCAC 03L .0201 SIZE LIMIT AND CULLING TOLERANCE

~~(a) It is unlawful to possess blue crabs less than five inches from tip of spike to tip of spike except mature females, soft and peeler crabs and from March 1 through October 31, and male crabs to be used as peeler bait. A culling tolerance of not more than 10 percent by number in any container shall be allowed.~~

~~(b) All crabs not of legal size, except mature female and soft crabs shall be immediately returned to the waters from which taken. Peeler crabs shall be separated where taken and placed in a separate container. White-line peeler crabs shall be separated from pink and red-line peeler crabs where taken and placed in a separate container. A culling tolerance of not more than five percent by number shall be allowed for white-line peelers in the pink and red-line peeler container. Those peeler crabs not separated shall be deemed hard crabs and are not exempt from the size restrictions specified in Paragraph (a) of this Rule.~~

(a) It is unlawful to possess more than 10 percent by number in any container, male and immature female hard blue crabs less than five inches from tip of spike to tip of spike and to fail to return hard blue crabs not meeting this restriction to the waters from which taken. All blue crabs not sorted into containers as specified in Paragraph (b) of this Rule shall be deemed hard blue crabs for the purpose of establishing the 10 percent culling tolerance.
(b) It is unlawful to possess blue crabs less than five inches from tip of spike to tip of spike unless individuals are sorted to and placed in separate containers for each of the following categories:

(1) soft crabs;
(2) pink and red-line peeler crabs;
(3) white-line peeler crabs; and
(4) from March 1 through October 31, male crabs to be used as peeler crab bait;

(c) It is unlawful to possess more than five percent by number of white-line peelers in a container of pink and red-line peelers.
~~(c)~~ (d) The ~~Director, may~~ Director may, by proclamation, impose the following restrictions when the sum of the carapace widths of mature female blue crabs collected during the September cruise of the Division of Marine Fisheries Pamlico Sound Fishery Independent Trawl Survey divided by the total number of tows (adjusted catch per effort) falls below the lower 90 percent confidence limit for two consecutive years (spawner index):

(1) It is unlawful to possess mature female blue crabs greater than 6¾ inches from tip of spike to tip of spike from September 1 through April 30. A culling tolerance of not more than five percent by number in any container shall be allowed.
(2) It is unlawful to possess female peeler crabs greater than 5¼ inches from tip of spike to tip of spike from September 1 through April 30.

History Note: *Authority G.S. 113-134; 113-182; ~~113-221;~~ 113-221.1; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. April 1, 1997; July 1, 1993;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. April 1, 2013; September 1, 2005; August 1, 2000.

ISSUE 11.12 DIAMONDBACK TERRAPIN INTERACTIONS WITH THE BLUE CRAB POT FISHERY IN NORTH CAROLINA

MFC Preferred Rule Change:

15A NCAC 03L .0204 CRAB POTS
(a) It is unlawful to take crabs with pots except as provided in 15A NCAC 03J .0301 and .0302.
(b) The Fisheries Director may, by proclamation, require the use of terrapin excluder devices in each funnel entrance in crab pots and impose the following restrictions concerning terrapin excluder devices:

(1) Specify areas;
(2) Specify time periods; and
(3) Specify means and methods.

History Note: *Authority G.S. 113-134; 113-182; 113-221.1; 143B-289.52;*
Eff. January 1, 1991.
Amended Eff. April 1, 2013.

14.9 STOCK STATUS OF NORTH CAROLINA BLUE CRAB (*CALLINECTES SAPIDUS*)

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Stock Assessment of the North Carolina Blue Crab (*Callinectes sapidus*)

2011

Prepared by

North Carolina Division of Marine Fisheries
Blue Crab Plan Development Team

September 2011

ACKNOWLEDGEMENTS

This report was prepared by the North Carolina Division of Marine Fisheries (NCDMF) Blue Crab Plan Development Team (PDT). The members are Jessi Baker, John Hadley, Lynn Henry (co-lead), Mike Marshall, Stephanie McInerny, Sean McKenna (co-lead), Tina Moore, Ray Mroch (lead analyst), Bryan Spain, David Taylor, and Stephen Taylor.

We would like to thank the following NCDMF staff members for their contributions to the stock assessment: Christine Jensen, Laura Lee, Katy West, and William Schmidt. We would also like to thank the members of the NCDMF Management Review Team and Biological Review Team Technical Committee for their review and comments. We also thank Richard Wong (Delaware Department of Natural Resources and Environmental Control) for his input.

We are especially grateful to the external peer reviewers for offering their time and effort to review the blue crab stock assessment: Peter Koeller (Scientist Emeritus, Bedford Institute of Oceanography), Jim Uphoff (Maryland Department of Natural Resources, Fisheries Service), Patrick Geer and Carolyn Belcher (Georgia Department of Natural Resources, Coastal Resources Division), Glen R. Sutton (Texas Parks and Wildlife Division, Coastal Fisheries Division), and Ryan Gandy and Michael Murphy (Florida Fish and Wildlife Conservation Commission).

EXECUTIVE SUMMARY

The North Carolina Fisheries Reform Act requires that fishery management plans be developed for the state's commercially and recreationally important species to achieve sustainable levels of harvest. Stock assessments are the primary tools used by managers to assist in determining the status of stocks and developing appropriate management measures to ensure the long-term viability of stocks.

In December 1998, the North Carolina Division of Marine Fisheries adopted a Fishery Management Plan for the blue crab resource. The 2004 amendment (Amendment 1) adopted a spawning stock trigger and associated measures to protect the blue crab spawning stock. Amendment 2 to the Fishery Management Plan is currently in development and this stock assessment was performed in support of the amendment.

A trend analysis and the Traffic Light approach were applied to available data to assess the status of North Carolina's blue crab stock. Information needed to produce a reliable assessment using traditional stock assessment methods was limited or unavailable. Data were available from commercial fishery monitoring programs and several fishery-independent surveys. The trend analysis was applied to evaluate temporal trends in commercial fishery catch rates, relative abundance indices, length at maturity, and median length. Assuming all data were representative of statewide trends was considered invalid so data were classified into regions when possible. The regions considered were the Albemarle, Pamlico, and Southern areas. The majority of indices for the Pamlico and Southern regions exhibited significant decreasing trends. Albemarle indices had no trend or an increasing trend.

A novel approach known as the Traffic Light method was used to synthesize information from a variety of sources in order to provide an overall indicator of stock health. The available data were examined to identify qualitative and quantitative measures considered appropriate for characterizing adult abundance, recruit abundance, and production. The Traffic Light analysis indicated that abundance of blue crab adults and recruits was higher overall before 2000. Adult and especially recruit abundance have shown evidence of negative trends in recent years. Production has been variable, but increasingly positive trends have been observed in recent years.

Based on the results of this assessment, the North Carolina blue crab resource is currently not overfished. The status with respect to overfishing cannot be determined because available data are not sufficient to produce reliable estimates of fishing mortality.

A number of recommendations for research and monitoring are offered to identify how deficiencies in the understanding of blue crab stock dynamics can be addressed.

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1. INTRODUCTION

1.1 The Resource

Blue crabs (*Callinectes sapidus*) are present from Nova Scotia to the northern coast of Brazil (Hay 1905; Guillory et al. 2001), supporting commercial and recreational fisheries along the Atlantic and Gulf coasts of the United States. The blue crab resource supports North Carolina's most valuable commercial fishery. Blue crabs are also commonly harvested by recreational fishermen in North Carolina.

Before 1995, the North Carolina Division of Marine Fisheries (NCDMF) did not have a sampling program dedicated to blue crabs, although limited information (landings statistics, juvenile abundance) was collected through other programs. Realizing the increasing importance of the blue crab fishery to the coastal economy, crabbers petitioned the North Carolina General Assembly in 1994 to allocate funding specifically for a blue crab assessment project. The resulting program focused on the establishment of fishery-dependent and -independent databases coast-wide. Section 5.5 of the Fishery Reform Act of 1997 specifically required that the North Carolina Marine Fisheries Commission adopt a Fishery Management Plan (FMP) for the blue crab fishery by January 1, 1999. The plan was adopted by the Marine Fisheries Commission on December 11, 1998 (McKenna et al. 1998). All of North Carolina's state Fishery Management Plans are reviewed and updated every five years. If the FMP includes a stock assessment, the assessment is reviewed and updated at the same time as the FMP. The Blue Crab FMP was first amended December 3, 2004 (NCDMF 2004). Amendment 2 to the Blue Crab FMP is currently in development.

The North Carolina blue crab stock was last assessed for management purposes in 2004 as part of the review and amendment of the Blue Crab FMP (Eggleston et al. 2004). Concerns regarding the uncertainty of estimates of maximum sustainable yield (MSY) as well as data and modeling limitations led the NCDMF to conclude that the status of the blue crab stock could not be accurately assessed at the time (NCDMF 2004). The results of the 2004 assessment were not used for management. The management tool that was adopted at the time was the implementation of restrictions to protect the blue crab spawning stock when the defined spawning stock biomass trigger is activated (see section 1.5.4.3, this report). In addition, an overfished[18] definition for blue crabs was adopted and is defined based on commercial landings trends. The blue crab resource is considered overfished when annual commercial landings decline for five consecutive years. No overfishing[19] definition was developed.

According to the above definition, North Carolina's blue crab stock is currently not overfished, but the NCDMF currently lists the stock as one of "concern" in its annual stock status report (NCDMF 2011). The blue crab stock was listed as one of concern due to reduced commercial landings of hard blue crabs during 2000 through 2002 and 2005 through 2007 following record-high commercial landings observed during 1996

[18] The North Carolina General Statutes define overfished 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" (N.C. Gen. Stat. § 113-129)

[19] The North Carolina General Statutes define overfishing as "Fishing that causes a level of mortality that prevents a fishery from producing a sustainable harvest" (N.C. Gen. Stat. § 113-129)

through 1999. Commercial blue crab landings in 2010 were the fifth lowest on record during the 10-year period of 2001 through 2010, potentially due to a multi-year drought that occurred beginning in 2002. Harvest from the Pamlico and Core sounds and tributaries has increased but continues to remain significantly less than historical levels.

The current stock assessment was developed as part of Amendment 2 to the Blue Crab FMP.

1.2 Life History

1.2.1 Stock Definitions

Although blue crab larvae mix when in the larval stages on the continental shelf, the interchange of larvae from North Carolina and other states is assumed to be negligible.

Available tagging data suggest that there is limited migration of adult females across state boundaries (NCDMF 2008; L. Henry, NCDMF, pers. comm.). Based on landings trends and tagging data, there is some evidence that the southern area of the state may be a separate population from the rest of the state (NCDMF 2008). In addition, adult female blue crabs do not migrate from the Pamlico Sound region to Albemarle Sound (see Figure 1.1 for map of water bodies in North Carolina). However, mature females from Albemarle Sound do migrate to northern Pamlico Sound and towards the ocean inlets (NCDMF 2008; Bridges 2009). Juvenile blue crabs disperse and recruit into the Albemarle area from the northern Pamlico Sound settlement areas.

1.2.2 Movements & Migration

The first larval stage (zoea) occurs offshore for several weeks where it undergoes several developmental stages before metamorphosing into megalopae (Van Engel 1958; Epifanio 1995). Because of the lack of inlets in Albemarle Sound, megalopae are transported primarily into Pamlico Sound, North Carolina via onshore wind events and nighttime incoming spring tides (Forward et al. 2004), which may be overshadowed by tropical storm forcing, depending on frequency and wind direction (Eggleston et al. 2010). Megalopae then settle in seagrass beds in the seaward portion of the sounds before exhibiting density-dependent secondary dispersal resulting in juveniles being widely distributed throughout the estuaries of North Carolina (Etherington and Eggleston 2000). Decreases in salinity and the presence of bottom structure encourage settlement after this secondary migration. After growth and maturation, females migrate to spawn in the high-salinity waters near the inlets (Whitaker 2006). Other studies have also shown that the migratory behavior of mature female blue crabs continues between clutches, and spawning females are continually moving seaward through the spawning season (Hench et al. 2004; Forward et al. 2005; Darnell et al. 2009). Males do not migrate regularly as adults.

A tagging study conducted in North Carolina during 2002 through 2005 demonstrated that most mature female blue crabs were recaptured shortly after release near the release site (NCDMF 2008). However, dispersal was greater and long distance returns were more prevalent in 2003 from the north to the south. Additionally, releases in the upper and mid-estuaries of the Albemarle-Pamlico systems and Cape Fear River show a general pattern of summer to fall movement towards the lower estuary areas and coastal inlets. This results in a general characterization of mature female movement seaward throughout the growing season.

Mature female blue crabs tagged in the southern coastal area (i.e., south of the Pamlico region) have a southward pattern of movement (NCDMF 2008). A similar trend was noted in mature female crabs released in the Atlantic Ocean south of the Cape Fear

River during February to April 2005 and 2006 and suggested the warming of the estuarine waters was a cue to female blue crab movement (Logothetis et al. 2007). A significant portion of mature females in the southern area overwinter in the ocean near the coastal inlets and move back into the estuaries the following spring to forage and potentially spawn multiple times (NCDMF 2008).

1.2.3 Age & Size

Fischler (1965) reported an average life span of three years for blue crabs in North Carolina and a maximum size of around 217 mm. Estimates of maximum age have ranged between five and eight years for blue crabs in the Chesapeake Bay (Rugolo et al. 1997).

Ageing crustaceans is notoriously difficult. Crustaceans do not have persistent hard parts usually used to track and count rapid- and slow-growing periods to determine age. Recent advances in quantifying and calibrating oxidation products (lipofuscins) in nerve tissue have been promising as an alternative to the traditional carapace width estimators used to calibrate carapace width with age estimates; however, lipofuscin extraction is a new and costly technique that has not been widely used in ageing laboratories (Puckett et al. 2008).

1.2.4 Growth

Traditional growth models used for finfish are impractical to apply to crustaceans in general because the models assume growth is continuous (von Bertalanffy 1938; Schnute 1981). For blue crabs and other crustaceans, the shell grows in discrete stages via shedding of the exoskeleton (molt). However, the von Bertalanffy growth function returned similar results to crustacean-specific growth models that accounted for the unique growth characteristics of the blue crab (Eggleston et al. 2004; Johnson 2004). The similarity of the two growth models is likely due to the increasing time between molts that occurs as the crabs grow larger, mirroring the decreasing rate of growth with size evident in the von Bertalanffy growth function.

1.2.5 Reproduction

Blue crabs mature at between one and two years of age in North Carolina (Johnson 2004). Mating occurs during the spring or summer in brackish estuarine waters as females molt into maturity (Forward et al. 2003; Whitaker 2006). Spawning typically occurs within two months after mating if mating occurs early in the growing season; however, females can retain sperm through winter for spawning the following spring (Hill et al. 1989; Forward et al. 2003). Spawning is initiated after migration to the high-salinity areas near oceanic inlets. In the Chesapeake Bay, Prager et al. (1990) found that fecundity was significantly related to carapace width and estimated that average fecundity was 3,200,000 eggs per clutch. Females may spawn once or several times a season. Spawning has two peak pulses, April–June and August–September, in North Carolina (Darnell et al. 2009).

For the current assessment, length at maturity for female blue crabs was determined by fitting a logistic model to the available maturity data. It was necessary to pool maturity data across multiple programs and areas to ensure sufficient sample sizes. Additionally, Otto et al. (1990, cited by Hjelset et al. 2009) recommended pooling data from different sampling methods to reduce bias in estimates of size at maturity. Maturity data collected by the NCDMF's Estuarine Trawl Survey (Program 120), Juvenile Anadromous Trawl Survey (Program 100), Pamlico Sound Survey (Program 195), and commercial fish house sampling (Program 436) were included in the model. Programs 100, 120, and 195 are described in more detail in section 2.2 of this report. Program 436 is described in more detail in section 2.1.1.3 of this report. Length at maturity was estimated by year for 1987 through 2009 to derive annual estimates of length at 50% maturity (L_{50}). Annual estimates were needed for use as an indicator in the assessment method (see section 3.2.4, this report).

Estimates of L_{50} for female blue crabs ranged from a low of 97.2 mm in 1999 to a high of 125 mm in 2007 (Figure 1.2).

1.2.6 Mortality

Natural mortality rate (*M*) is a key parameter in stock assessments but often is one of the most uncertain. Johnson (2004) estimated natural mortality of blue crabs in North Carolina using Hoenig's method (1983), which relates *M* to the maximum age in the population. Assuming a maximum age of 5 years, Johnson (2004) estimated *M* to equal 0.87. This value of *M* was also assumed in the 2004 stock assessment of North Carolina blue crabs (Eggleston et al. 2004).

Hewitt et al. (2007) estimated *M* for blue crabs in the Chesapeake Bay using a variety of methods and concluded that *M* values ranging between 0.7 and 1.1 per year were reasonable for that stock. Wong (2010) assumed $M = 0.80$ in the 2010 assessment of the Delaware Bay blue crab stock.

Total mortality (*Z*) is the sum of natural, fishing, and any other sources of mortality. Johnson (2004) and Eggleston et al. (2004) estimated *Z* using length-based methods based on data collected during June by NCDMF Program 195 (see section 2.2.3, this report). The length-based *Z* estimates ranged from 0.91 to 1.22 between 1987 and 2003 and averaged 1.03 per year during that time period. Estimates of *Z* for blue crabs in the Chesapeake Bay in the 1990s ranged from 1.0 to 1.5 (Rugolo et al. 1997). Estimates of Z derived from the results of a catch-survey analysis applied to the Delaware Bay blue crab stock ranged from 0.50 to 2.69 and averaged 1.51 per year during 1978 to 2009 (Wong 2010).

Fishing mortality rates (*F*) can be estimated directly (e.g., tagging studies) or indirectly. The results of a catch-survey analysis applied to the North Carolina blue crab stock were used to derive estimates of *F*, which ranged from 0.13 to 2.03 between 1987 and 2003 when *M* was assumed equal to 0.87 (Eggleston et al. 2004; Johnson 2004). Wong (2010) applied a catch-survey analysis to the Delaware Bay blue crab stock and the results were used to estimate upper bound *F* (see reference for details). Estimates of upper bound *F* ranged between 0.22 and 1.74 during 1978 to 2009 and averaged 0.75 per year.

Fishing mortality rates are difficult to estimate, especially when losses to the fishery are unknown. For example, reporting of discards and bycatch is not always required; if these quantities are significant and associated mortality is high, estimating *F* is made increasingly difficult. For blue crabs, the mortality associated with shedding operations may be substantial, with estimated losses of 10 to 30% daily after the crabs are taken from the water but before sold as soft crabs (Chaves and Eggleston 2003).

1.2.7 Food & Feeding Habits

Blue crabs consume a wide variety of food, fulfilling roles as predators and detritivores. They are large consumers of annelids, polychaetes, crustaceans, live or dead fish, vegetation, and feed heavily on oyster spat and juvenile clams (Williams 1984). They are also cannibalistic, and larger crabs are capable of exhibiting a check on population growth by consuming large amounts of small crabs and juveniles.

1.3 Habitat

1.3.1 Overview

The blue crab life cycle consists of an offshore phase and an estuarine phase. Blue crabs use a wide range of habitats based on its life stage, sex, maturity, and associated salinity preferences. The blue crab is common to all North Carolina coastal waters.

1.3.2 Spawning Habitat

Blue crabs spawn weeks after mating in late spring to early fall (Whitaker 2006). After mating, inseminated female blue crabs migrate from their usual brackish areas to high-salinity waters near ocean inlets. Females rely on high-salinity cues to ensure eggs are released for their development on the continental shelf.

1.3.3 Nursery & Juvenile Habitat

The first larval stage (zoeae) is carried offshore by ocean currents (Costlow and Bookhout 1959; Costlow et al. 1959; Epifanio 1995). Zoeae larvae are restricted to high salinity areas because of their intolerance of low salinity water (Costlow and Bookhout 1959). Their intolerance of low salinity water continues into the megalopal stages, when they return to the estuary.

Once within the estuary, megalopae settle in beds of submerged aquatic vegetation and other complex habitats (i.e., salt marsh, detritus, and oyster shell) where they undergo further metamorphosis to become juveniles (Heck and Thoman 1981; Orth and van Montfrans 1987; Hill et al. 1989; Pardieck et al. 1999; Posey et al. 1999; Etherington and Eggleston 2000; Ruiz et al. 1993). Seagrass beds are an important nursery habitat that provide refuge from predators but are not available in all coastal waters of North Carolina to support juvenile blue crab development (Posey et al. 2005). Lower salinity regions in the river-dominated estuaries may provide important nursery areas for the blue crab population. After their metamorphosis, juveniles undergo a secondary migration to shallow, less-saline waters in the upper estuaries and rivers (Etherington and Eggleston 2000).

1.3.4 Adult Habitat

Adult blue crabs have differential habitat distribution by sex and salinity. Since females undergo a spawning migration and are observed migrating even when not gravid (Darnell et al. 2009), they are more likely to be found in higher-salinity waters near the oceanic inlets than in areas with relatively freshwater.

1.3.5 Habitat Issues & Concerns

Blue crabs use five of the six habitats identified by the North Carolina Coastal Habitat Protection Plan including water column, wetlands, submerged aquatic vegetation, soft bottom, and shell bottom. These habitats may be impaired by physical degradation by dredges, watercraft, and fishing practices or through poor water quality caused by freshwater drainage, land use changes, eutrophication (excessive nutrients), high organic loading, and chemical pollution (Steele and Perry 1990). Sea level rise, subsidence, invasive species, storms, disease, and erosion are natural processes—perhaps exacerbated by human activities—but also responsible for loss of critical habitat.

Although indirect, blue crabs are affected by natural disturbances of their environment. In particular, tropical cyclones can affect crab harvest in the short term by concentrating crabs in areas where they are vulnerable to fishing gear (Eggleston et al. 2004). These short-term effects can have long-term effects as well. Since the relocation of crabs induces a change in localized abundance, harvest could be affected. Not all the effects of tropical cyclones are detrimental. For example, peaks in post-larval blue crab settlement coincided with tropical cyclone tracks that came from a southwesterly direction (Eggleston et al. 2010). The massive ingress of post-larval crabs could make a significant contribution to the blue crab population. The caveat is that storm forces must be moderate. Excessive freshwater input can alter the salinity of large bodies of water, increasing megalopae and juvenile crab mortality, and thereby negating the benefits of increased settlement.

1.4 Description of Fisheries

1.4.1 Commercial Fishery

The blue crab resource supports North Carolina's most valuable commercial fishery. During 1950 through 2009, commercial landings of blue crabs have ranged from a low of 6.29 million pounds per year to a high of 67.1 million pounds per year (Figure 1.3). During the last decade (2000–2009), an average of 32.2 million pounds per year has been landed by the commercial fishery. The ex-vessel value of commercial blue crab landings was highest during 1994 through 2003, averaging 47.9 million dollars (2009 USD)[20] per year (Figure 1.4). Before 1994, the average ex-vessel value of North Carolina's commercial blue crab landings was 10.1 million dollars (2009 USD) per year (1950–1993 average). During 2004 through 2009, the ex-vessel value of commercial blue crab landings averaged 24.2 million dollars (2009 USD) per year.

Commercial fishermen have harvested blue crabs with a variety of different gears over time, including dredges, trotlines, pots, and trawls (Figure 1.5). The majority of blue crabs (81.5%) landed from 1950 to 2009 was harvested by pots. Pots have accounted for 96.8% of North Carolina's commercial blue crab landings during the last decade (2000–2009).

Peeler and soft crabs have been a relatively small portion of the commercial fishery for blue crabs, comprising less than 2% of the total blue crab landings reported from 1950 to 2009 (Figure 1.6). Peeler crabs are a value-added harvest that is captured via peeler pots and trawling for hard crabs and shrimp, mainly during the spring, as well as peeler trawls that target the peeler crabs. The peelers are then held in shedding systems until they molt and are sold as soft crabs, either shipped live or cleaned and frozen. The peeler crab portion of the overall blue crab commercial fishery is small; however, the impact of the peeler crab fishery may be underestimated due to unreported mortality in the shedding operations. Blue crabs placed in shedding operations are not reported and thus not currently represented in the mortality estimates.

The commercial fishery for blue crab primarily occurs during late spring through the fall (Figure 1.7). Reported landings are highest in July and August, and this pattern has persisted for at least the last three decades.

The number of commercial fishermen that have reported landings of blue crabs and the associated number of trips have generally decreased from 1994 to 2009 (Table 1.1). The number of commercial fishermen that have reported landings of blue crabs has ranged between 914 and 2,288 during that time period. The number of trips in which blue crabs were landed in North Carolina ranged from a low of 52.6 thousand to a high of 143 thousand over the same period.

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[20] All values converted to 2009 U.S. dollars (USD) based on the annual average consumer price index values (U.S. Bureau of Labor Statistics, pers. comm.)

1.4.2 Recreational Fishery

Recreational fishermen in North Carolina harvest blue crabs with a variety of gears, including pots (collapsible and rigid), gill nets, trawls, hand lines, and dip nets. A separate license category, the Recreational Commercial Gear License (RCGL), allows recreational fishermen to use limited amounts of certain commercial gear to harvest seafood for personal consumption (see section 1.5.4.2, this report). Estimates of the RCGL blue crab harvest are available from NCDMF surveys conducted from 2002 to 2008. During 2002 through 2008, an estimated average of 26,402 RCGL recreational fishing trips per year was directed at blue crabs (Table 1.2). In that same time period, RCGL-licensed recreational fishermen harvested from 94.5 thousand pounds to 157 thousand pounds of blue crabs per year (Figure 1.8). In terms of number of blue crabs, recreational harvest by RCGL licensees has averaged 321 thousand blue crabs per year between 2002 and 2008 (Table 1.4). The amount of blue crabs discarded by recreational fishermen has been approximately half the recreational harvest during this time period. The mortality of blue crabs discarded from the recreational fishery is unknown.

Individuals are permitted to fish one pot per person from privately owned land or a privately owned pier with no license. It is not known whether this unlicensed recreational fishery constitutes a significant proportion of total recreational fishery for blue crabs.

1.5 Fisheries Management

1.5.1 Management Authority

The NCDMF is responsible for the management of estuarine and marine resources occurring in all state coastal fishing waters extending to three miles offshore (Figure 1.1). There are no federal or interstate FMPs that apply specifically to the blue crab fishery in North Carolina.

1.5.2 Management Unit Definition

The management unit includes the blue crab and its fisheries in all of North Carolina's coastal fishing waters.

1.5.3 Regulatory History

In December 1998, the first FMP for blue crabs was approved for North Carolina (McKenna et al. 1998). The 1998 FMP instituted a minimum size limit of 5 inches and a 10% tolerance per container on commercial fishing vessels. Mature females, soft crabs, and peeler crabs were exempt from the minimum size limit. The original FMP also modified existing rules to clarify language on fishing in or near blue crab spawning sanctuaries and recommended use of a 4 or 4.5-inch mesh trawl in inland waters. These changes included limits on allowable blue crab landings as bycatch from the shrimp fishery (50 crabs per person and a 100 crab vessel limit for RCGL holders and the larger of 50% of combined catch or 300 pounds for commercial operations), prohibited the baiting of peeler pots with anything but live male crabs, and made it unlawful to possess white-line peeler crabs between June 1 and September 1.

The Blue Crab FMP was amended in 2004 (NCDMF 2004). The 2004 amendment adopted a spawning stock trigger and associated measures to protect the blue crab spawning stock (see section 1.5.4.3, this report). Management measures included implementing by proclamation a seasonal maximum size limit of 6.75 inches (5% tolerance) for mature female hard crabs and 5.25 inches for mature female peeler crabs from September 1 through April 30 when the spawning stock index is abnormally low. This maximum size limit was enacted in January of 2006 and has remained in effect.

1.5.4 Current Regulations

Commercial Fishery

The Standard Commercial Fishing License (SCFL) and Retired Standard Commercial Fishing License are annual licenses issued to commercial fishermen who harvest and sell fish, shrimp, or crab. The number of SCFL licenses is currently capped at 8,896. A Commercial Fishing Vessel Registration is also required for fishermen who use boats to harvest seafood.

There is no regulatory season for commercial harvesting of blue crabs with the exception of a restriction on crab dredge usage from January 1 to March 1 and a cleanup period for lost and abandoned pots between January 15 and February 7.

Current commercial fishery regulations include a year-round carapace width size limit of 5 inches for male and immature female hard blue crabs and a 10% tolerance based on the number of blue crabs in any storage container on a vessel. Mature females, soft and peeler crabs, and male crabs for use as peeler bait are exempt from this size limit. If pots are used, they must contain two unobstructed escape rings no less than 2 5/16-inches in inside diameter. Peeler pots with a mesh size less than 1 ½ inches are exempt from the escape ring requirement. For trawls, a 4-inch stretch tailbag mesh is required west of a line dividing Pamlico Sound down the middle and a 3-inch stretch tailbag mesh is required to the east of this line.

From March 1 to August 31, it is unlawful to use trawls, pots, and mechanical methods for oysters or clams or take blue crabs with the use of commercial fishing equipment from crab spawning sanctuaries (Figure 1.9). During the remainder of the year the director of the NCDMF may, by proclamation, close these areas and may impose any or all of the following restrictions: number of days, areas, means and methods which may be employed in the taking, time period, and limit the quantity.

Detailed information regarding North Carolina's current commercial fishery regulations is available on the NCDMF website (http://portal.ncdenr.org/web/mf/home).

Recreational Fishery

Prior to 1999, no recreational fishing license was required unless a vessel was used. After July 1, 1999, the RCGL was required when using certain allowable commercial gear. No license is required for the following non-commercial equipment: collapsible crab traps, cast nets, dip nets, and seines less than 30 feet. A RCGL is required to use commercial gear to harvest finfish and crustaceans for personal consumption. Recreational crabbers are prohibited by law from selling their catch, even if in possession of a RCGL.

Current regulations for recreationally-harvested blue crabs include a year-round 5-inch minimum carapace width limit for males and immature females. A maximum of five pots of any type (peeler pots are disallowed) is allowed and must be fished at least every five days; pots cannot be fished at night. Pots must be removed from the water during January 15 through February 7. The current possession limit for the recreational fishery is 50 blue crabs per person per day not to exceed 100 blue crabs per vessel per day. One pot per person may be used to fish from privately owned land or a privately owned pier with no license. The recreational fishery is not subject to reporting requirements. Detailed information regarding North Carolina's current recreational fishery regulations is available on the NCDMF website (http://portal.ncdenr.org/web/mf/home).

Spawning Stock Trigger

In addition to the regulations described above, the 2004 amendment to the Blue Crab FMP adopted a spawning stock trigger to protect the blue crab spawning stock (NCDMF 2004). A spawning stock index derived from September data collected by the Pamlico Sound Survey (Program 195; see section 2.2.3, this report) is evaluated annually to determine whether the trigger has been activated (Figure 1.10). The spawning stock index is calculated as the sum of the carapace widths of mature female blue crabs divided by the total number of tows. The trigger is activated when the spawning stock index falls below the lower 90% confidence limit of the reference baseline average for two consecutive years. In the 2004 amendment, the reference baseline was 1987 through 2003. The amendment states that the reference baseline will be updated every five years as part of the FMP review. However, if the trigger is active at the time of the review, the reference baseline update will be delayed until the trigger is no longer active.

When the trigger is activated, the NCDMF has the proclamation authority to implement spawning stock protection measures. These measures include a 6 ¾-inch maximum size limit on mature female blue crabs and a 5 ¼-inch maximum size limit on female peeler crabs from September through April for all fisheries in order to protect mature female crabs during their spawning migration. In addition, the culling tolerance of blue crabs in any container on a vessel in the commercial fishery will be lowered from 10% by number to 5% by number.

The spawning stock trigger has been activated every year since 2006, and the associated measures have been implemented.

1.5.5 Management Performance

The decline of commercial blue crab landings continued after the adoption of the Blue Crab FMP in 1998 (Table 1.3; Figure 1.3). Based on data collected from the NCDMF Trip Ticket Program (see section 2.1.1, this report), commercial landings of blue crabs during 1994 through 1997 averaged 55.8 million pounds per year. During 1998 through 2009, commercial fishermen landed an average of 36.8 million pounds of blue crabs per year. The decrease in commercial landings is due, at least partly, to the shutting down of crab processing plants, which reduced the amount of crabs that seafood dealers could move, thereby reducing demand and ultimately reducing harvest. It is not certain how much of the decline in landings is attributable to the FMP. Changes in stock size could also be a factor in the decline. Other potential contributing factors could include changes in effort and environmental variability.

1.6 Assessment History

1.6.1 Review of Previous Methods & Results

The previous assessment of blue crab in North Carolina waters for management purposes was performed by Eggleston et al. (2004). The assessment applied surplus production modeling and catch-survey analysis to estimate population size and fishing mortality rates. Yield-per-recruit and spawning stock biomass-per-recruit analyses were used to estimate appropriate reference points. The results of the assessment suggested that the stock was overfished and fishing mortality was at or higher than sustainable levels.

The primary author of the assessment (D. Eggleston, NCSU, pers. comm.) and the NCDMF (NCDMF 2004) expressed concerns about the reliability of the estimates of MSY, primarily due to data and modeling limitations. The NCDMF felt that the estimated MSY was not valid due to the following factors:

- Fishery-independent datasets do not allow tracking of the various life history stages and harvest data
- Harvest and fishery-independent data between and within areas are extremely variable, both, temporally and spatially
- Fishery-independent survey data from the Pamlico Sound complex may not be a reliable indicator of population trends in other coastal systems
- Environmental conditions appear to play a significant role in population variability

The results of the 2004 stock assessment were not used by management. Instead, management adopted a spawning stock trigger to protect the blue crab spawning stock (see section 1.5.4.3, this report). Additionally, the overfished definition for blue crabs in North Carolina was defined based on commercial landings trends. The blue crab resource is considered overfished when annual commercial landings decline for five consecutive years. There is currently no overfishing definition.

1.6.2 Previous Research Recommendations

The 2004 amendment to the Blue Crab FMP listed insufficient assessment data as one of the principal issues identified during the development of the amendment (NCDMF 2004). The 2004 amendment stated that "Necessary data needed to accurately assess the status of the blue crab stock are currently not available." The 2004 amendment went on to recommend that the North Carolina Marine Fisheries Commission and the NCDMF prioritize research needs and implement actions to accomplish the identified research and data needs. Neither of these recommendations has been addressed to date.

The research needs specific to the issue of insufficient assessment data listed in the 2004 amendment to the Blue Crab FMP (NCDMF 2004) were borrowed from a list of research needs identified at a November 2003 meeting of blue crab managers from the Atlantic coast (ASMFC 2004). Those research needs are:

Maximum Age: Continue ongoing research to determine the maximum age of blue crabs, including:

- Encourage cooperation for expansion of lipofuscin research,
- Continue tagging methods with incorporation of verification,
- Evaluate use of historical methods using parasitic worms, and
- Conduct long-term holding experiments.

Variation in Natural Mortality (*M*): Evaluate age-specific mortality rates and determination of more accurate estimates of *M* possibly through use of closed areas.

- Evaluate geographic variation in *M*
- Evaluate annual variations in *M*

Reproductive Biology: Conduct research to better understand the reproductive biology of blue crabs in more detail, including:

- Evaluate geographic variation in reproductive biology
- Conduct field experiments to verify lab studies,
- Determine maturity at age
- Evaluate sperm limitation, fecundity schedule,

Predation and Cannibalism: There was agreement that predation occurs, but little scientific evidence that a single species is having a major impact on blue crab populations. However, the cumulative impacts of guilds of predators are unknown.

- Encourage food web dynamics studies and continue current research activities involving modeling and diet studies.

Recruitment/Habitat Utilization: Identify specific habitats for each system within each state.

Dispersal: Evaluate the stock structure on the Atlantic and Gulf coasts, including:

- Evaluate the percentage of recruits from one bay system supporting other systems
- Evaluate the magnitude of mixing between populations, especially at low abundance levels (meta-populations)
- Evaluate transport systems between estuaries
- Conduct larval dispersal and recruitment studies, particularly in southern region
- Research where females go after spawning

Disease: More research is needed to evaluate the impacts that diseases are having on crab stocks.

Environmental Factors

- Drought, Winter Mortality, and Hypoxia: The consequences of these factors affect the whole ecosystem, with some affects being positive and some being negative. Evaluate the effects of environmental effects on the distribution of blue crabs and potential for increased mortality on a state-by-state basis since these effects will be unique to each system.
- Hurricanes have affected all east coast states at one time or another through direct and indirect effects. Effects depend on timing, where you are in relation to hurricane, tidal stage, etc. Each state should quantify the direct and indirect impacts of hurricanes, and use this list as a tool for adaptive management.

Human Development Effects: Each state should evaluate the impacts of other indirect processes on blue crab populations, such as shoreline development, point and non-point source pollution, nutrient loading, and water control and utilization.

Commercial Landings: Regional trends can be separated into three regions:

- Delaware north—state landings with no evidence of drastic declines
- Chesapeake Bay—drastic declines in recent years
- South Atlantic—drastic declines in recent years with the exception of North Carolina

Recreational Landings: Each state should conduct a recreational survey at least once, with periodic updates if percentages of total landings are high. Evaluate the addition of an add-on question to the MRFSS telephone survey to collect participation data.

Non-directed fisheries: Evaluate non-directed fisheries for bycatch of blue crabs- gill net and shrimp trawl fisheries.

Aquaculture: Continue small scale aquaculture activities, including continuation of ongoing research studies, improvements to collaborative efforts, and evaluation of feasibility as a large scale enhancement tool for blue crab management.

Monitoring Programs: Compile information on trawl efficiency for blue crab sampling. States should continue to fund trawl and seine monitoring programs to support blue crab assessments. [From ASMFC 2004.]

2. DATA

2.1 Fisheries-Dependent

2.1.1 Commercial Fishery Monitoring

Prior to 1978, North Carolina's commercial landings data were collected by the National Marine Fisheries Service (NMFS). In 1978, the NCDMF entered into a cooperative program with the NMFS to maintain and expand the monthly surveys of North Carolina's major commercial seafood dealers. Beginning in 1994, the NCDMF instituted a trip-ticket system to track commercial landings.

Survey Design & Methods

On January 1, 1994, the NCDMF initiated a Trip Ticket Program (TTP) to obtain more complete and accurate trip-level commercial landings statistics (Lupton and Phalen 1996). Trip ticket forms are used by state-licensed fish dealers to document all transfers of fish sold from coastal waters from the fishermen to the dealer. The data reported on these forms include transaction date, area fished, gear used, and landed species as well as fishermen and dealer information.

The majority of trips reported to the NCDMF TTP only record one gear per trip; however, as many as three gears can be reported on a trip ticket and are entered by the program's data clerks in no particular order. When multiple gears are listed on a trip ticket, the first gear may not be the gear used to catch a specific species if multiple species were listed on the same ticket but caught with different gears. In 2004, electronic reporting of trip tickets became available to commercial dealers and made it possible to associate a specific gear for each species reported. This increased the accuracy of reporting by documenting the correct relationship between gear and species.

Sampling Intensity

North Carolina dealers are required to record the transaction at the time of the transactions and report trip-level data to NCDMF on a monthly basis.

Biological Sampling

Program 436 (P436) was initiated in April 1995 to collect fisheries-dependent data at fish houses from North Carolina's commercial blue crab fishery. Initially, sampling was limited to the northeast and Pamlico Sound regions of North Carolina. Statewide sampling was initiated in 1998. Subsamples of sorted (by market category) and unsorted catches are taken and biological information is recorded. All blue crabs in a subsample are measured and sexed, and maturity of females is recorded. Program 436 only samples voluntarily cooperative fish houses, and sampling distribution may not reflect landing patterns.

Biases

Because trip tickets are only submitted when fish are transferred from fishermen to dealers, records of unsuccessful fishing trips are not available. As such, there is no direct information regarding trips where a species was targeted but not caught. Information on these unsuccessful trips is necessary for calculating a reliable index of relative abundance for use in stock assessments.

Another potential bias relates to the reporting of multiple gears on a single trip ticket. This bias is considered minimal for blue crab landings because the commercial blue crab fishery uses gears specific to crabbing (e.g., crab pots, crab trawls, trotlines). Therefore, it is often possible to identify the gear used to catch blue crabs on a trip ticket that lists multiple gears and species.

Development of Estimates

Total landings (pounds) of blue crabs were calculated by year and region for 1994 to 2009. Catch per unit effort (CPUE) was calculated using a simple ratio estimator in which the total pounds landed were divided by the number of pots fished. The number of pots fished was not reported on trip tickets prior to 1996 and the numbers reported in that year are considered inaccurate[21]; therefore, commercial fishery CPUE was only calculated for 1997 through 2009. Only records in which crab or peeler pots were listed as the first gear on the trip ticket were used in the landings and CPUE calculations. Records of trips for which fewer than two pots were reported or for which no crabs were caught were excluded. Only records of trips by fishermen that have had at least 15 years of experience were included to provide a more stable index. A total of 220 fishermen met this criterion. The commercial landings and CPUE indices included all blue crab types (hard, soft, and peeler crabs) and were calculated by area.

The length-frequency distribution of blue crabs in North Carolina's commercial landings was calculated using the biological sampling data (Program 436). The length-frequency distributions were computed by year for 1995 to 2009.

Estimates

Among the Albemarle, Pamlico, and Southern regions, the majority of blue crabs landed by commercial fishermen during 1997 through 2009 were harvested from the Pamlico region (Figure 2.1). Commercial landings of blue crabs harvested from the Albemarle region have been variable, and there has been a general increase since 2005. Commercial landings of blue crabs harvested from the Pamlico region generally decreased from 2003 to 2009. Commercial landings of blue crabs harvested from the Southern region slightly declined between 2006 and 2009.

Commercial fishery CPUE in the Pamlico and Southern regions shows a decrease from the beginning of the time series through 2000–2001 (Figure 2.2). In the Albemarle region, commercial CPUE increased slightly from 1997 to 1999, decreased through 2001, and has demonstrated an overall increasing trend since 2001. In the Pamlico and Southern regions, commercial CPUE increased from 2001 to 2003 and then varied with little trend through the rest of the time series. The CPUE indices ranged from a low of 1.04 pounds per pot to a high of 2.99 pounds per pot over all regions during the available time series. Commercial fishery CPUE index values were highest in the Southern region in almost all years, likely due to different fishing practices since adult abundance indices are among the lowest in the Southern region.

There has been little variation in the length-frequency distribution of blue crabs sampled from North Carolina's commercial landings (Figure 2.3). Blue crab samples ranged from 31.0 mm carapace width to 232 mm carapace width during 1995 to 2009 and averaged 145 mm carapace width per year over the available time series (Figure 2.3).

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[21] In the first year that required the reporting of the number of pots fished in the trip ticket program (1996), a number of old tickets that did not have a field for the number of pots fished were still in circulation

2.1.2 Recreational Fishery Monitoring

Survey Design & Methods

During 2001 through 2002, a telephone survey of RCGL holders was conducted to determine the 2001 recreational harvest of blue crabs (Nobles et al. 2002). Phone surveys of 388 RCGL holders were conducted between September 2001 and March 2002 to determine use of the RCGL, type of equipment, location of harvest, number of days harvesting, and daily and seasonal harvest estimates.

A mail survey of coastal and estuarine landowners was conducted in North Carolina between May 1, 2002 and April 30, 2003 (Vogelsong et al. 2003). The survey requested information on property characteristics, crabbing effort, and harvest. A total of 382 surveys was returned.

The NCDMF conducted monthly surveys of RCGL holders from 2002 to 2008 to collect information on recreational fishing. Participants were randomly selected and were asked about the number of trips taken and the type and number of gears used during the survey month. Participants were also asked to provide estimates for the numbers and pounds of each species caught and retained as well as the numbers of each species discarded.

From 2007 to 2010, the NCDMF surveyed approximately 20% of Coastal Recreational Fishing License (CRFL) holders regarding their participation in saltwater fishing activities including gigging, use of a cast net, shellfish collection, and crabbing.

Biological Sampling

There are currently no programs that collect biological samples of blue crabs from North Carolina's recreational fishery.

Biases

The Nobles et al. (2002) survey and NCDMF survey of RCGL holders were limited to fishermen in possession of a RCGL, thereby omitting non-licensed recreational fishermen that harvested blue crabs. The NCDMF survey of CRFL holders also omitted non-licensed recreational fishermen that harvested blue crabs. Estimates of recreational harvest by non-licensed fishermen are unknown. While initiating an estuarine landowner survey filled some of this gap, including many recreational crabbers who are exempt from RCGL and CRFL licensing, it does not take into account harvest from renters or that of fishermen legally harvesting blue crabs without a license.

Development of Estimates

Estimates

Fifty percent of all blue crabs were harvested along the Intracoastal Waterway, between Pamlico Sound and the Cape Fear River (Nobles et al. 2002). The total estimated blue crab harvest from RCGL holders in 2001 was 118,051 pounds. In this survey, 23.5% of the surveyed RCGL holders indicated that they targeted blue crabs.

The NCDMF survey of RCGL holders estimated that RCGL licensees took an average of 26,402 blue crab directed trips per year between 2002 and 2008 (Table 1.2). During this time period, RCGL holders harvested an average of 116,797 pounds per year, which amounted to 20% of the total estimated RCGL harvest (Figure 1.8).

Estimated blue crab harvest by RCGL holders was less than 0.40% of total blue crab commercial landings for 2001 through 2008. While the harvest of exempted shore- and pier-based pots and other non-commercial gear are unknown, it is unlikely that recreational harvest of blue crabs is significant in North Carolina.

2.2 Fisheries-Independent

2.2.1 Estuarine Trawl Survey (Program 120)

Survey Design & Methods

In 1971, the NCDMF initiated a statewide Estuarine Trawl Survey, also known as Program 120 (P120). The initial objectives of the survey were to identify the primary nursery areas and produce annual recruitment indices for economically important species. Other objectives included monitoring species distribution by season and by area and providing data for evaluation of environmental impact projects.

The survey samples shallow-water areas south of the Albemarle Sound system (Figure 2.4). Major gear changes and standardization in sampling occurred in 1978 and 1989. In 1978, tow times were set at one minute during the daylight hours. In 1989, an analysis was conducted to determine a more efficient sampling time frame for developing juvenile abundance indices with acceptable precision levels for the target species. A fixed set of 105 core stations was identified and sampling was to be conducted in May and June only, except for July sampling for weakfish (dropped in 1998, Program 195 deemed adequate), and only the 10.5-ft headrope, ¼-inch bar mesh trawl would be used.

The current gear is a 3.2-m (10.5 ft) otter trawl with 6.4-mm (1/4-inch) bar mesh body netting of 210/6 size twine and a tailbag mesh of 3.2-mm (1/8-inch) Delta-style knotless nylon with a 150-mesh circumference and 450-mesh length. The gear is towed for one minute during daylight hours during similar tidal stages and covers 75 yards.

Environmental data are recorded, including temperature, salinity, dissolved oxygen, wind speed, and direction. Additional habitat fields were added in 2008.

Sampling Intensity

Prior to 1989, sampling was seasonal. From 1989 to 2003, a fixed set of 105 core stations was identified and sampling was conducted in May and June only. Since 2004, additional July sampling of a subset of the core stations has been conducted.

Biological Sampling

All blue crabs caught are counted. The catch of blue crabs is subsampled if there are more than 30 individuals that are less than 20 mm carapace width (CW). These crabs (<20 mm CW) are measured but not sexed. Larger blue crabs (>=20 mm CW) are sexed and measured.

Biases

Mature female blue crabs are present throughout the coastal waterways of North Carolina. When it is time to spawn, mature females migrate to the oceanic inlets near the barrier islands. Depending on the timing of sampling, the migration could artificially inflate the perceived abundance of mature females in Pamlico Sound by including transient, not resident, mature female crabs. Adult blue crabs more commonly occupy deeper water (<2 m) and are therefore less likely to be encountered by the gear in the locations sampled by Program 120.

Development of Estimates

Spatially, Program 120 samples shallow-water areas in most of the estuarine areas in North Carolina. It almost completely omits Albemarle Sound, deeper areas of Pamlico Sound, and samples the sound side of the Outer Banks lightly. For this reason, data collected from locations in Albemarle Sound were not included in the development of estimates. Additionally, only data collected during May and June were used in the development of estimates.

Abundance: Annual indices of relative abundance were calculated for adults, recruits, and pre-recruits. Adult blue crabs were defined as blue crabs with a carapace width greater than or equal to 100 mm. Recruits were defined as blue crabs less than 100 mm and greater than or equal to 30 mm in carapace width. Pre-recruits were defined as blue crabs less than 30 mm in carapace width. The pre-recruit length cutoff was chosen because crabs settle and immediately metamorphose to their first juvenile instar, ranging from about 22–33 mm (Etherington and Eggleston 2000). Having the juvenile life history stage begin at the most likely upper size limit of the settling megalopae limits the variation to crabs most likely to have made the transition to their final morphology. The lengths used to define adult and recruit life stages were based on examination of length-frequency distributions. The majority of blue crabs collected in Pamlico Sound and Southern region areas are less than 100 mm in carapace width (Figures 2.5, 2.6). Adult and recruit indices were calculated separately for the Pamlico and Southern regions. The frequency of pre-recruits occurring in the survey catches was insufficient to develop area-specific pre-recruit indices. As such, the pre-recruit index was calculated based on data collected from all sites and is considered a statewide index. The adult, recruit, and pre-recruit indices were calculated as the geometric average number per tow.

Length: The annual median CW of all blue crabs caught was computed for 1981 through 2009 for the Pamlico and Southern regions.

Estimates

<u>Pamlico Region</u>

Recruit Abundance: Relative abundance of blue crab recruits in Pamlico Sound ranged from a low of 1.23 blue crabs per tow in 1978 to a high of 6.47 blue crabs per tow in 1996 over the survey time series (Figure 2.7). The recruit index has been variable over the time series and no overall trend is apparent.

Adult Abundance: Most adult index values during 1978 through 2009 were less than 1 crab per tow, suggesting that adult blue crabs have been encountered less frequently than recruits in the Pamlico Sound sampling area (Figure 2.8), perhaps because larger crabs tend to inhabit deeper water. Since the mesh size of this gear is smaller than that used for the deeper water Pamlico Sound Survey (Program 195), it is likely that this difference is due to adult crabs migrating to deeper water. Adult relative abundance ranged from a low of 0.300 blue crabs per tow in 1978 and a high of 1.01 blue crabs per tow in 1999 over the time series. Similar to the recruit index, the index of adult relative abundance varied without trend over the survey time series.

Length: The annual median CW of blue crabs in Pamlico Sound ranged from 23.0 mm to 55.0 mm over the survey time series and averaged 39.2 mm per year (Figure 2.9). Median CW has been variable among years and has shown an overall decrease over the survey time series.

<u>Southern Region</u>

Recruit Abundance: Recruit abundance ranged from a low of 0.175 blue crabs per tow to a high of 1.84 blue crabs per tow over the survey time series (Figure 2.10). The recruit index has been variable but exhibited an overall decline over the 1978 to 2009 time period.

Adult Abundance: Adult abundance in the Southern region has been variable, ranging from a low of 0.0293 blue crabs per tow to a high of 0.335 blue crabs per tow over the survey time series (Figure 2.11). The adult index demonstrated an overall declining trend over time.

Length: The annual median CW of blue crabs in the Southern region has varied among years, ranging from 18.0 mm to 60.0 mm over the survey time series and averaging 32.9 mm per year (Figure 2.12).

<u>Statewide</u>

Pre-recruit abundance: Relative abundance of pre-recruits has been variable over the time series and no overall trend is apparent (Figure 2.13).

2.2.2 Juvenile Anadromous Trawl Survey (Program 100)

Survey Design & Methods

The NCDMF Juvenile Anadromous Trawl Survey, also known as Program 100 (P100), was initiated in 1982 and targets juvenile alosines and striped bass in Albemarle Sound (Figure 2.14). Since its inception, the survey has sampled seven stations (Hassler stations) in western Albemarle Sound. In July 1984, twelve sampling stations were added in the central Albemarle Sound area (Central stations) to monitor juvenile striped bass abundance and to determine if a shift in the striped bass nursery area had occurred.

The survey uses an 18-foot semi-balloon trawl with a body bar mesh size of ¾- inch and a ¼-inch bar mesh tailbag. Tow duration is 15 minutes at the Hassler stations and ten minutes at the Central stations. Temperature, salinity, and dissolved oxygen are recorded.

Sampling Intensity

Sampling is conducted bi-weekly from mid-July to October.

Biological Sampling

The catch of each tow is sorted by species, counted, and measured. The carapace width, sex, and maturity (if female) are recorded for blue crabs. Subsampling methods are used if the catch of blue crabs is excessive.

Biases

The Program 100 survey samples only a couple of deepwater areas in Albemarle Sound, and the sampling does not include many of the tributaries or parts of the sound east of the Alligator River. This gap in sampling potentially omits mature females on their spawning migration to the oceanic inlets. Also, the survey trawl cannot sample in shallow waters in Albemarle Sound because of the complex structure, primarily stumps, associated with the shoreline. This potentially omits capture of juvenile blue crabs using the complex, shallow-water habitat as refuge from predators.

Development of Estimates

Abundance: The length distribution of blue crabs sampled from Program 100 suggests both recruits and adults have been encountered and there has been no clear modal distinction (Figure 2.15). For this reason, an index of relative abundance was calculated using all available data and represents recruits and adults combined. The index was computed as the geometric average number per minute. Computing the index on a per minute basis was done to account for differences in sampling times between the Hassler and Central stations.

Length: The annual median CW of all blue crabs caught was computed for all survey years.

Spawning Stock: Since individual crab weights were not collected during sampling, the sum of the CWs of mature female crabs was used as a proxy for spawning stock biomass (also see section 1.5.4.3, this report). The spawning stock index was calculated as the sum of CWs per minute based on data collected during September and October. The frequency of occurrence of mature females was also computed and calculated as the proportion of tows in which mature female blue crabs were observed.

Estimates

Abundance: Relative abundance varied without trend throughout most of the survey time series (Figure 2.16). The index was less than 0.50 blue crabs per minute in all years through 2007. In 2008, relative abundance increased to 1.26 blue crabs per minute. The 2009 index was the largest for the survey time series at 1.28 blue crabs per minute.

Length: The annual median CW of blue crabs captured in Program 100 averaged 120 mm per year over the survey time series, ranging from 104 mm to 146 mm (Figure 2.17). Median CW was variable among years and no overall trend is apparent.

Spawning Stock: The spawning stock biomass index was at a stable, low level from the beginning of the survey through 1993 (Figure 2.18). Small peaks occurred in 1995, 1999, and 2002, but there is no overall trend. The largest index occurred in 2008 (153 mm/minute). The index decreased in 2009 (88.4 mm/minute) but was still the second largest value on record. The frequency of occurrence of mature females was variable from 1987 through 2004 (Figure 2.19). The frequency of occurrence of mature females generally increased from 2004 through 2009. The 2009 value was the largest observed for the time series.

2.2.3 Pamlico Sound Survey (Program 195)

Survey Design & Methods

The Pamlico Sound Survey, also known as Program 195 (P195), was instituted in March 1987 to provide a long-term, fishery-independent database for the waters of the Pamlico Sound, eastern Albemarle Sound, and the lower Neuse and Pamlico rivers. Data collected from the survey have been used to calculate juvenile abundance indices and estimate population parameters for interstate and statewide stock assessments of recreationally and commercially important fish stocks.

The survey samples 52 randomly selected stations based on a grid system (one-minute by one-minute grid system equivalent to one square nautical mile). Sampling is stratified by depth and geographic area. Shallow water is considered water between 6 to 12 feet in depth and deep water is considered water greater than 12 feet in depth. The seven designated strata are: Neuse River; Pamlico River; Pungo River; Pamlico Sound east of Bluff Shoal, shallow and deep; and Pamlico Sound west of Bluff Shoal, shallow and deep. As of March 1989, the randomly selected stations have been optimally allocated among the strata based upon all the previous sampling in order to provide the most accurate abundance estimates [Proportional Standard Error (PSE) < 20] for selected species. A minimum of three stations (replicates) are maintained in each strata. A minimum of 104 stations are sampled each year to ensure maximum areal coverage. Sampling now occurs only in the Pamlico Sound and associated rivers and bays (Figure 2.20).

Sampling is conducted aboard the RV *Carolina Coast*, equipped with double-rigged demersal mongoose trawls. The RV *Carolina Coast* is a 44-ft fiberglass hulled double-rigged trawler. The trawl consists of a body made of #9 twine with 47.6-mm (1 7/8-inch) stretch mesh, a codend of #30 twine with 38.1-mm (1 ½-inch) stretch mesh, and a 3.05-m (10 ft) tailbag. A 36.6-m (120 ft) three-lead bridle is attached to each of a pair of wooden chain doors that measure 1.22 m (4 ft) by 0.610 m (2 ft) and a tongue centered on the headrope. A 4.76-mm thick, 9.26-m tickler chain is connected to the door next to the 10.4-m (34 ft) footrope. Tow duration is 20 minutes at 2.5 knots.

Sampling Intensity

The sampling season has undergone some changes since the survey's inception. Beginning in 1991, sampling has been performed over a two-week period, usually the second and third weeks of both June and September. In 1999, samples were collected during the month of July and the end of September and October because vessel repairs and hurricanes prevented following the normal schedule. In September 2003, Hurricane Isabel caused a delay and sampling was completed during two days in October.

Biological Sampling

All blue crabs are counted and the sum weight of the catch is recorded. Carapace width, sex, maturity stage, and sponge color are recorded for all mature female blue crabs and from all subsampled blue crabs.

Beginning in September 2002, catches of blue crabs that were too large to process efficiently in the field were set aside for processing later. Subsamples were taken if the amount of crabs in the catch consisted of about ¼ of a 50-lb orange basket or more. The subsampling process involved dumping the basket on the culling table and immediately dividing the sample into quarters. The carapace width and sex were recorded and the sum of the crab weights in the subsample was taken. The remaining crabs (the other three quarters) were counted and mature females segregated. The sum weight of mature females was recorded and the carapace width of mature females was taken.

In 2005, the subsampling protocol was modified for situations where the number of blue crabs caught exceeds 100 individuals. In this situation, all mature females are separated, counted, weighed, and measured. The sum weight of all remaining crabs (males and immature females) is recorded before being subdivided into quarters. One quarter of the sample is then processed, recording the same data that are recorded for samples with fewer than 100 crabs. This process is repeated if necessary until a minimum of 100 crabs are measured.

Biases

One shortfall is that this survey, due to the vessel's size, cannot sample shallow water. The survey also cannot sample areas with complex benthic structure, like stumps or other submerged aquatic vegetation. These two limitations could omit important blue crab habitat.

Mature female blue crabs are present throughout the waterways of North Carolina. When it is time to spawn, mature females migrate to the oceanic inlets. Depending on the timing of sampling, the migration could artificially inflate the perceived abundance of mature females in Pamlico Sound by including transient, not resident, mature female crabs.

Development of Estimates

Abundance: The length distribution of blue crabs caught by Program 195 differs between fall and summer (Figure 2.21). Distinct modes for recruits and adults are evident in the fall length distribution. The summer length distribution suggests the majority of blue crabs encountered are recruits. Annual indices of relative adult abundance were calculated for the fall only and annual indices of relative recruit abundance were calculated using data collected during summer and fall sampling. Adult blue crabs were defined as blue crabs with a carapace width greater than or equal to 100 mm. Recruits were defined as blue crabs less than 100 mm in carapace width. The indices were calculated as the geometric average number per tow.

Length: The annual median CW of all blue crabs caught was computed for all survey years for fall and summer individually.

Spawning Stock: Since blue crabs grow discretely, there is a high amount of variation in weight associated with carapace width. Therefore, the sum of the CWs of mature female crabs was used as a proxy for spawning stock biomass. The spawning stock index was calculated as the sum of CWs per tow based on data collected in September. The frequency of occurrence of mature females was also computed and was calculated as the proportion of tows in which mature female blue crabs were observed.

Estimates

Recruit Abundance: The relative abundance of recruits in the fall and summer has varied and has shown a substantial decline over the survey time series (Figure 2.22). The fall recruit index ranged from a high of 8.24 blue crabs per tow in 1996 to a low of 0.505 blue crabs per tow in 2009 over the survey time period. The summer recruit index has ranged from a high of 75.3 blue crabs per tow in 1990 to a low of 2.37 blue crabs per tow in 2009 over the course of the survey.

Adult Abundance: Adult fall abundance was relatively higher in the earlier years (before 2000) of the survey time series relative to later years (Figure 2.23). The two largest index values were observed in 1996 (18.2 blue crabs per tow) and 1998 (11.3 blue crabs per tow). With the exception of the 2004 index value, the adult fall index values have all been less than 2.0 blue crabs per tow since 2000.

Length: The annual median CW of blue crabs has been variable but generally declining over the survey time series in both the fall and summer (Figure 2.24). Median CW in the fall ranged from 72.0 mm to 133.0 mm and averaged 109 mm per year over the time series. In the summer, median CW ranged from 53.0 mm to 95.0 mm and averaged 72.6 mm per year over the time series.

Spawning Stock: The spawning stock index demonstrates a general decline over the time series with the exception of two substantial peaks that occurred in 1996 (3,788 mm/tow) and 2003 (2,124 mm/tow; Figure 2.25). The 2009 spawning stock index was 192 mm/tow. The frequency of occurrence of mature females has been variable and generally declining over the time series (Figure 2.26).

2.2.4 Striped Bass Independent Gill-Net Survey (Program 135)

Survey Design & Methods

In October 1990, the NCDMF initiated the Striped Bass Independent Gill-Net Survey, also known as Program 135 (P135). The survey was designed to monitor the striped bass population in the Albemarle Sound and Roanoke River.

The survey follows a random stratified design, stratified by geographic area. This survey divides the water bodies comprising the Albemarle region into six sample zones that are further subdivided into one-mile square quadrants with an average of 22 quadrants per zone (Figure 2.27). The survey gear is a multi-mesh monofilament gill net. Four gangs of twelve meshes (2½, 3, 3½, 4, 4½, 5, 5½, 6, 6½, 7, 8, 10 inch stretch) of gill nets are set in each quadrant by the fishing crew, one two-gang set is weighted to fish at the bottom (sink net), and the other is floating unless the area is unsuitable for gill net sampling (marked waterways and areas with excessive submerged obstructions). Alternate zones and quadrants are randomly selected in the event that the primary selection cannot be fished. A fishing day is defined as the two crews fishing the described full complement of nets for that segment for one day. One unit of effort is defined as each 40-yard net fished for 24 hours.

Sampling Intensity

The sampling year is divided into three segments: fall-winter, spring, and summer. Summer sampling was discontinued in 1993. The areas fished, sampling frequency, and sampling effort are altered seasonally to sample the various segments of the striped bass population.

Biological Sampling

All striped bass are measured and additional parameters are completed while other species collected are counted and subsampled for length, including blue crabs for carapace width.

Biases

Program 135 samples the mouths of the tributaries leading into Albemarle Sound and concentrates on the southern coast and western half of Albemarle Sound. It does not sample the middle of the sound or the nearshore portions in the northeast part of the sound. Since blue crabs typically stratify themselves, with larger crabs inhabiting deeper water than the smaller crabs, this sampling regime may omit the relatively large and the relatively small crabs in Albemarle Sound. Additionally, the mid-sound areas are classified as the deeper sections of the sound and therefore more likely to undergo hypoxic events than the relatively shallower areas.

Blue crabs are not typically vulnerable to gill nets, and captures are usually a result of getting tangled in the webbing or riding atop finfish that are captured in the netting and functioning as bait. Since the netting is standardized among study sites, the blue crabs that are captured by entanglement are likely to vary with abundance. Blue crabs are also likely to be attracted to the net as a source of food due to the finfish that are caught in the net. The amount of fish caught in the net and functioning as bait would not be similar among sampling sites and dates, introducing a potential covariate for abundance indices. Additionally, competition for this food source may induce some size selectivity as the larger crabs displace smaller ones.

Development of Estimates

An index of relative adult abundance was calculated using data collected from sink gill nets during November sampling. November data were used because November was the most consistently sampled month during the survey time series, and the highest catches of blue crabs have occurred in November. The majority of blue crabs encountered in Program 135 during November sampling have been adults (Figure 2.28). Blue crabs less than 100 mm CW were excluded in the calculation of the index of relative adult abundance. The index was calculated as the geometric average number per net gang.

Estimates

The Program 135 relative abundance index fluctuated without trend over the entire survey time series (Figure 2.29). Relative abundance of adults was lowest from 1999 to 2001. After 2000, the adult index demonstrates an overall increasing trend through 2008, when the largest index value was observed (6.26 blue crabs per net gang). In 2009, relative abundance declined to 4.37 blue crabs per net gang.

2.2.5 Fisheries-Independent Gill-Net Survey (Program 915)

Survey Design & Methods

The Fisheries-Independent Gill-Net Survey, also known as Program 915 (P915), began on March 1, 2001 and includes Hyde and Dare counties (Figure 2.30). In July 2003, sampling was expanded to include the Neuse, Pamlico, and Pungo rivers (Figures 2.31, Figure 2.32). Additional areas in the Southern District were added in April 2008.

Floating gill nets are used to sample shallow strata while sink gill nets are fished in deep strata. Each net gang consists of 30-yard segments of 3-, 3 ½-, 4-, 4 ½-, 5-, 5 ½-, 6-, and 6 ½-inch stretched mesh, for a total of 240 yards of nets combined. Catches from an array of gill nets comprise a single sample; two samples (one shallow, one deep)—totaling 480 yards of gill net—are completed each trip. Gill nets are typically deployed within an hour of sunset and fished the following morning. Efforts are made to keep all soak times within 12 hours. All gill nets are constructed with a hanging ratio of 2:1. Nets constructed for shallow strata have a vertical height between 6 and 7 feet. Prior to 2005, nets constructed for deep and shallow strata were made with the same configurations. Beginning in 2005, all deepwater nets were constructed with a vertical height of approximately 10 feet. With this configuration, all gill nets were floating and fished the entire water column.

A stratified random sampling design is used, based on area and water depth. Each region is overlaid with a one-minute by one-minute grid system (equivalent to one square nautical mile) and delineated into shallow (≤6 feet) and deep (>6 feet) strata using bathymetric data from NOAA navigational charts and field observations. Beginning in 2005, deep sets have been made along the 6-ft contour. Sampling is divided into two regions: Region 1, which includes areas of eastern Pamlico Sound adjacent to the Outer Banks from southern Roanoke Island to the northern end of Portsmouth Island; and Region 2, which includes Hyde County bays from Stumpy Point Bay to Abel's Bay and adjacent areas of western Pamlico Sound (Figure 2.30). Each of the two regions is further segregated into four similar sized areas to ensure that samples are evenly distributed throughout each region. These are denoted by either Hyde or Dare and numbers 1 through 4. The Hyde areas are numbered south to north, while the Dare areas are numbered north to south. The rivers are divided into four areas in the Neuse River (Upper, Upper-Middle, Lower-Middle, and Lower; Figure 2.32), three areas in the Pamlico River (Upper, Middle, and Lower; Figure 2.31), and only one area for the Pungo River (Figure 2.31). The upper Neuse area was reduced to avoid damage to gear from obstructions, and the lower Neuse was expanded to increase coverage in the downstream area. The Pungo area was expanded to include a greater number of upstream sites where a more representative catch of striped bass may be acquired.

Sampling Intensity

Initially, sampling occurred during all 12 months of the year. In 2002, sampling during December 15 to February 14 was eliminated due to extremely low catches and unsafe working conditions. Each of the sampling areas within each region is sampled twice a month. Within a month, a total of 32 core samples are completed (eight areas × twice a month × two samples) in the river systems.

Biological Sampling

The total weight of all blue crabs caught is recorded and the number of individuals is counted. Carapace width, sex, maturity, and sponge color are recorded for each blue crab.

Biases

This survey is not intended to target blue crabs. Also, blue crabs are not typically vulnerable to gill nets, and captures are usually a result of getting tangled in the webbing or alongside finfish that are captured in the netting and functioning as bait. Blue crabs are likely to be attracted to the net as a source of food due to the finfish that are caught in the net. The amount of fish caught in the net and functioning as bait would not be similar among sampling sites and dates, introducing a potential covariate for abundance indices. Additionally, competition for this food source may induce some size selectivity as the larger crabs displace smaller ones.

Development of Estimates

Abundance: The majority of blue crabs encountered in Program 915 sampling have been adults (Figure 2.33). An index of relative adult abundance was calculated as the geometric average number per sample using all available data. Blue crabs less than 100 mm CW were excluded in the calculation of the index of relative adult abundance.

Length: The annual median CW of all blue crabs caught was computed for all survey years.

Estimates

Adult: Relative abundance of adult blue crabs ranged from a low 0.597 blue crabs per haul in 2007 to a high of 1.18 crabs per haul in 2003 between 2001 and 2009 (Figure 2.34). The index has varied with little trend over the short survey time series.

Length: The annual median CW of blue crabs observed in Program 915 averaged 133 mm per year over the time series (Figure 2.35). Median CW has shown a steady increase from the time series low observed in 2006 (126 mm) to the time series high observed in 2009 (145 mm).

2.3 Evaluation of Observed Data

2.3.1 Temporal Trends

The Mann-Kendall test was performed to evaluate trends in the computed indices. The Mann-Kendall test is a non-parametric test for monotonic trend in time-ordered data (Gilbert 1987). The test was applied to the indices of commercial fishery CPUE, relative abundance, spawning stock, median length, and L_{50} described in sections 0, 0, and 0 of this report. Trends were considered statistically significant at $\alpha = 0.05$.

The Mann-Kendall test was applied to a total of twenty-six indices (Table 2.1). No trends were detected in thirteen of the indices. Statistically significant increasing trends were detected in the index of total abundance derived from Program 100 (Figure 2.16), the spawning stock index derived from Program 100 (Figure 2.18), and the frequency of occurrence of mature females derived from Program 100 (Figure 2.19). Statistically significant decreasing trends were detected in ten indices: Program 120 recruit and adult indices for the Southern region (Figures 2.10, 2.11); Program 195 fall and summer recruit indices (Figure 2.22); Program 195 fall adult index (Figure 2.23) and spawning stock index (Figure 2.25); frequency of occurrence of mature females during the fall in Program 195 (Figure 2.26); Program 120 median length indices for the Pamlico and Southern regions (Figures 2.9, 2.12); and the Program 195 summer median length index (Figure 2.24).

2.3.2 Consistency of Trends

Commercial CPUE: The commercial CPUE indices among the three regions exhibited minimum variability over the time series (Figure 2.2). Commercial CPUE values were highest in the Southern region from the beginning of the time series through 2005 and in 2007. No statistically significant trends were detected in the commercial CPUE indices (Table 2.1).

Recruits: The statewide pre-recruit abundance index derived from Program 120 varied without trend throughout the entire time period (Figure 2.13). The Program 120 recruit index for the Pamlico region also varied without trend over the time series (Figure 2.7). The indices of relative recruit abundance derived from Program 120 samples in the Southern region (Figure 2.10) and from the fall and summer components of the Program 195 survey (Figure 2.22) were variable but demonstrated a statistically significant decrease over time (Table 2.1).

Adults: The Program 120 relative index of adult abundance for the Southern region (Figure 2.11) and the Program 195 (Pamlico region) index of fall adult abundance (Figure 2.23) were both found to have significant declining trends during the survey time periods (Table 2.1). The Program 120 adult abundance index for the Pamlico region was variable and no obvious trend over the time series is evident (Figure 2.8). Most values for this index were less than 1.00 blue crabs per tow. The Program 100 (Albemarle region) relative index of total abundance was low and variable through 2004 and demonstrated a substantial increasing trend during the remainder of the time series (Figure 2.16). The results of the Mann-Kendall test indicated that the Program 100 index significantly increased over time. The Program 135 adult relative index showed a general increase during 2000 to 2009 (Figure 2.29). The adult index derived from Program 915 showed little trend over the short time series (Figure 2.34).

Length: Annual average carapace widths of blue crabs sampled from the Pamlico (Figure 2.9) and Southern (Figure 2.12) regions by Program 120 and sampled during the summer by Program 195 (Figure 2.24) showed statistically significant declines over time (Table 2.1). Blue crab annual average carapace widths derived from Program 100 (Figure 2.17) and fall sampling by Program 195 (Figure 2.24) varied without trend over time. The average carapace widths of blue crabs sampled by Program 915 increased during the last four years of the survey (2006–2009), but no significant trend over the time series was detected (Table 2.1).

Spawning Stock: Significant, opposing trends in spawning stock and frequency of occurrence of mature females were detected between the Albemarle and Pamlico regions. Both the spawning stock index (Figure 2.18) and frequency of occurrence of mature females (Figure 2.19) derived from Program 100 exhibited significant increases over time (Table 2.1). The Program 195 index of spawning stock (Figure 2.25) and frequency of occurrence of mature females (Figure 2.26) showed significant decreases over time (Table 2.1).

Overall: The majority of indices for the Pamlico and Southern regions exhibited significant decreasing trends. Albemarle indices had no trend or an increasing trend.

3. ASSESSMENT

3.1 Overview

3.1.1 Scope

The unit stock includes blue crabs occurring in all coastal fishing waters of North Carolina.

3.1.2 Current vs. Previous Method

As part of the last FMP review and update, a catch-survey analysis was one of the methods applied to attempt to assess North Carolina's blue crab stock (Eggleston et al. 2004); however, the time series data were extremely variable, there was not much correspondence between the pre-recruits and full recruits, and the data showed a poor fit when compared to the predicted model results (J. Hightower, NCSU, pers. comm.). This previous assessment was included in the 2004 FMP update but was not used for management given its uncertainty (NCDMF 2004). Instead, management adopted a spawning stock trigger to protect the blue crab spawning stock (see section 1.5.4.3, this report).

The assessment working group considered applying a surplus production model and catch-survey analysis for the current assessment, but the working group concluded that the information needed to conduct a reliable assessment using these methods was limited or unavailable. Uncertainties include unclear boundaries of the unit stock, lack of discard data, limited estimates of recreational harvest, and lack of a reliable statewide index of abundance. Additional factors specifically limiting the use of a catch-survey analysis include highly variable estimates of natural mortality, differing size limits, high coefficients of variation in many indices, and no knowledge of an appropriate scaling factor to relate indices of pre-recruits to indices of full recruits.

Because blue crabs do not retain any hard parts throughout their life cycle (i.e., otoliths, scales, fin spines, or a permanent shell) that are traditionally used to age other finfish and shellfish, ageing blue crabs has been notoriously difficult, making it difficult to employ traditional age-based stock assessment models. Although ageing methodology has been developed using lipofuscin accumulation rates (Ju et al. 1999; Puckett et al. 2008), it has only been recently described and has not been applied to the North Carolina stock. In situations where ageing of an organism is not possible, length-based assessments are sometimes used as a proxy for age-based ones but are often not recommended for producing management advice. Hilborn and Walters (1992) state, "attempts to use length-based analysis to formulate management advice for species that do not exhibit unambiguous modes is misguided and fundamentally hopeless". Blue crabs do not exhibit distinctive modal patterns in length beyond age 0. The inability to adequately determine age and the lack of appropriate tagging data further limits the available assessment options.

North Carolina lacks the appropriate data and information to apply a "traditional" stock assessment model (e.g., surplus production, VPA, statistical catch at age) to the blue crab population. Although traditional models could be attempted, a large number of assumptions would be required and the results would likely be highly uncertain and ultimately unusable for management. Therefore, the working group decided it would be more appropriate to conduct an index-based assessment.

For the current assessment, the Traffic Light method was applied to synthesize a variety of information to provide a qualitative description of stock condition and propose an overfished definition for the blue crab stock.

3.2 Traffic Light Method

3.2.1 Definition of Terms

Before the Traffic Light method is described, it may be helpful to define several terms associated with the method. The terms and definitions were modified following Halliday et al. (2001). An **indicator** is a measure of some attribute of the population and is often based on a time series of data. For example, an index of blue crab relative abundance (number per tow) derived from a fisheries-independent survey is an indicator of blue crab stock abundance. Multiple indicators may be available for a single attribute. A **characteristic** is an aggregate of indicators and is used in further analysis or decision making. Halliday et al. (2001) proposed the following system characteristics: Abundance, Production, Fishing Mortality, and Ecosystem/Environment. The process of **scaling** is the assignment of colors, or “traffic lights”, to indicators to normalize them before integration. The use of colors is not required; numbers could also be used. In the current assessment, a three-color system is used. **Normalization** is the rescaling of data to a common scale. Here, indicators are normalized to a scale ranging from 0 to 1. Finally, **integration** is the combining of several indicators into a characteristic or into an overall summary indicator.

3.2.2 Description

The Traffic Light method was initially developed to reduce the reliance on data-intensive stock assessment models (Caddy 1999, 2002). Because of the lack of data manipulation necessary, the Traffic Light method can result in more timely fisheries management decisions. Another potential advantage is that fewer assumptions may be necessary for the Traffic Light method when compared to traditional stock assessment models, making them more useful. Additionally, attention can be focused on a variety of information, rather than just the most recent estimates of abundance and fishing mortality as is traditionally done.

The Traffic Light method involves evaluating qualitative and quantitative indicators that provide information on the status of the stock. Relevant information may include fishing mortality, biomass, recruitment, length and age at maturity, and spatial distribution (Halliday et al. 2001). The indicator value in each year is assigned a green, yellow, or red ‘signal’ based on the state of the indicator relative to stock health (condition). Typically the color green is indicative of a favorable stock condition, yellow is indicative of an uncertain or transitioning stock condition, and red is indicative of an unfavorable stock condition. Similar indicators are aggregated into characteristics. Characteristics can be further aggregated into a single Traffic Light that represents the overall condition of the stock. The main assumptions of the Traffic Light method are that the indicators reflect the characteristic to which they are assigned and that the characteristics adequately reflect the feature of the stock they are meant to represent.

The resulting set or sets of Traffic Light scores can serve as a stock status index (e.g., Koeller et al. 2000; Ceriola et al. 2007) or provide the basis for a precautionary management framework (e.g., Caddy 2004). It is important to note that management responses to Traffic Light scores should be determined *a priori*.

3.2.3 Dimensions

The assessment working group decided that the indicators selected for use in the Traffic Light method should cover the same time period in order to avoid the currently controversial issue of combining indicators of different time series length (Halliday et al. 2001). The longest time series of fisheries-independent blue crab data were available from a single survey—Program 120 (1978–2009). The working group was not comfortable relying on a single survey for characterizing the blue crab stock. The next longest time series that could be used was 1987 through 2009. Selection of this time series allowed incorporation of data from a variety of fisheries-independent surveys[22] including Program 120, Program 100, Program 195, and Program 135; however, the earliest year for which fisheries-dependent data are considered reliable is 1994. Further restricting the time series to the 1994 through 2009 period would result in eliminating much of the contrast exhibited by the fisheries-independent surveys. The working group felt the contrast shown in the fisheries-independent surveys provided valuable information and selected the years 1987 through 2009 as the time period for the stock assessment.

Most of the indices considered for use in the Traffic Light were considered to represent one of three regions: Albemarle, Pamlico, or Southern (Figure 3.1). The relative index of pre-recruit abundance derived from Program 120 and the annual estimates of L_{50} for female blue crabs were considered statewide indices. Indices selected for use as indicators were weighted in the integration process (see section 3.2.6, this report) based on regional weights. Regions were weighted based upon the percentage of water surface area within a region relative to all other regions. The regional weights were: Albemarle 27.1%, Pamlico 66.1%, and Southern 6.83%. Statewide indicators were given full (100%) weight.

3.2.4 Indicators

The available data were reviewed to identify appropriate indicators for describing the characteristics of abundance and production. Two abundance characteristics were used—adult and recruit. Abundance indicators characterize the size of the population providing the production, while production indicators reflect the status of the population with respect to growth, survival, maturity, and spawning potential (Halliday et al. 2001).

Four indicators of adult abundance, four indicators of recruit abundance, and eleven indicators of production were selected (Table 3.1). Relative indices of abundance were selected as indicators for adult and recruit abundance. The production indicators include measures of median length (CW), pre-recruit abundance, length at 50% maturity, spawning stock, and frequency of occurrence of mature females.

3.2.5 Scaling

The process of scaling in the Traffic Light context is the assignment of colors to indicators to normalize them to a common scale before integration (Halliday et al. 2001). The Fuzzy Set method of scaling was selected since it allows the representation of uncertainty in indicator values and provides a method for expressing conflicting evidence. The Fuzzy Set method also provides an established mathematical method for developing decision rules.

A brief introduction to the strict scaling method, one of the simplest scaling methods, is provided to facilitate understanding of the Fuzzy Set approach. In the Strict Traffic Light approach, individual indicator values are associated with a single color category. The assignment of color is sensitive to the choice of color boundaries. For example, consider an indicator based on the relative index of adult abundance for the Pamlico region derived from Program 120. Figure 3.2 depicts this indicator using the Strict scaling method in which the boundaries between colors are defined by the upper and lower 95%

[22] Biological data collected from Program 436 (fisheries-dependent commercial sampling) were included in the estimates of annual lengths at 50% maturity for female blue crabs (see section 1.2.5, this report)

confidence limits of the time-series average. Indicator values greater than the upper 95% confidence limit are assigned the color green. Indicator values less than the lower 95% confidence limit are assigned the color red. Indicator values that fall between the upper and lower 95% confidence limits are assigned the color yellow.

The sharp transition between colors can result in a loss of information in the integration process. For example, the 1988 indicator value of the Program 120 adult index for the Pamlico region is yellow but near the lower 95% confidence limit (Figure 3.2). The 2002 value is also yellow but close to the upper 95% confidence limit. In the integration process, both of these indicator values would be given equal weight; however, one may be interested in differentiating between a yellow value nearing red and a yellow value nearing green. The Fuzzy Set method provides such an approach by introducing transition zone between colors, allowing indicator values to be associated with more than one color category. The representation of uncertainty with this method is straightforward and the gradual change between colors can improve resolution.

In the current assessment, the transition zones between colors were based on the statistical properties of individual time series. A three-color system was used. For each indicator, the average and upper and lower 95% confidence limits defined the proportion of each color assigned, normalized to a scale of 0 to 1 (Figure 3.3). In this approach, the color boundaries restrict the color assignment within an individual indicator value to a maximum of two co-occurring colors. Continuing with the earlier example, the average and 95% confidence limits of the Pamlico region adult index derived from Program 120 were computed to determine the transition zones for scaling by the Fuzzy Set method (Figure 3.4). The average of the annual values for this index was 0.622 blue crabs per tow. The upper 95% confidence limit was 0.711 blue crabs per tow and the lower 95% confidence limit was 0.533 blue crabs per tow. Consider the 2002 index value, which was 0.690 blue crabs per tow. A vertical black line was drawn in Figure 3.4 where the 2002 value falls on the x-axis. Where the black line intersects with the green and yellow lines indicates the proportion of each of those colors assigned to the 2002 indicator value. In this example, the 2002 indicator is 38% green and 62% yellow.

3.2.6 Integration

Within the Traffic Light context, integration is the combining of indicators into a characteristic or to provide an overall summary index. In the current assessment, indicators were integrated into one of three characteristics: adult abundance, recruit abundance, and production. When individual indicators are integrated to represent a characteristic, the indicators can be combined by a simple integration of colors because all the indicators within a characteristic are assumed to represent the same thing. Using the Fuzzy Set approach, the simplest method of integration is to sum the proportions of assigned colors over the individual integrators for each year and rescale to 1. Note that, following integration, an individual characteristic value can include up to three colors, the sum of the proportions adding to 1. In the current assessment, indicators were weighted before integration based upon the relative percentage of water surface area within the region represented by the indicator (see section 3.2.3, this report). Statewide indicators were given full (100%) weight. If multiple indicators within a characteristic represented the same region, the spatial weighting was divided by the number of indicators representing a particular region.

The assessment working group also decided to apply additional weighting to the indices of adult abundance for the Pamlico and Southern regions derived from Program 120. The length distribution of blue crabs encountered in the Pamlico (Figure 2.5) and Southern (Figure 2.6) regions suggests adults are encountered much less frequently than recruits. The working group decided to give less weight to these indices and, in addition to the spatial weighting, the weight of both of these indices was reduced by one-third based on the limited availability of adults in the areas sampled by this program.

3.2.7 Results & Discussion

The results of integration of the indicators into the characteristics of adult abundance, recruit abundance, and production provide an overall summary of trends across the state. The Traffic Light series for adult abundance suggests conflicting trends in the indicators during the late 1980s through the mid-1990s (Figure 3.5). During the mid- to late 1990s, the adult abundance Traffic Light was indicative of mostly positive trends; however, the majority of Traffic Lights for adult abundance from 2000 to 2009 were red. This could potentially be the initial and lingering effects of a multi-year drought that began in 2002. The recruit abundance Traffic Light series during 2000 through 2009 exhibited a pattern similar to the one demonstrated by adult abundance over that time period (Figure 3.6). The Traffic Light for recruit abundance showed no obvious patterns before 2000. The production Traffic Light in 2000 was largely red (Figure 3.7). Since 2000, the proportion of red has decreased while the proportion of green has increased. Prior to 2000, the Traffic Light series for production demonstrated nearly equal amounts of green and yellow; red was present to a slightly lesser degree.

The Traffic Light analysis indicated that adult and recruit abundance levels were higher overall before 2000 (Figure 3.8). There is some suggestion of negative trends in recent years, especially in recruit abundance. Production has been variable, but the Traffic Light gives evidence of increasingly positive trends in recent years.

3.3 Management Implementation

The intent of NCDMF stock assessments is to provide a valid scientific basis for management. The assessments are not intended to provide specific management advice. Limited applications of the Traffic Light method to fisheries management currently exist (e.g., Koeller et al. 2000; DFO 2003a, 2003b, 2005, 2006; Ceriola et al. 2007; DFO 2007; GADNR 2008; DFO 2009, 2010), and this is the first time the NCDMF has considered the method for resource management. For the current assessment, the working group felt it would be beneficial to provide managers with an example of how the results of the Traffic Light method could be used for management. The management implementation scenario given below is strictly an example and should not be considered a recommendation for specific management. The actual and specific implementation of the Traffic Light method should occur through the NCDMF's normal development process (e.g., FMP Amendments, Rule Changes, Proclamations, and Supplements).

The Traffic Light method was originally envisioned as an approach for developing limit reference points based on life history characteristics measured by multiple indicators (Caddy 1999). Limit reference points differ from target reference points in that they define an undesirable condition for the stock—a situation management would want to avoid. In contrast, a target reference point represents a desirable condition and management actions are implemented in an attempt to achieve the defined target. It is clear that the implementation of limit reference points provides for a more precautionary management framework.

The results of the Traffic Light could be applied to the North Carolina blue crab stock in the precautionary context; that is, the results could be used to define conditions that are considered undesirable and to identify situations when management action should be considered and implemented. As an example, the amount of red exhibited by a characteristic for three consecutive years could serve as the trigger for management. The proportion of red that a characteristic can exhibit ranges from 0 to 1. This range can be divided in quartiles for which different management strategies can be associated. That is, if a characteristic falls within a particular quartile for three years in a row, the management strategy associated with the given quartile for that characteristic should be pursued.

The assessment working group developed some example management strategies for the adult abundance, recruit abundance, and production characteristics based on the three-year quartile approach. If the proportion of red in the Traffic Light for any of the characteristics is less than the first (<0.25) or second (<0.50) quartile for three consecutive years, no management action may be necessary (i.e., status quo). If the proportion of red exhibited is greater than or equal to the second (>=0.50) quartile and less than the third quartile (<0.75), one or more of several moderate management actions could be taken, depending on the characteristic. For example, moderate management actions for the adult abundance characteristic might include reductions in adult harvest, season or area closures, an increase in minimum size limits, implementation of a maximum size limit, and gear restrictions. Moderate management actions associated with the recruit abundance characteristic might include reductions in recruit harvest, an increase in minimum size limits, restriction of gear that catches a large proportion of juvenile blue crabs, reduction of blue crab bycatch in other fisheries, and reduction in tolerance of sub-legal size blue crabs. The moderate management actions for the production characteristic might include reduction of bycatch of mature female blue crabs in the crab and other fisheries, gear modifications, and implementation of sizes limits on the harvest of mature female blue crabs. Finally, if the proportion of red in the Traffic Light for any of the characteristics is greater than or equal to the third quartile (>=0.75), then elevated management measures could be implemented. For example, elevated management actions for the adult abundance characteristic might include control of fishing effort directed at adult blue crabs, area closures, and closure of the fishery. Elevated management actions for the recruit abundance characteristic might include an increase in the minimum size of cull rings, area closures, and closure of the fishery. Elevated management measures associated with the production characteristic might include limits on the harvest of sponge crabs, limits or elimination of the harvest of mature female blue crabs, season or area closures, and limits in the peeler pot fishery.

The management strategy described above is provided strictly as an example implementation of the Traffic Light method for management and is intended to be used as a starting point for discussion.

4. STATUS DETERMINATION

The General Statutes of North Carolina define overfished 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” (NCGS § 113-129). The General Statues define overfishing as “fishing that causes a level of mortality that prevents a fishery from producing a sustainable harvest.”

The 2004 FMP for blue crab defined the overfished condition for the blue crab stock based on commercial landings trends (NCDMF 2004). The blue crab resource is considered overfished when annual commercial landings decline for five consecutive years. No overfishing definition was developed.

An overfishing definition and status relative to overfishing cannot be determined at this time because available data are considered insufficient for estimating reliable fishing mortality rates. Therefore, the current assessment considers the status of the North Carolina blue crab stock relative to overfishing as unknown.

The current assessment recommends defining the overfished condition based on the blue crab production Traffic Light such that when the proportion of red for the production Traffic Light is greater than or equal to the third quartile (>=0.75) for three consecutive years, the blue crab stock is considered overfished. Based on this definition, the results of this assessment suggest the North Carolina blue crab stock is currently not overfished.

Though the recommended overfished definition is based only on the production Traffic Light, the working group recommends evaluating the adult and recruit characteristics for warning signs that the stock may be approaching an undesirable state. If a series of negative trends is evident in the adult and recruit Traffic Lights, managers and fishermen may want to consider implementation of actions to prevent the stock from becoming overfished.

5. SUITABILITY FOR MANAGEMENT

Stocks assessments performed by the NCDMF in support of management plans are subject to an extensive review process. Internal reviews are conducted by various groups within the NCDMF including the species plan development team, the Biological Review Team Technical Committee, and the Management Review Team. External reviews are designed to provide an independent peer review and are conducted by experts in stock assessment science and experts in the biology and ecology of the species. The goal of the external review is to ensure the results are based on sound science and provide a valid basis for management.

The blue crab stock assessment was reviewed by external experts in July 2011. All but one of the external reviewers agreed that the assessment provided a valid basis for management for at least the next five years, given the available data and current knowledge of the species stock dynamics and fisheries. The reviewers felt it was important to update the Traffic Lights annually to allow managers to make informed decisions on management actions. The reviewers also noted that the Traffic Light method should be considered an interim procedure that should be refined or replaced with an improved method for the next amendment. One reviewer questioned how managers would use the information from the Traffic Light without estimates of MSY or F_{MAX}, commonly used with setting fishing targets. The dissenting reviewer mentioned that the Traffic Light method is reasonable to use, but without a more complete understanding of the relative magnitude of environmental versus fishing impacts it would be difficult for managers to use this method. All reviewers commented on the importance of taking environmental factors into account when interpreting the results of the Traffic Lights.

6. RESEARCH RECOMMENDATIONS

One of the principal issues identified in the 2004 amendment to the Blue Crab FMP was the lack of sufficient data to apply a traditional method to assess the status of the blue crab stock (NCDMF 2004). To address this deficiency, the following recommendations for research and monitoring are offered (no particular order):

- Continue existing programs that have been used to monitor North Carolina's blue crab stock to maintain baseline data
- Identify key environmental factors that significantly impact North Carolina's blue crab stock and investigate assessment methods that can account for these environmental factors
- Conduct a study of the selectivity of the gear used in the Juvenile Anadromous Trawl Survey (Program 100) to evaluate the size at which blue crabs are fully-selected to the survey gear; the results of such a study could help determine whether the survey data could be used to develop a reliable index of blue crab recruitment for the Albemarle region; no such index is currently available
- Expand spatial coverage of the Estuarine Trawl Survey (Program 120) to include shallow-water habitat in Albemarle Sound; sampling in shallow-water habitat is intended to target juvenile blue crabs so that a recruitment index for the Albemarle Sound could be developed
- Expand temporal coverage of the Estuarine Trawl Survey (Program 120) beyond May and June sampling; additional sampling later in the blue crab's growing season would provide more information on within-year changes in growth, mortality, and abundance; at a minimum, recommend addition of September sampling in order to capture the fall settlement peak
- Expand spatial coverage of Pamlico Sound Survey (Program 195) to include deepwater habitat in Albemarle Sound and the Southern Region; expanding the sampling region of adult blue crab habitat would allow for a more spatially-comprehensive adult index; additionally, there would be increased confidence in comparison of adult abundance trends among regions since all would derive from the same sampling methodology
- Implement a statewide survey with the primary goal of monitoring the abundance of blue crabs in the entire state; such a survey would need to be stratified by water depth to ensure capture of all stages of the blue crabs life cycle and standardized among North Carolina waters
- Implement monitoring of megalopal settlement near the ocean inlets could potentially add a predictive function to the blue crab stock assessments in the future; Forward et al. (2004) detected a positive, linear relationship between megalopal abundance and commercial landings of hard blue crabs for both the local estuarine area and the entire state of North Carolina when a two-year time lag was implemented (Forward et al. 2004); such monitoring is critical to track larval ingress peaks and the effect of natural forces, such as tropical storms and prevailing winds, on ingress.
- Continue surveys of recreational harvest and effort to improve characterization of the recreational fishery for blue crabs
- Identify programs outside the NCDMF that collect data of potential use to the stock assessment of North Carolina's blue crabs
- Perform in-depth analysis of available data; consider standardization techniques to account for gear and other effects in development of indices; explore utility of spatial analysis in assessing the blue crab stock

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8. TABLES

Table 1.1. Number of fishermen (excluding crew) that reported landings of blue crabs in North Carolina, associated number of trips, average crew size, and estimated total number of participants (fishermen + crew), 1994–2009.

Year	Number fishermen	Number trips	Average crew size	Total participants
1994	2,060	121,833		
1995	2,211	125,974		
1996	2,288	123,900		
1997	2,284	132,493		
1998	2,004	143,063		
1999	1,919	124,378	1.42	2,718
2000	1,756	111,221	1.40	2,463
2001	1,787	113,572	1.42	2,535
2002	1,681	93,620	1.48	2,483
2003	1,578	91,730	1.45	2,289
2004	1,489	80,828	1.47	2,182
2005	1,216	64,029	1.43	1,744
2006	1,010	52,886	1.43	1,442
2007	952	53,833	1.46	1,388
2008	914	52,641	1.53	1,402
2009	990	59,072	1.60	1,582

Table 1.2. Estimated number of blue crab directed recreational fishing trips compared to estimated total number of recreational fishing trips, taken by RCGL license holders in North Carolina, 2002–2008.

	Number of trips		Percent of
Year	Total	Directed	total trips
2002	80,159	28,324	35%
2003	55,787	27,907	50%
2004	53,488	28,021	52%
2005	47,120	26,278	56%
2006	43,384	24,401	56%
2007	41,617	25,153	60%
2008	40,556	24,732	61%

Table 1.3. Annual commercial fishery landings (pounds) of blue crabs in North Carolina since the adoption of the Blue Crab Fishery Management Plan in 1998, 1998–2009.

Year	Pounds
1998	62,076,170
1999	57,546,676
2000	40,638,384
2001	32,180,390
2002	37,736,319
2003	42,769,797
2004	34,130,608
2005	25,430,119
2006	25,343,159
2007	21,424,960
2008	32,916,691
2009	29,707,232

Table 1.4. Estimated number of blue crabs harvested and discarded by RCGL license holders in North Carolina, 2002–2008.

Year	Harvest	Discards
2002	346,550	185,939
2003	354,425	124,196
2004	329,478	138,316
2005	323,531	152,905
2006	297,875	123,787
2007	286,856	102,695
2008	311,690	132,519

Table 2.1. Results of Mann-Kendall trend analyses applied to the full time period for each index. *P*-value is the one-tailed probability for the trend test. Type indicates whether the program is fisheries-dependent (FD) or fisheries-independent (FI). Trend indicates the direction of the trend if a statistically significant temporal trend was detected (two-tailed test: *P*-value < α/2; α = 0.05); NS = not significant.

Index	Life stage	Program	Type	Available years	*P*-value	Trend
Catch per effort (lb/pot)	All	TTP (Albemarle)	FD	1997–2009	0.123	NS
		TTP (Pamlico)	FD	1997–2009	0.123	NS
		TTP (Southern)	FD	1997–2009	0.0384	NS
Relative abundance	Pre-recruits	P120 (Statewide)	FI	1978–2009	0.0414	NS
	Recruits	P120 (Pamlico)	FI	1978–2009	0.253	NS
		P120 (Southern)	FI	1978–2009	*P* < 0.001	↓
		P195 (fall)	FI	1987–2009	*P* < 0.001	↓
		P195 (summer)	FI	1987–2009	0.0224	↓
		P915	FI	2001–2009	0.126	NS
	Adults	P120 (Pamlico)	FI	1978–2009	0.253	NS
		P120 (Southern)	FI	1978–2009	*P* < 0.001	↓
		P195 (fall)	FI	1987–2009	0.00109	↓
		P135	FI	1991–2009	0.0918	NS
		P915	FI	2001–2009	0.301	NS
	All	P100	FI	1987–2009	0.0101	↑
Spawning stock	Mature Females	P100	FI	1987–2009	0.00325	↑
		P195	FI	1987–2009	0.00155	↓
Frequency of Occurrence	Mature Females	P100	FI	1987–2009	0.00153	↑
		P195 (fall)	FI	1987–2009	*P* < 0.001	↓
Median length	All	P120 (Pamlico)	FI	1981–2009	0.0155	↓
		P120 (Southern)	FI	1981–2009	0.00301	↓
		P100	FI	1987–2009	0.317	NS
		P195 (fall)	FI	1987–2009	0.500	NS
		P195 (summer)	FI	1987–2009	0.00166	↓
		P915	FI	2001–2009	0.0877	NS
Length at 50% maturity	Females	P120, P100, P195, and P436	FI	1987–2009	0.437	NS

Table 3.1. Summary of indicators included in the Traffic Light for North Carolina blue crabs, grouped by stock characteristic.

Characteristic	Indicator
Adult Abundance	Total Abundance (Albemarle, P100)
	Adult Abundance (Pamlico, P120)
	Adult Abundance (Pamlico, P195, Fall)
	Adult Abundance (Southern, P120)
Recruit Abundance	Recruit Abundance (Pamlico, P120)
	Recruit Abundance (Pamlico, P195, Fall)
	Recruit Abundance (Pamlico, P195, Summer)
	Recruit Abundance (Southern, P120)
Production	Median CW (Albemarle, P100)
	Spawning Stock (Albemarle, P100)
	Freq. Mature Females (Albemarle, P100)
	Median CW (Pamlico, P120)
	Median CW (Pamlico, P195, Fall)
	Median CW (Pamlico, P195, Summer)
	Spawning Stock (Pamlico, P195)
	Freq. Mature Females (Pamlico, P195)
	Median CW (Southern, P120)
	Pre-Recruit Abundance (Statewide, P120)
	Length @ 50% Maturity (Statewide, various)

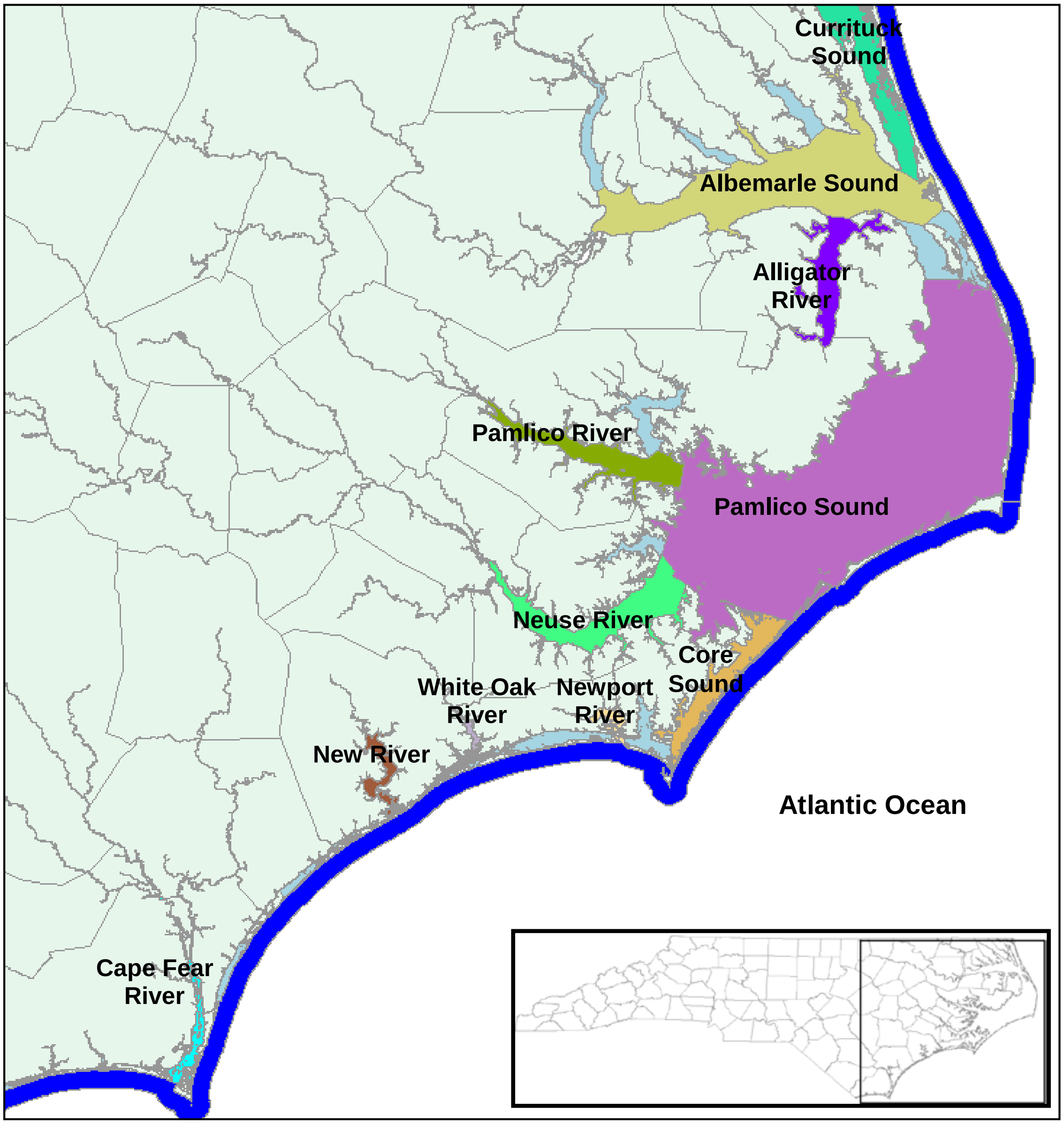


Figure 1.1. Major water bodies of North Carolina. The dark blue area represents the extent of the state's coastal fishing waters, which extend to three miles offshore.

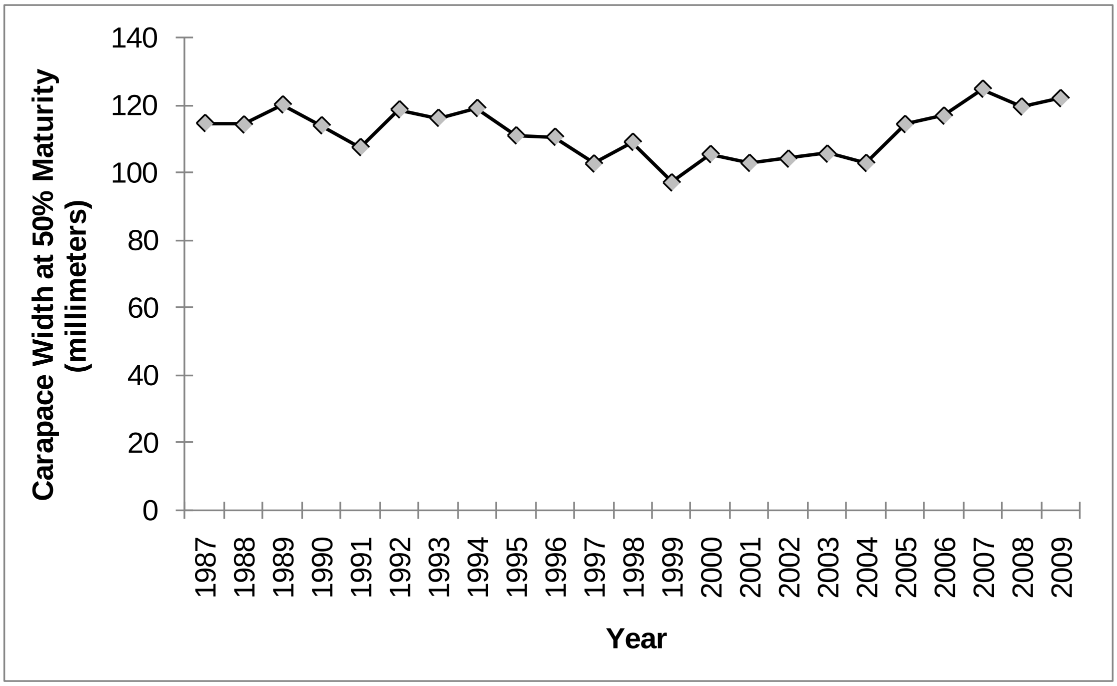


Figure 1.2. Annual carapace width at 50% maturity for female blue crabs collected in multiple NCDMF sampling programs (120, 100, 195, and 436) in North Carolina water bodies, 1987–2009.

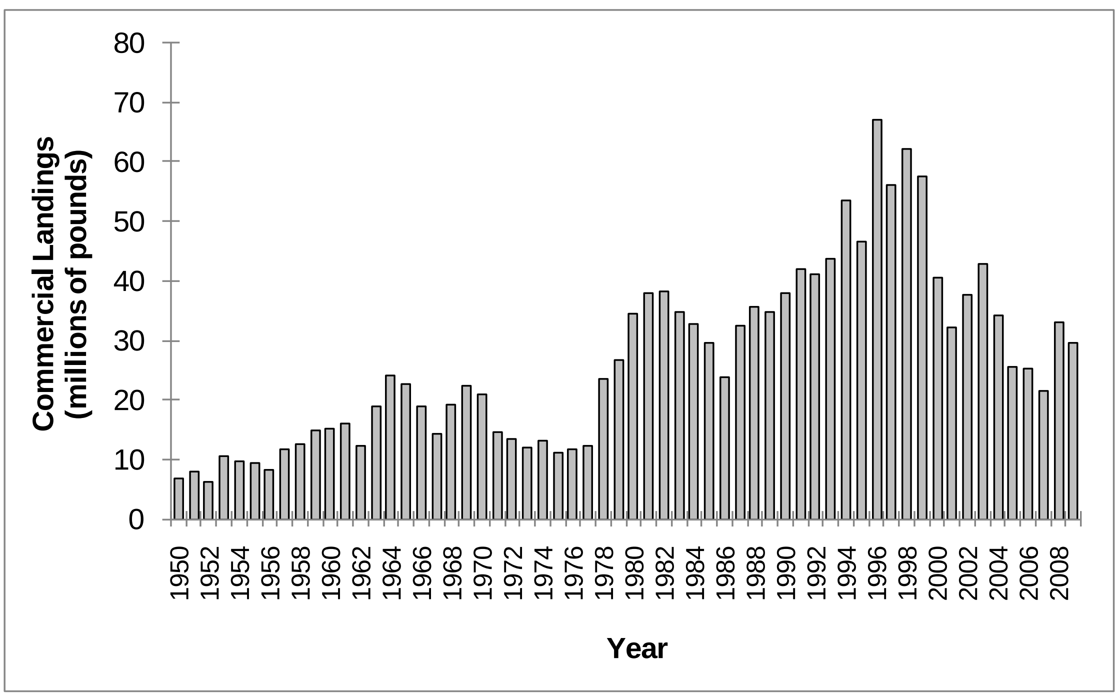


Figure 1.3. Annual commercial fishery landings of blue crabs in North Carolina, 1950–2009.

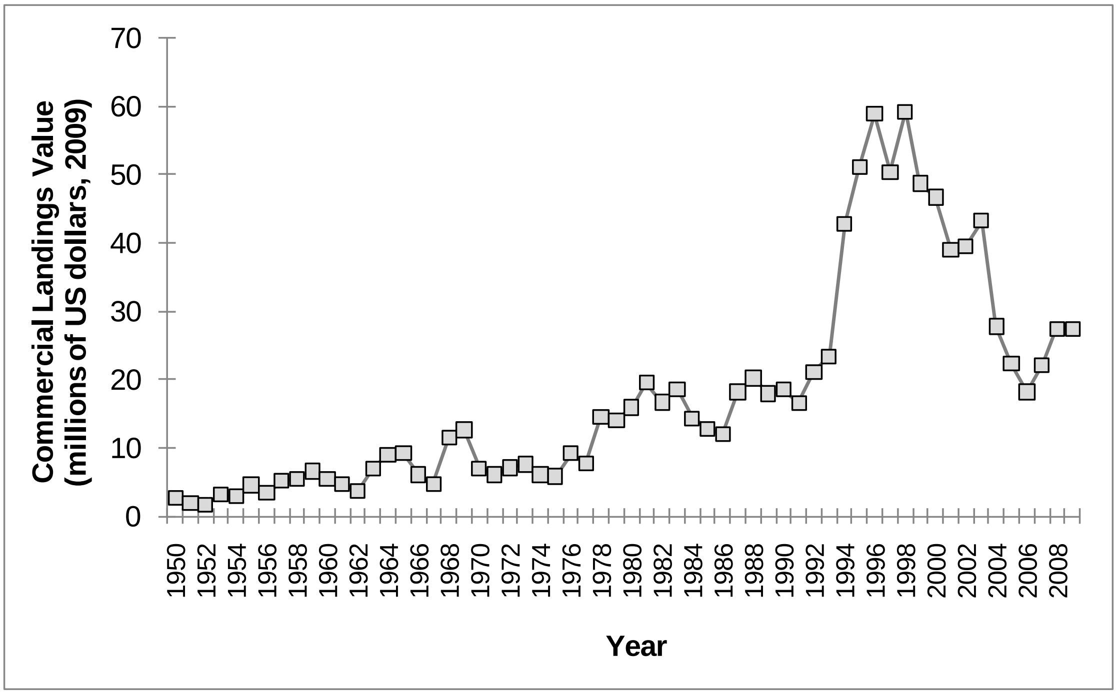


Figure 1.4. Annual ex-vessel values of North Carolina's commercial fishery blue crab landings, 1950–2009. Note that historical values were converted to 2009 dollars.

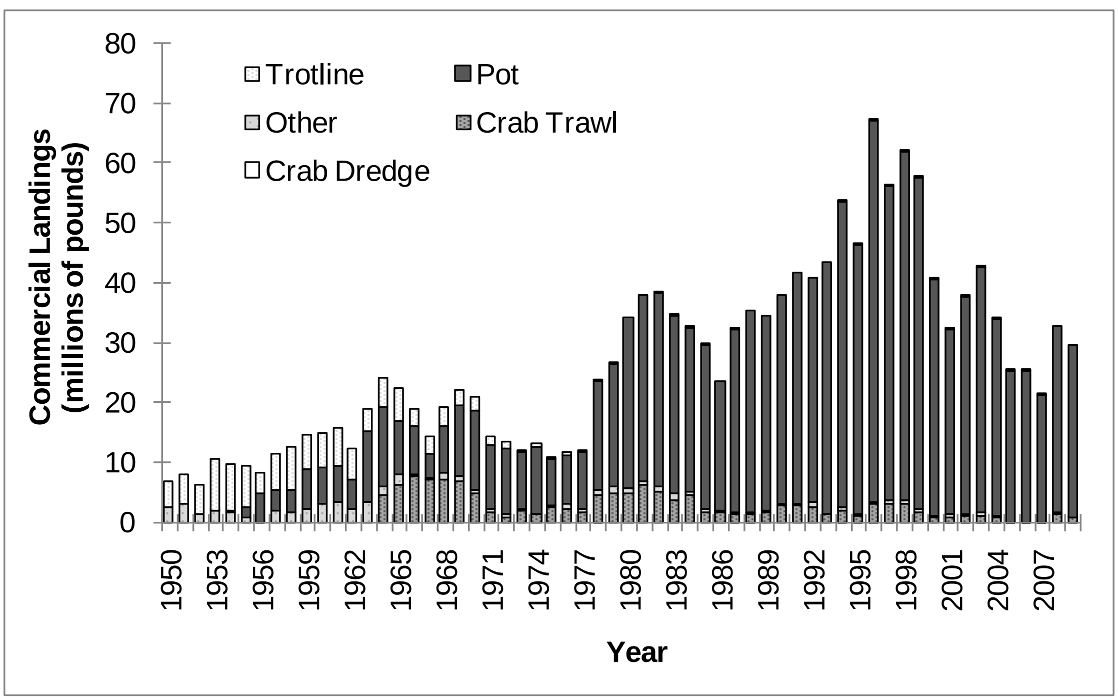


Figure 1.5. Annual commercial fishery landings of blue crabs in North Carolina, by major gear, 1950–2009.

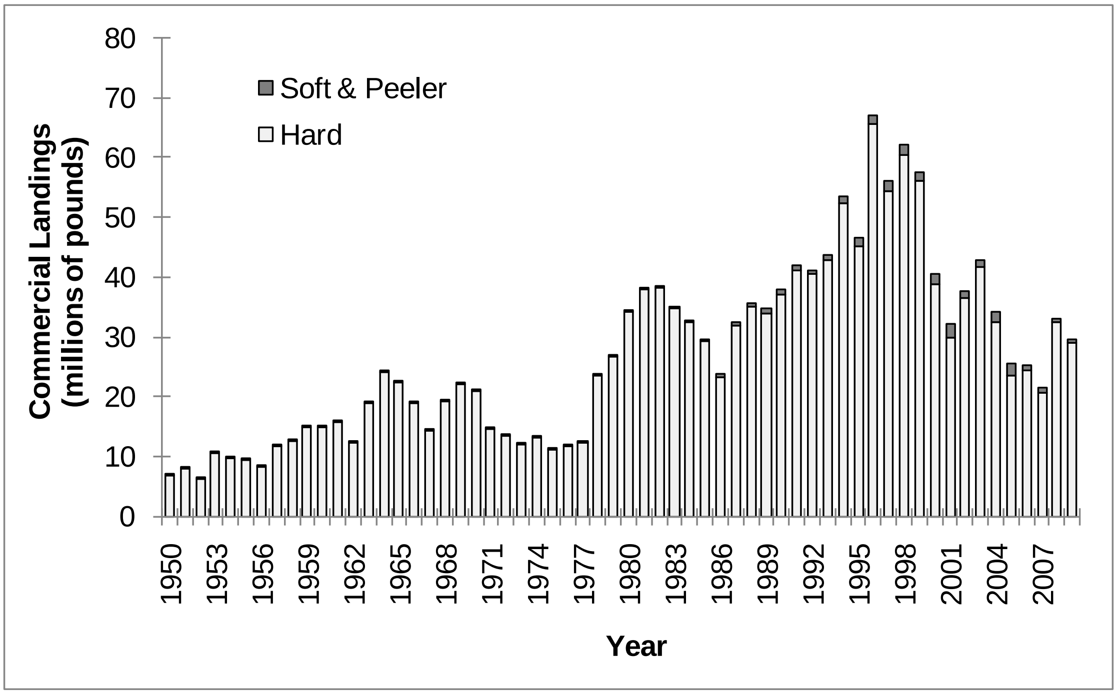


Figure 1.6. Annual commercial fishery landings of blue crabs in North Carolina, by crab type, 1950–2009.

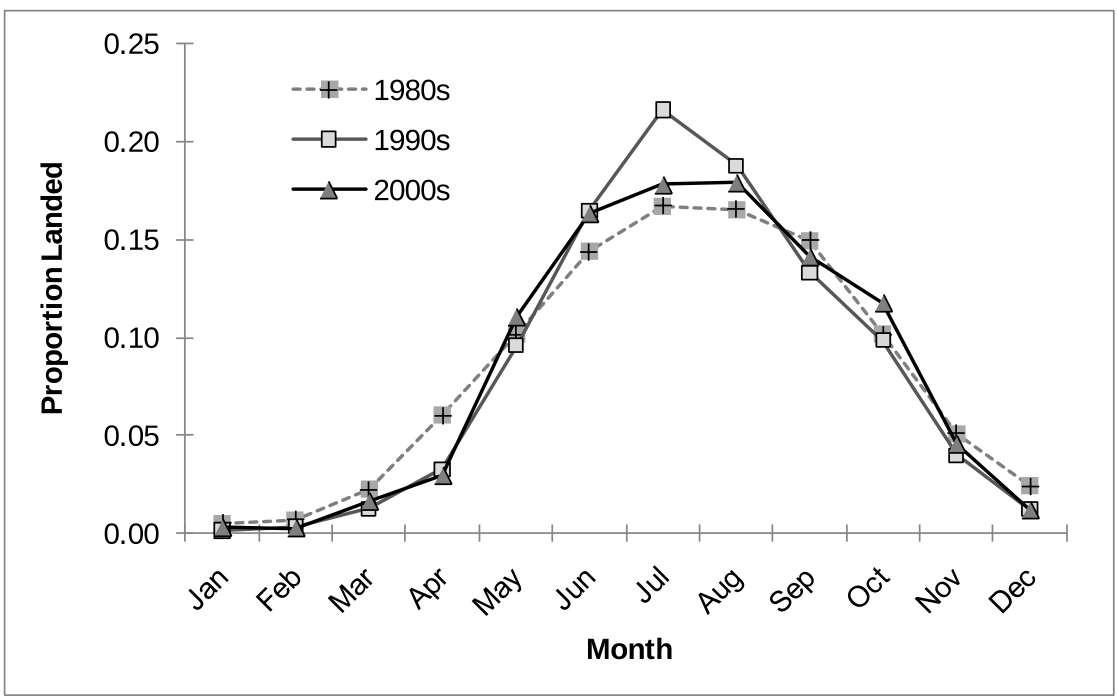


Figure 1.7. Proportion of blue crab commercial landings among months, by decade, 1980–2009.

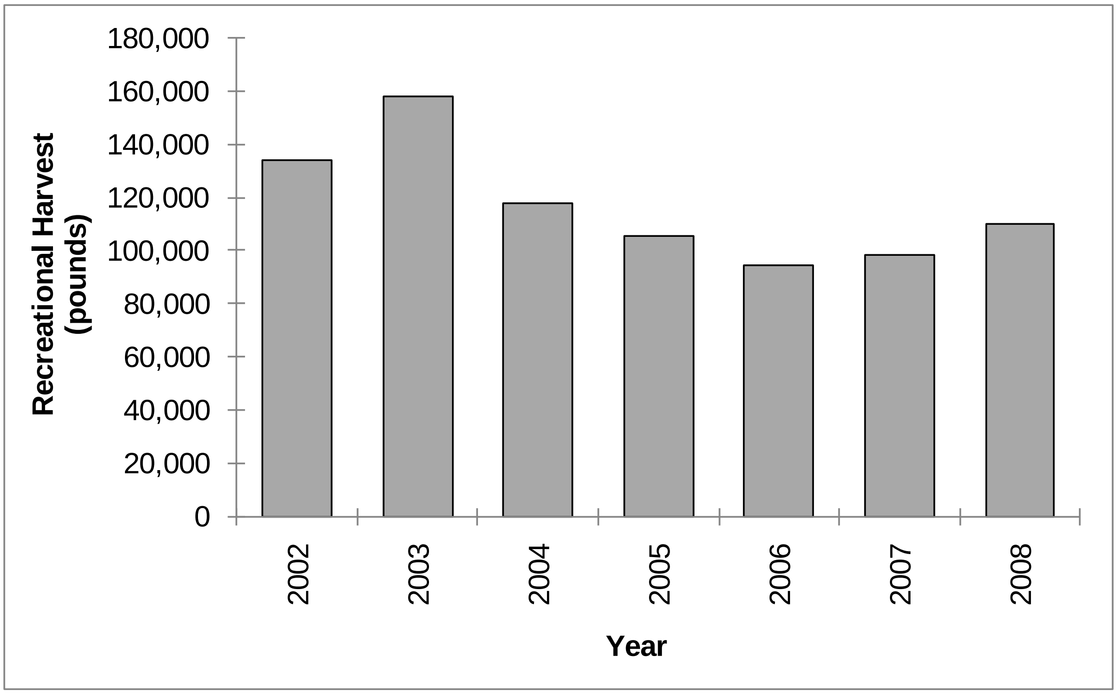


Figure 1.8. Estimated recreational harvest of blue crabs in North Carolina by RCGL license holders, 2002–2008.

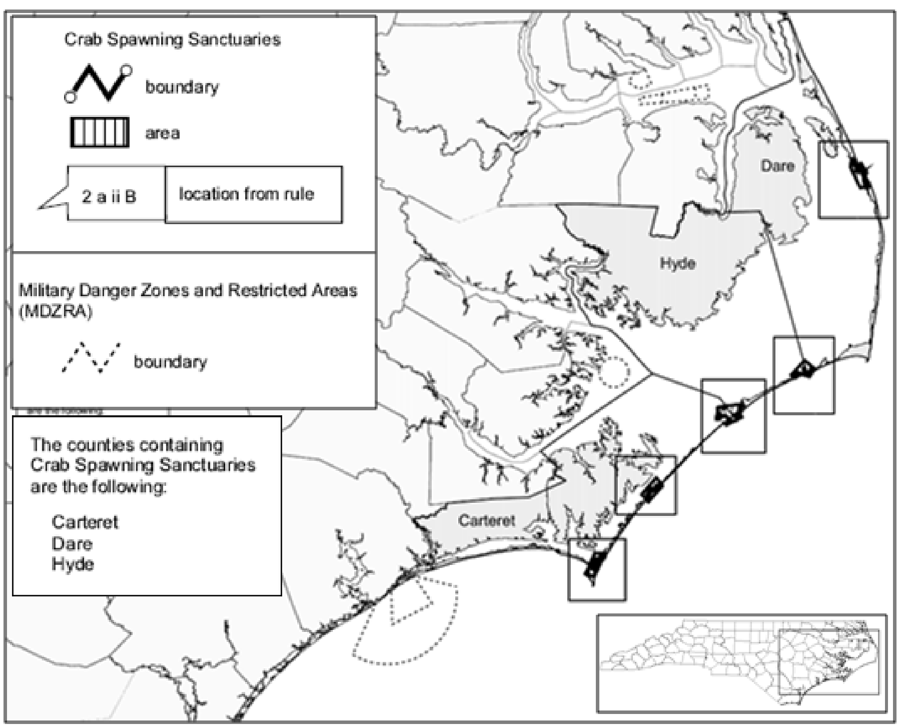


Figure 1.9. General location of blue crab spawning sanctuary areas designated by NCDMF for the protection of mature female crabs (15 NCAC 03L .0205; 15 NCAC 03R .0110).

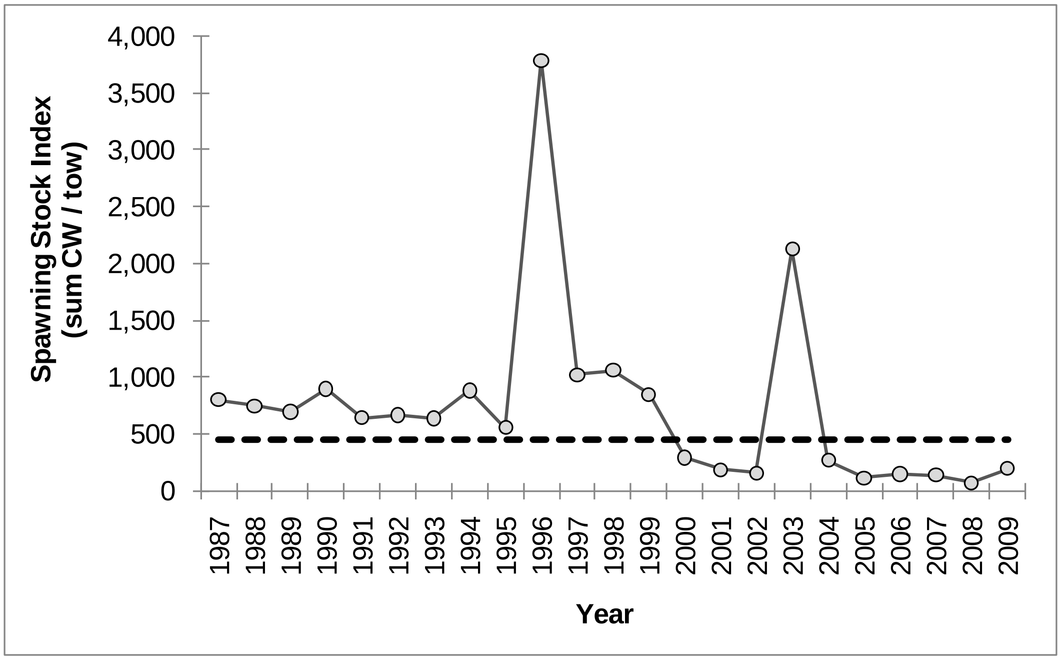


Figure 1.10. Spawning stock index adopted for evaluating management trigger in the 2004 amendment to the North Carolina Blue Crab FMP. The dashed line represents the lower 90% confidence limit of the reference baseline average (1987–2003). When the spawning stock index falls below this line for two consecutive years, the NCDMF has the proclamation authority to implement spawning stock protection measures.

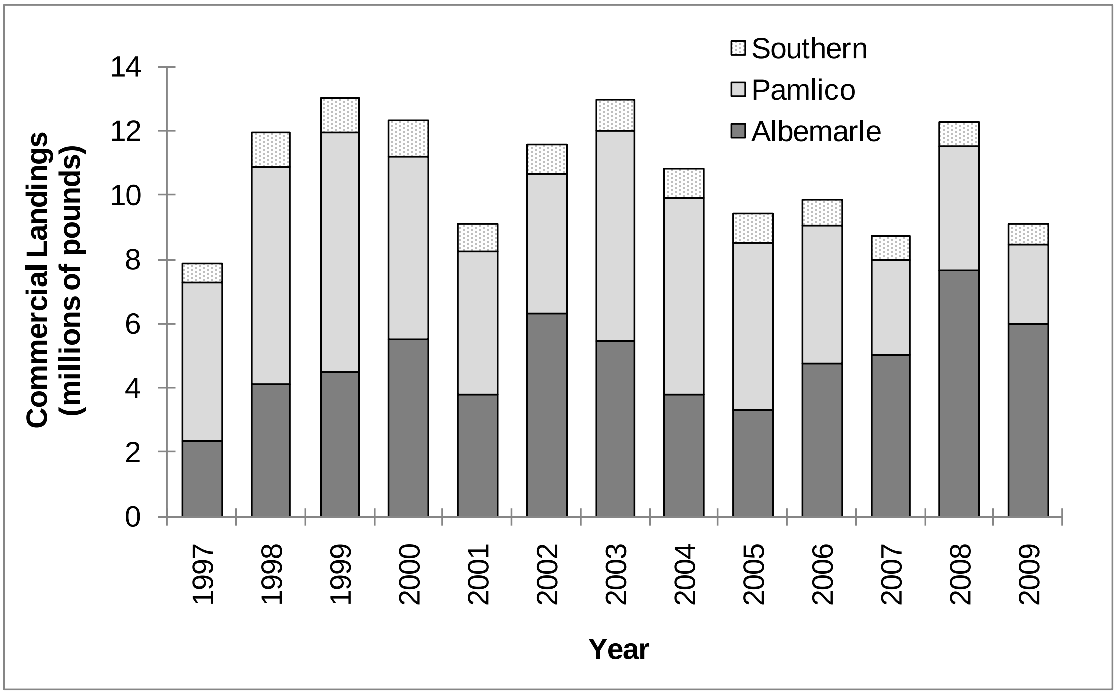


Figure 2.1. North Carolina's annual blue crab pot landings reported by commercial fishermen that have had at least 15 years experience, by harvest area, 1997–2009.

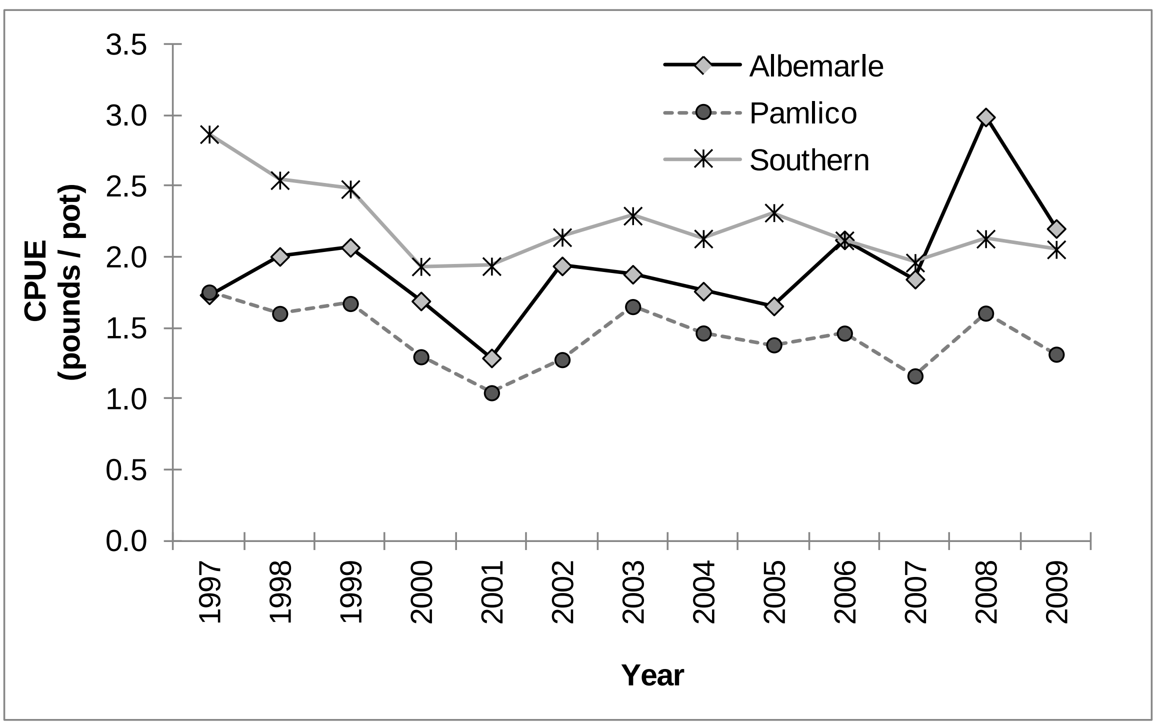


Figure 2.2. Annual index of commercial fishery catch per unit effort (CPUE) for blue crabs landed in North Carolina, by harvest area, 1997–2009. The CPUE indices are based on pot landings reported by fishermen that have had at least 15 years experience.

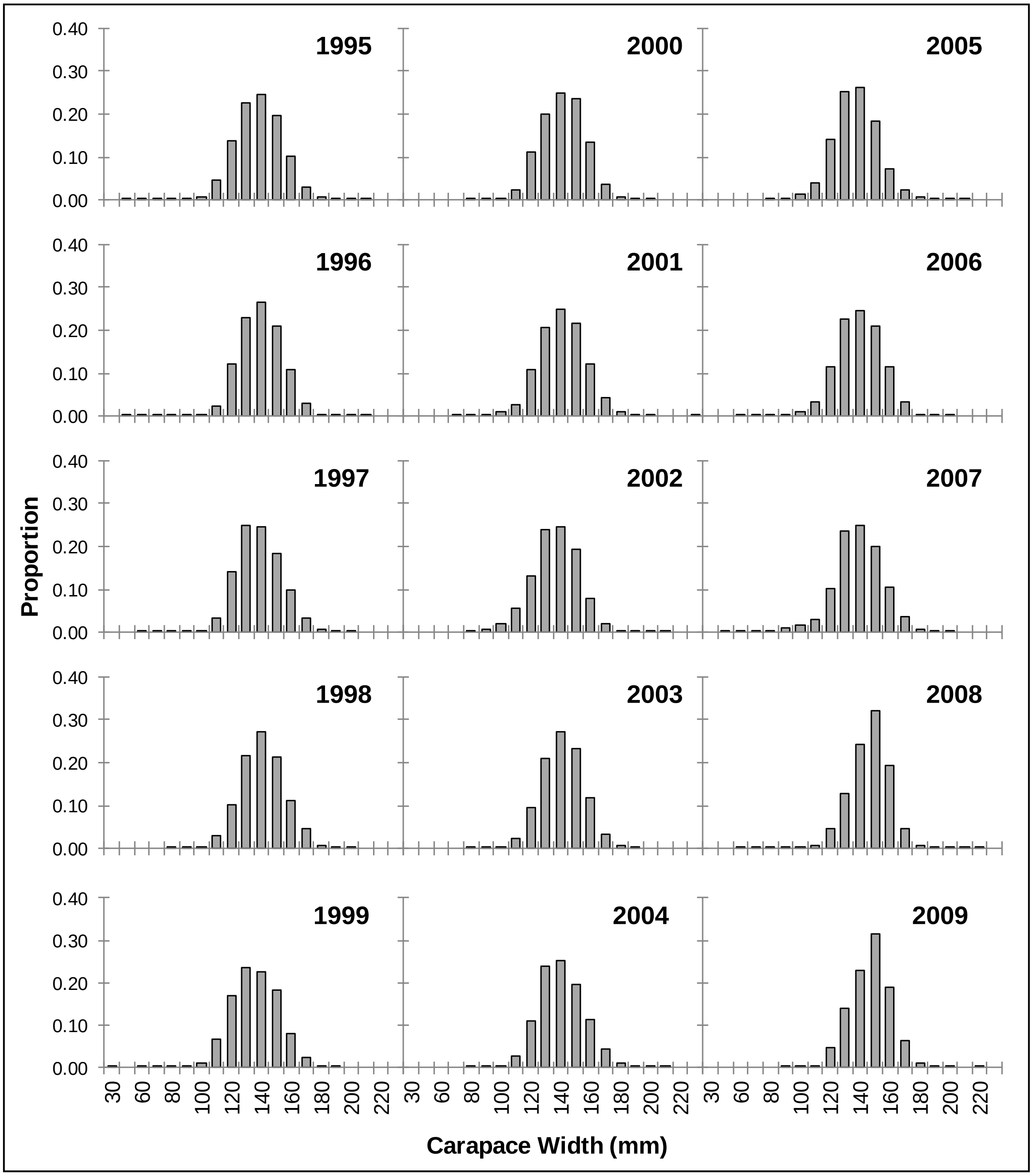

1995
2000
2005
1996
2001
2006
1997
2002
2007
1998
2003
2008
1999
2004
2009
Proportion
0.40
0.30
0.20
0.10
0.00
30 60 80 100 120 140 160 180 200 220
Carapace Width (mm)

Figure 2.3. Annual length-frequency distributions of blue crabs landed by commercial fisheries in North Carolina, 1995–2009.

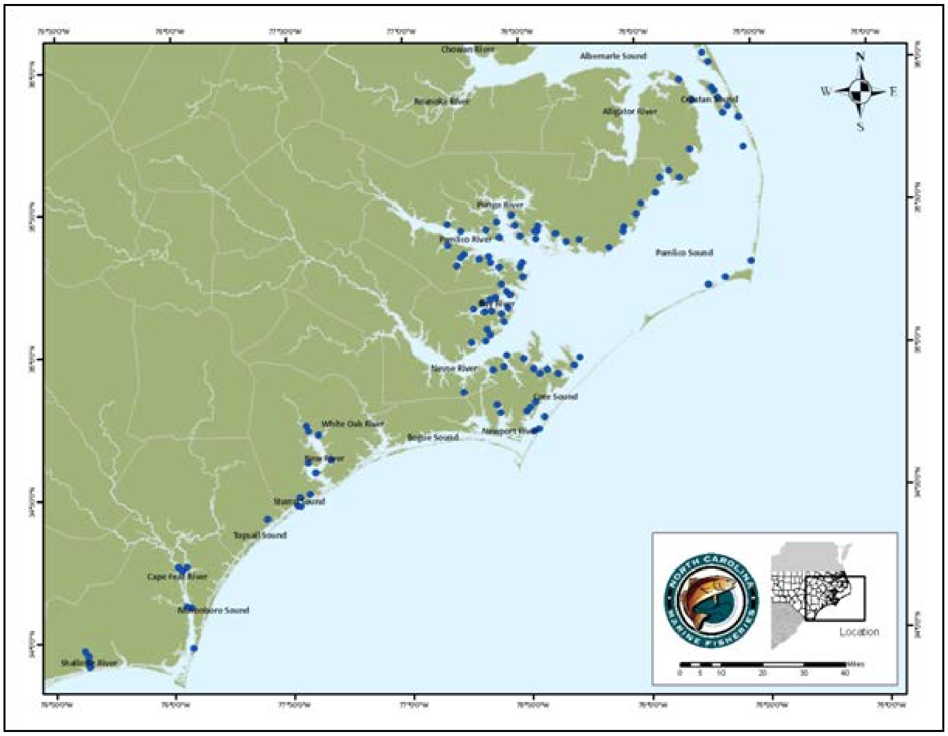


Figure 2.4. Locations of core stations sampled by NCDMF Program 120.

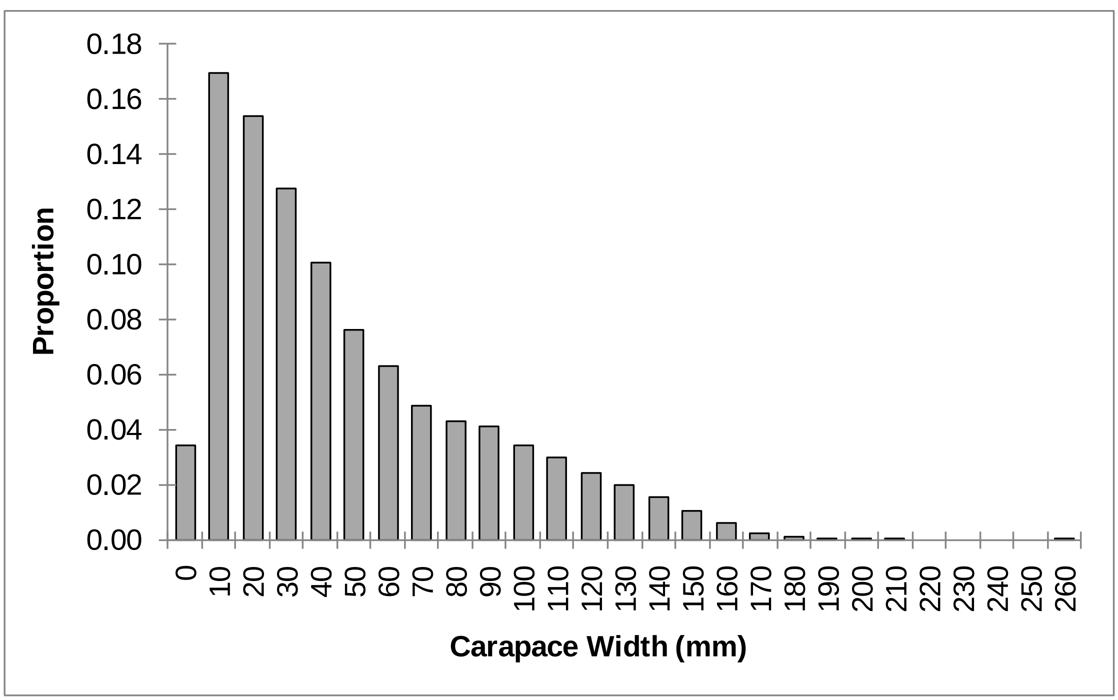


Figure 2.5. Length-frequency distribution of blue crabs collected from Pamlico Sound by NCDMF Program 120, 1978–2009.

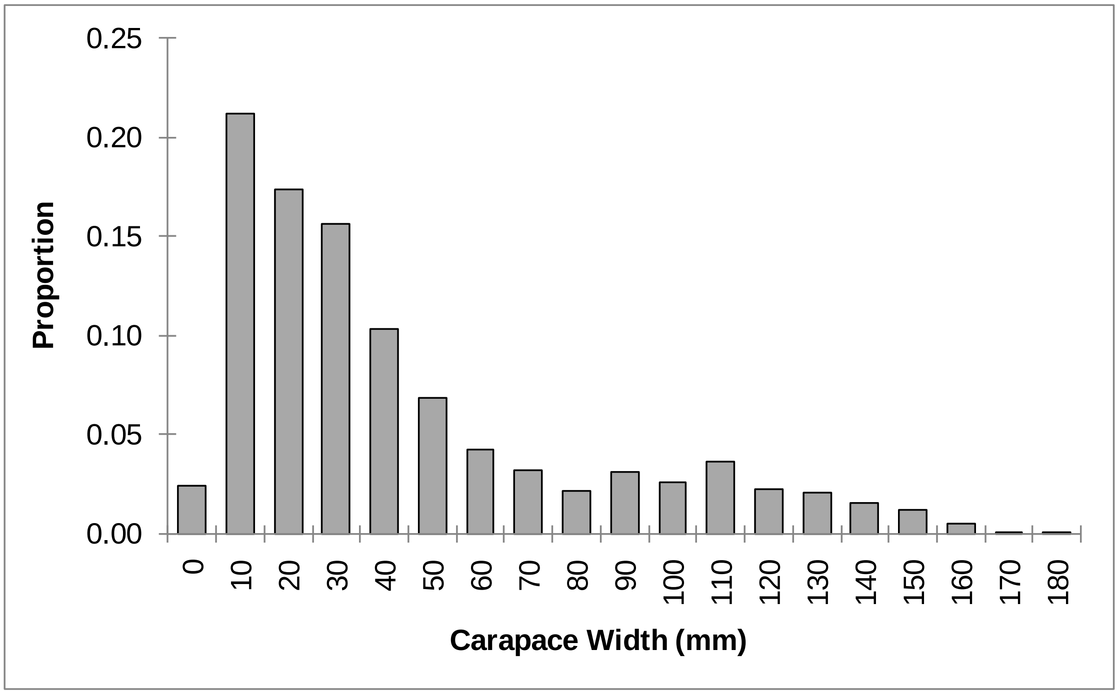


Figure 2.6. Length-frequency distribution of blue crabs collected from the Southern Region by NCDMF Program 120, 1978–2009.

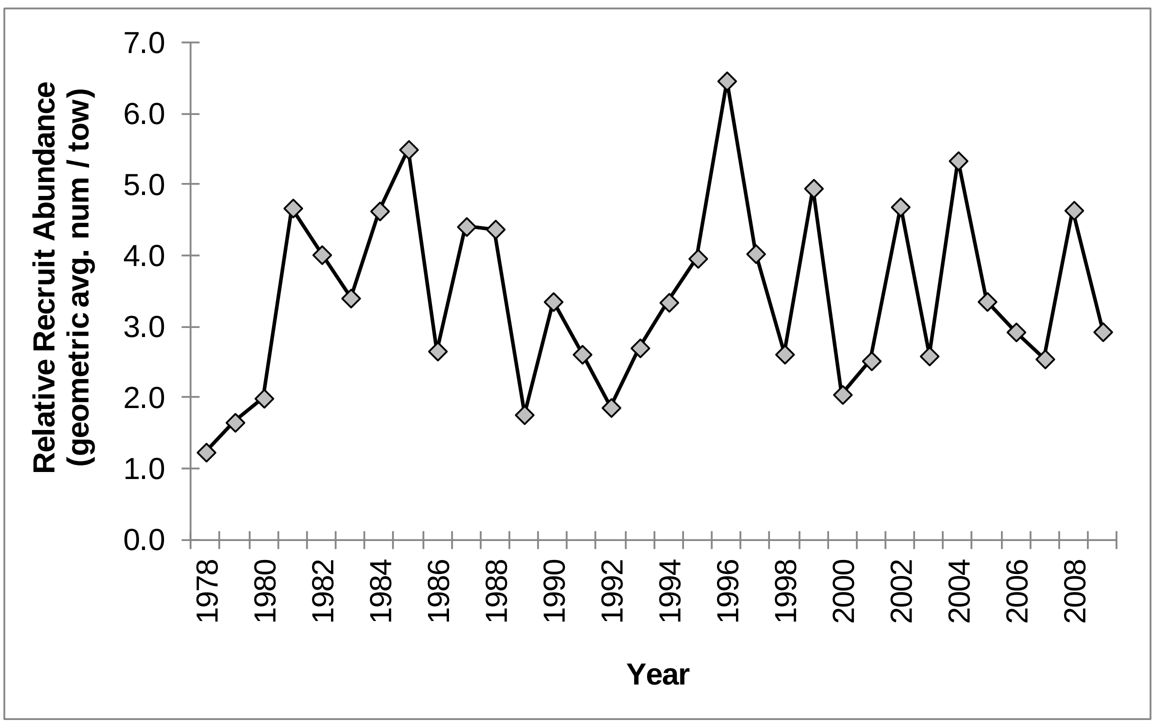


Figure 2.7. Annual index of relative recruit abundance for blue crabs collected from Pamlico Sound by NCDMF Program 120, 1978–2009.

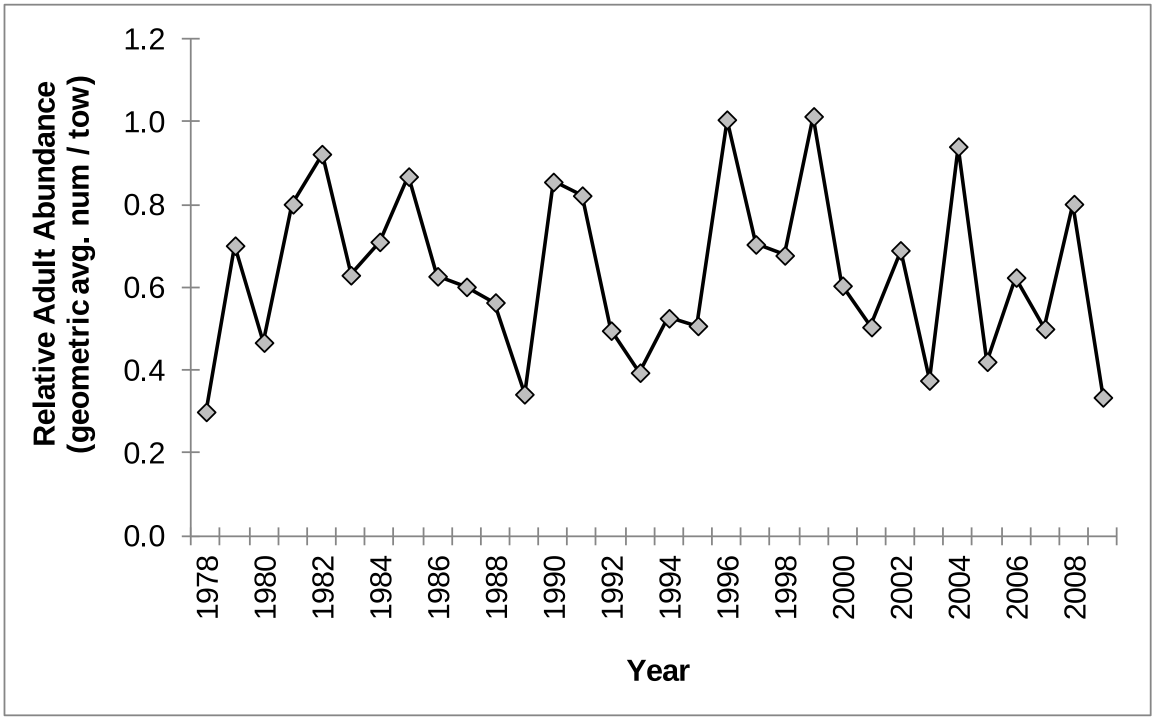


Figure 2.8. Annual index of relative adult abundance for blue crabs collected from Pamlico Sound by NCDMF Program 120, 1978–2009.

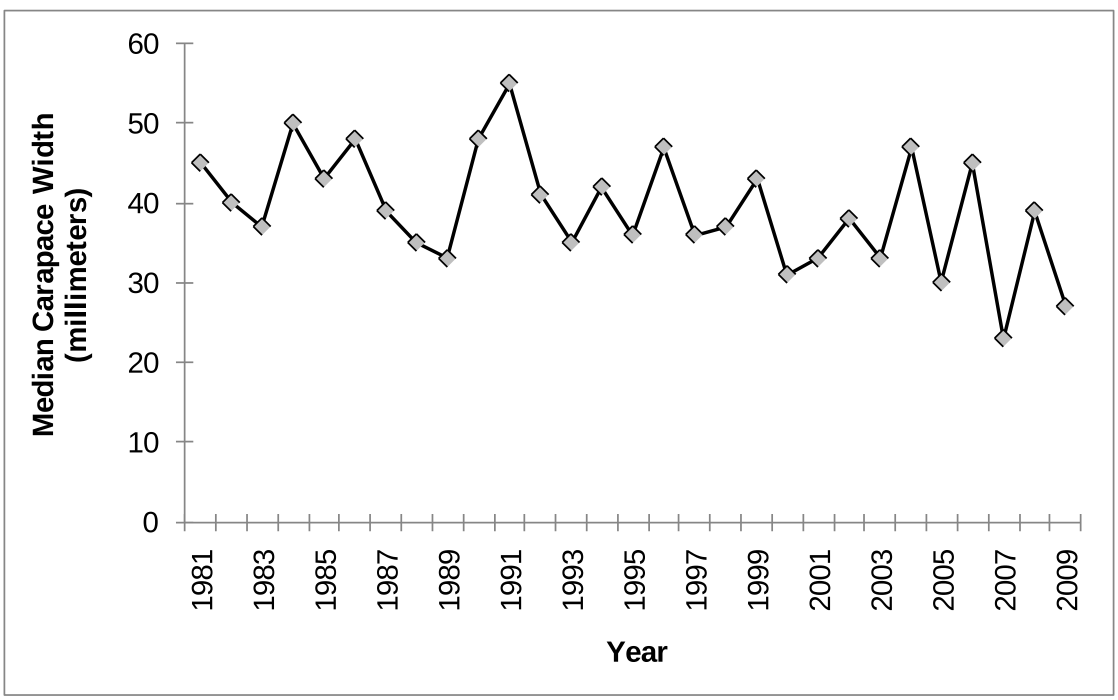


Figure 2.9. Annual median carapace widths of blue crabs collected from Pamlico Sound by NCDMF Program 120, 1981–2009.

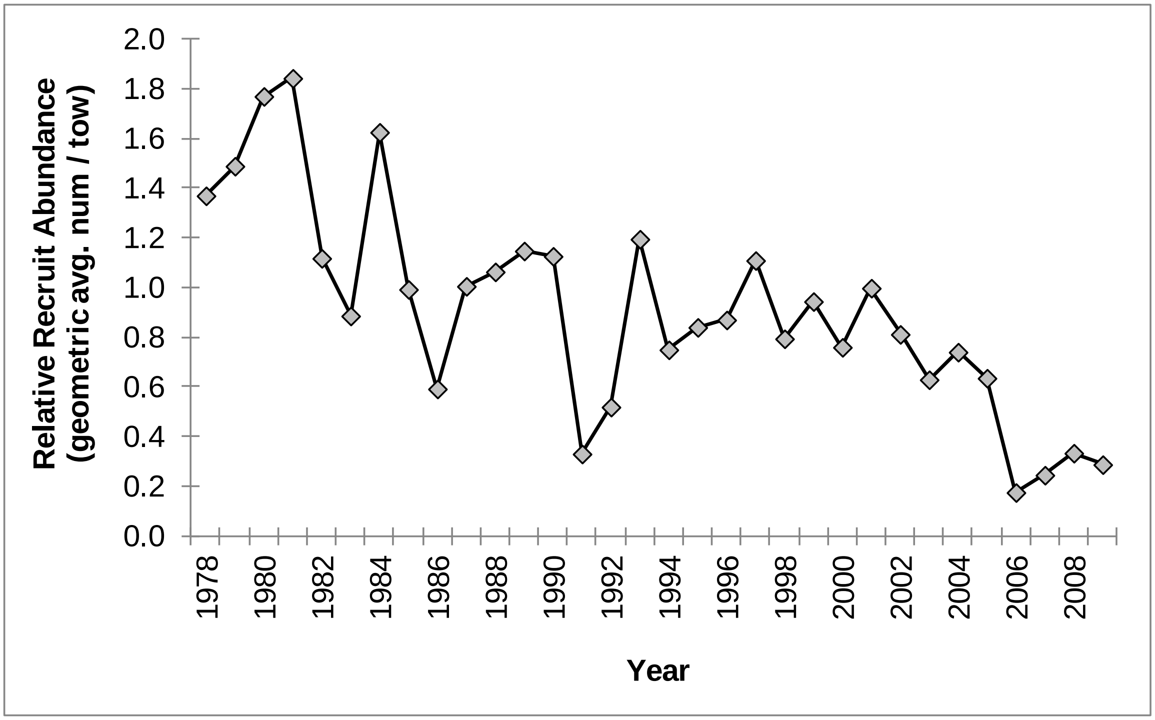


Figure 2.10. Annual index of relative recruit abundance for blue crabs collected from the Southern Region by NCDMF Program 120, 1978–2009.

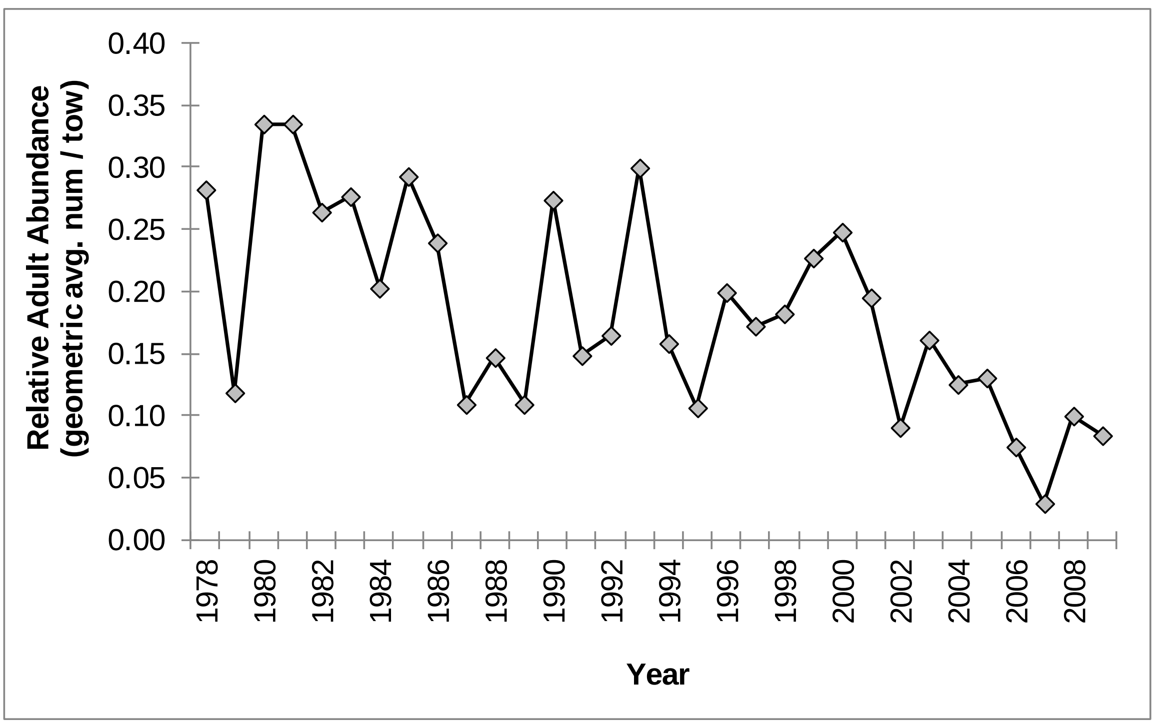
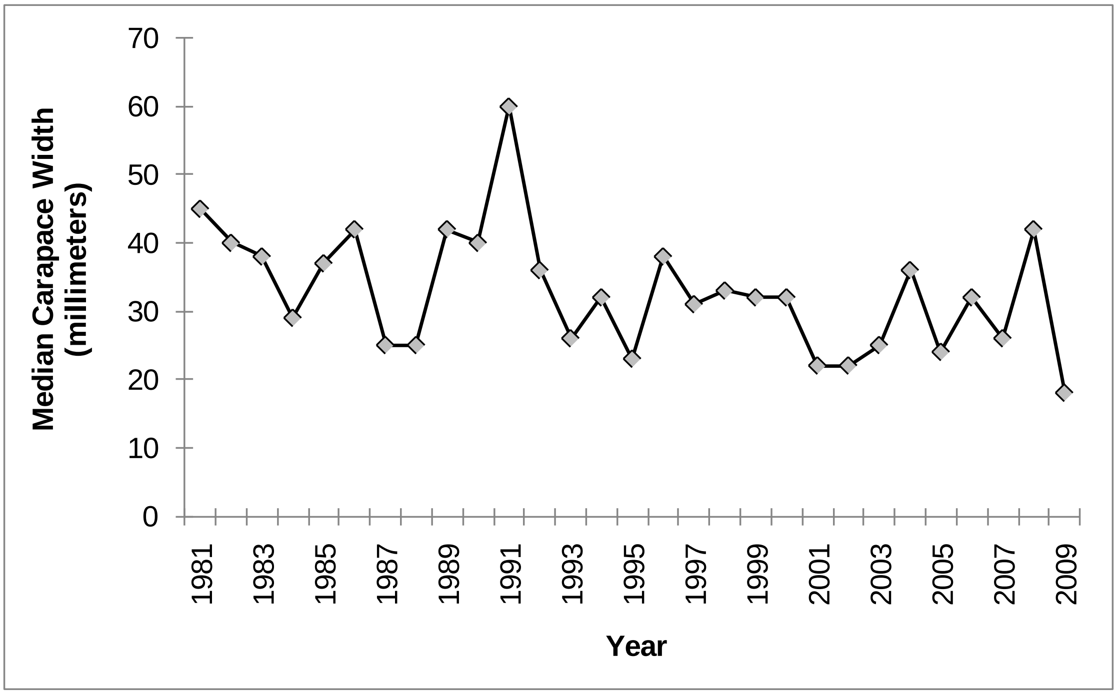


Figure 2.11. Annual index of relative adult abundance for blue crabs collected from the Southern Region by NCDMF Program 120, 1978–2009.



Median Carapace Width (millimeters)
70
60
50
40
30
20
10
0
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
Year

Figure 2.12. Annual median carapace widths of blue crabs collected from the Southern Region by NCDMF Program 120, 1981–2009.

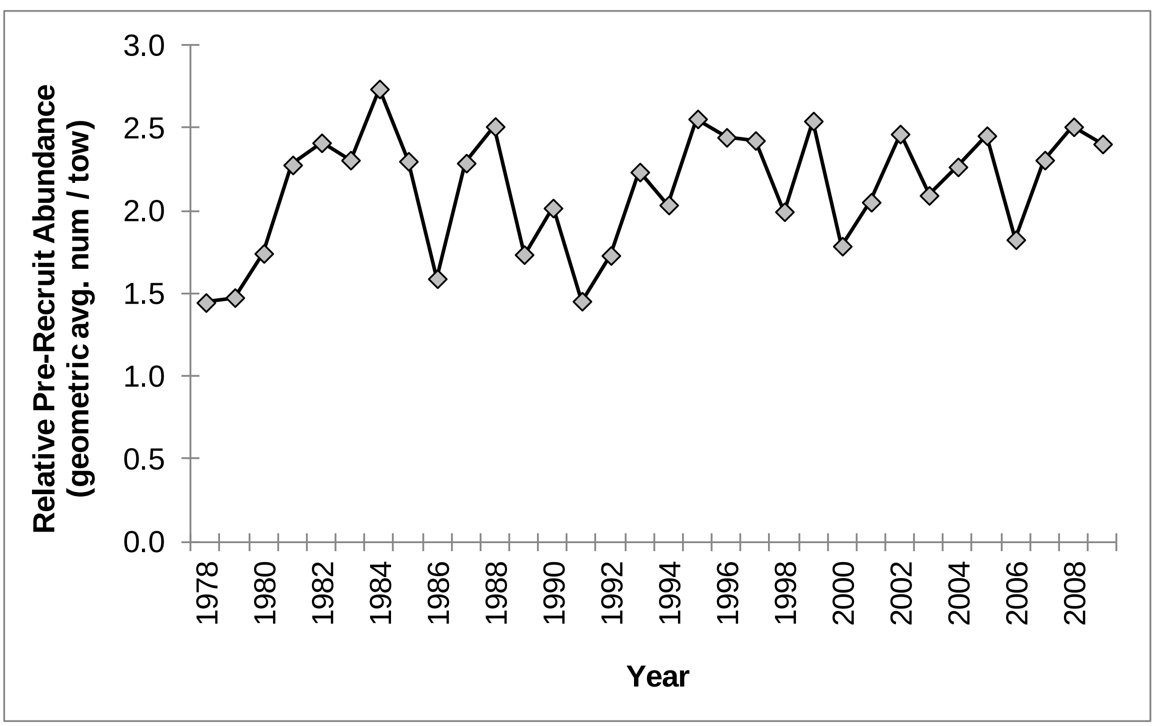


Figure 2.13. Annual index of relative pre-recruit (<30 mm CW) abundance for blue crabs collected from all areas by NCDMF Program 120, 1978–2009.

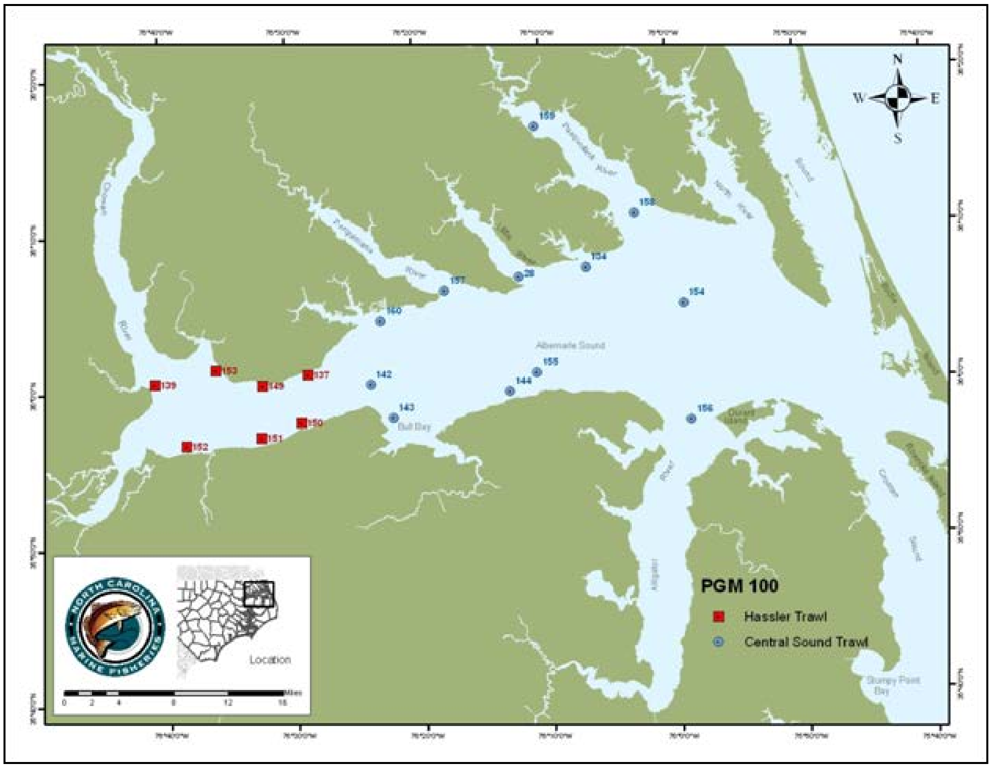

PGM 100
Hassler Trawl
Central Sound Trawl
Albemarle Sound
Location
N
S
E
W

Figure 2.14. Locations of sites in Albemarle Sound sampled by NCDMF Program 100.

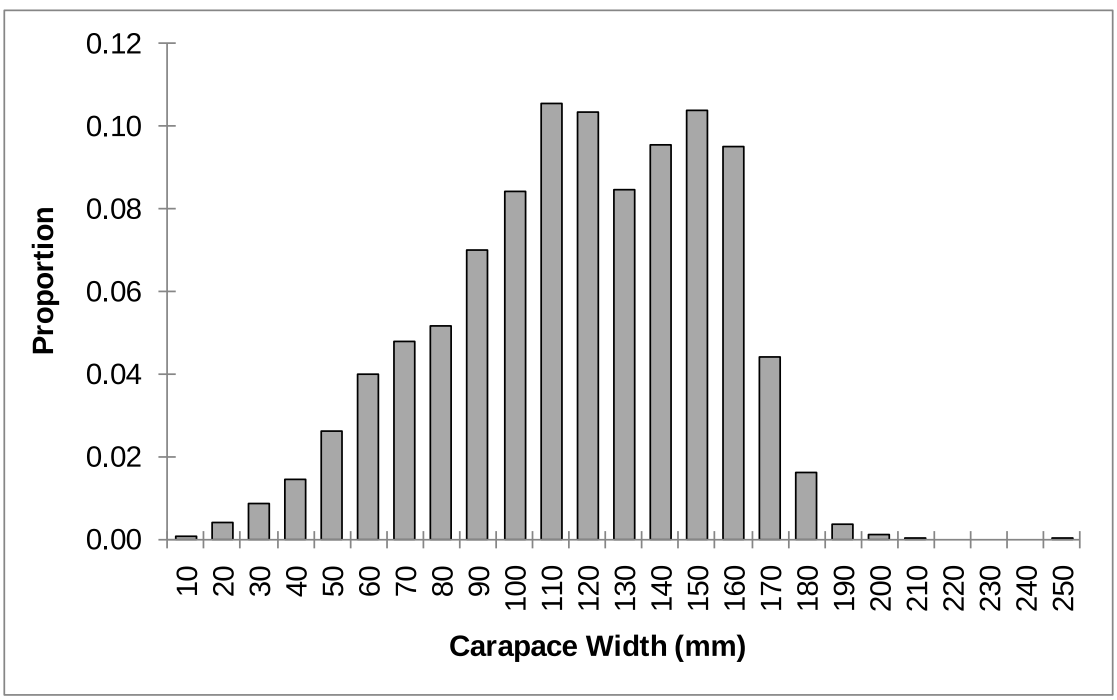


Figure 2.15. Length-frequency distribution of blue crabs collected by NCDMF Program 100, 1987–2009.

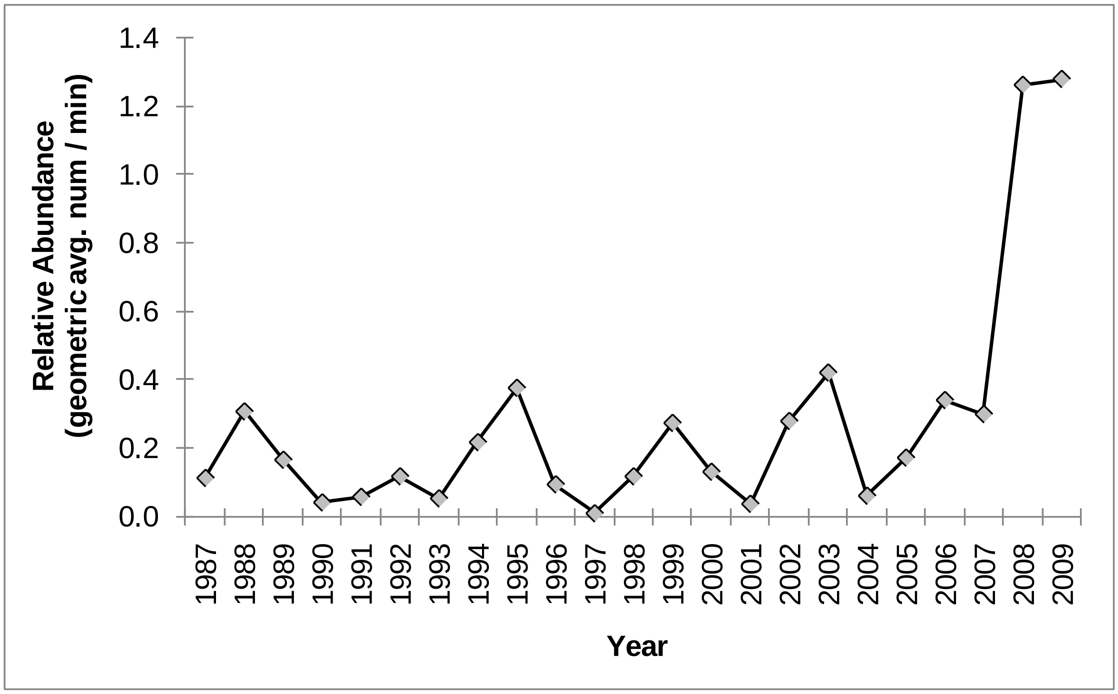


Figure 2.16. Annual index of relative abundance for blue crabs (all sizes) collected from Albemarle Sound by NCDMF Program 100, 1987–2009.

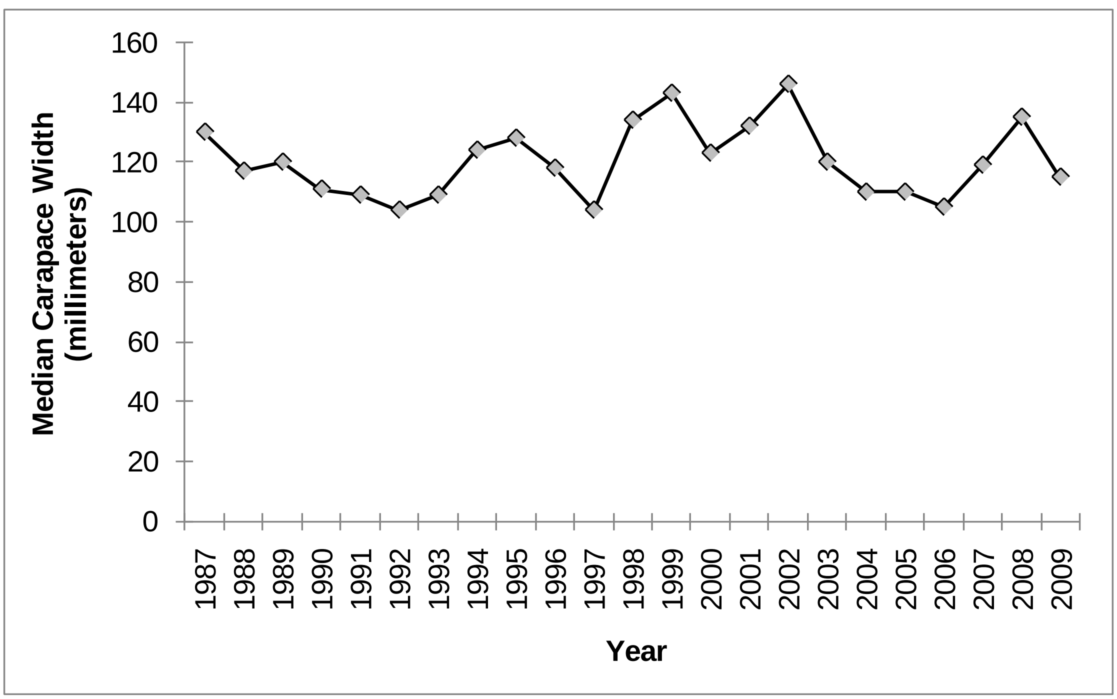


Figure 2.17. Annual median carapace widths of blue crabs collected from Albemarle Sound by NCDMF Program 100, 1987–2009.

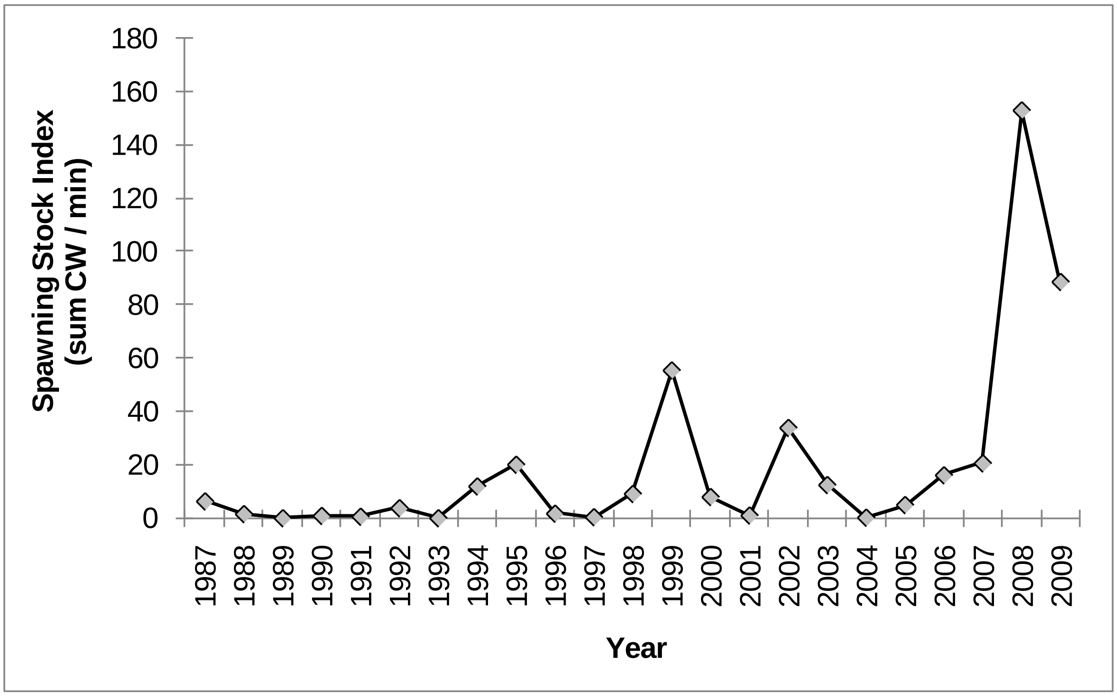


Figure 2.18. Annual spawning stock index for female blue crabs collected from Albemarle Sound by NCDMF Program 100, 1987–2009.

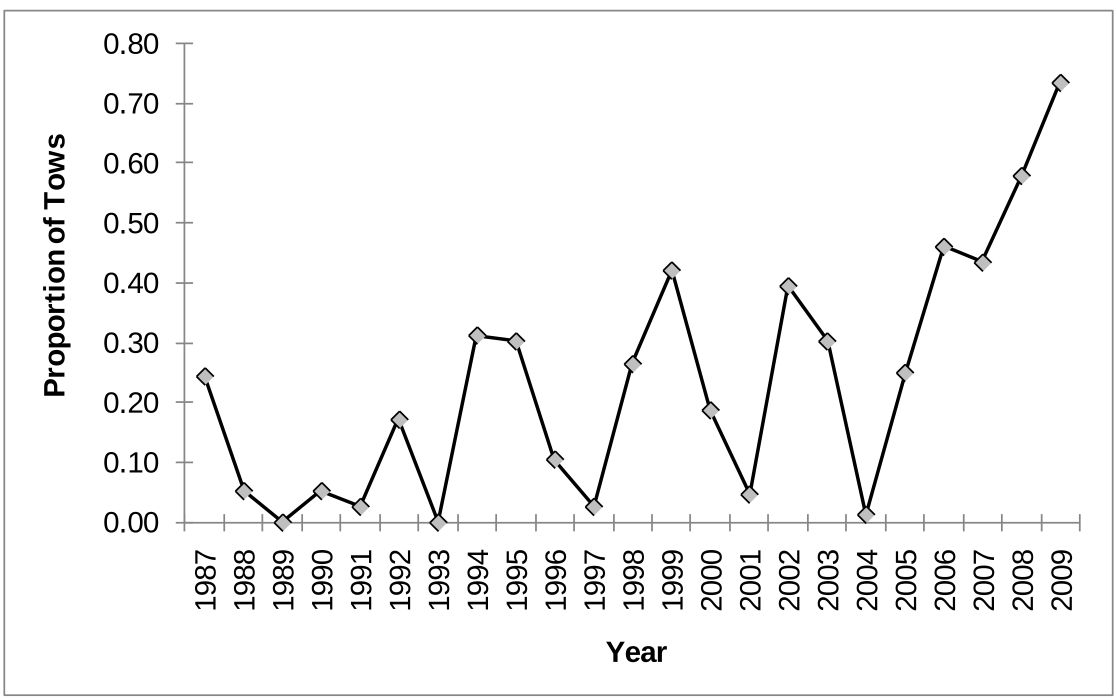


Figure 2.19. Frequency of occurrence of mature female blue crabs collected from Albemarle Sound by NCDMF Program 100, 1987–2009.

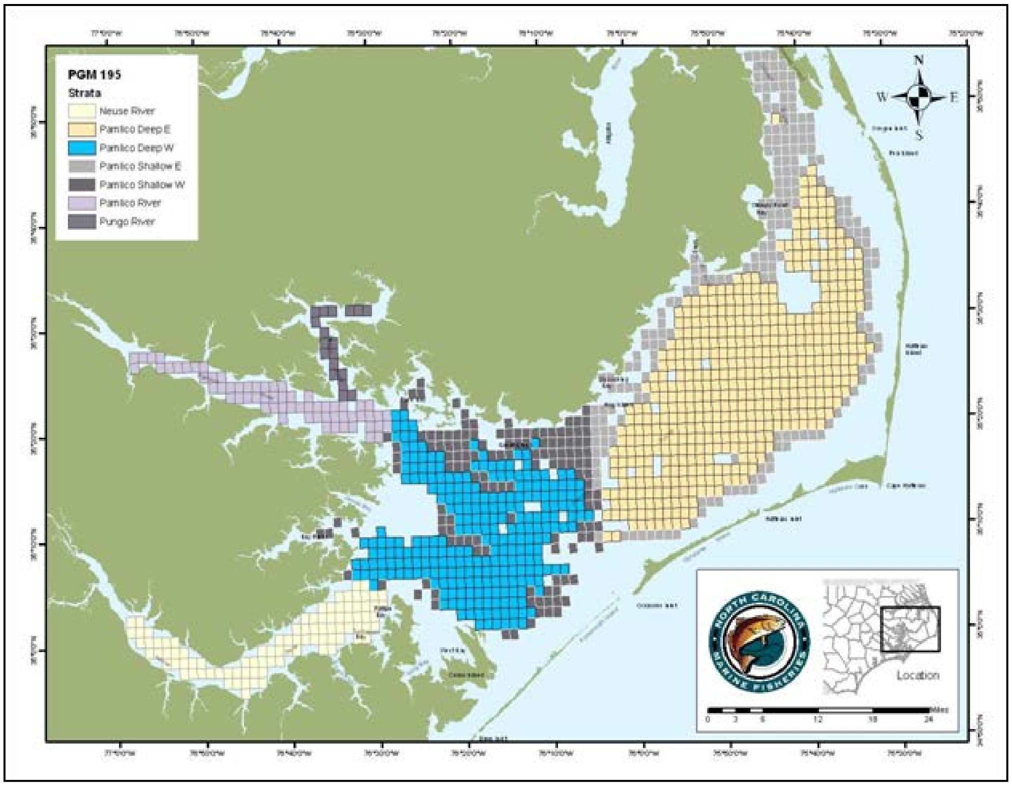


Figure 2.20. Locations of sites in Pamlico Sound sampled by NCDMF Program 195.

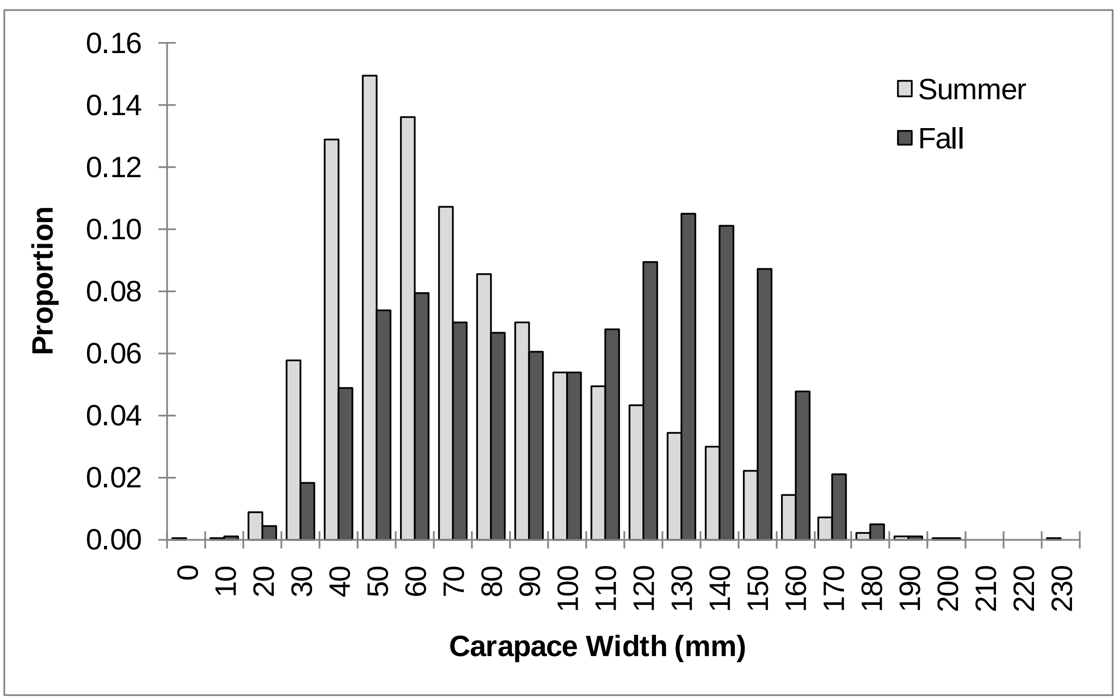


Figure 2.21. Length-frequency distribution of blue crabs collected by NCDMF Program 195, by season, 1987–2009.

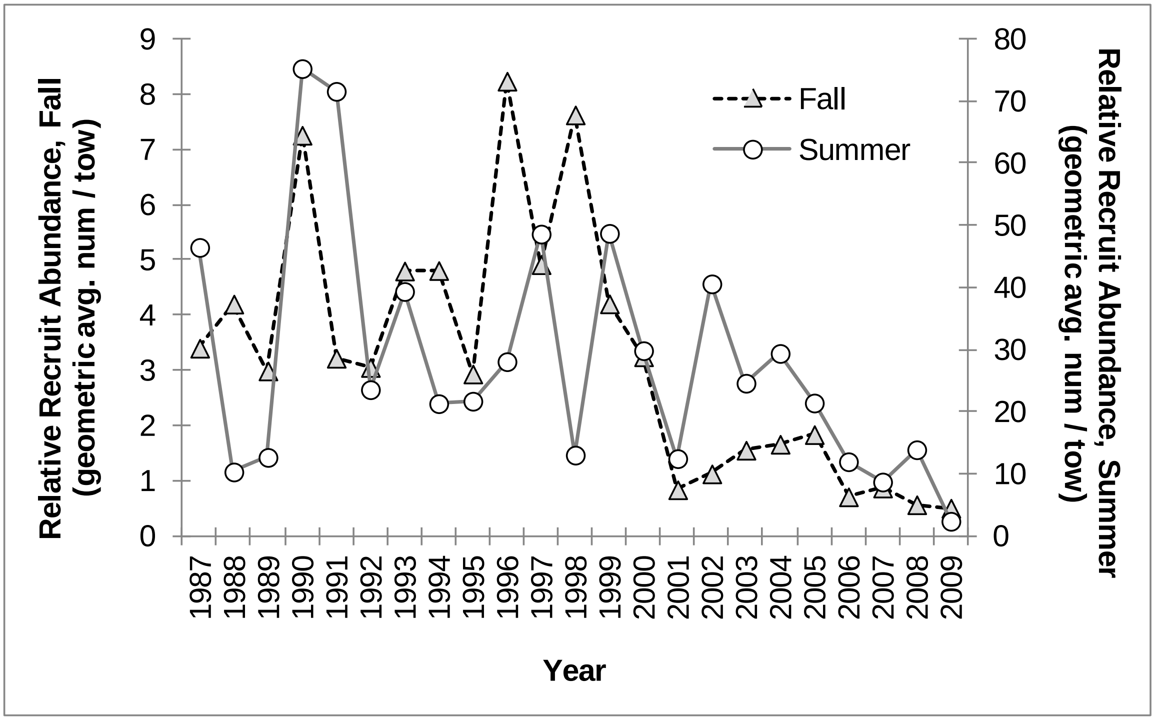


Figure 2.22. Annual index of relative recruit abundance for blue crabs collected from Pamlico Sound by NCDMF Program 195, by season, 1987–2009.

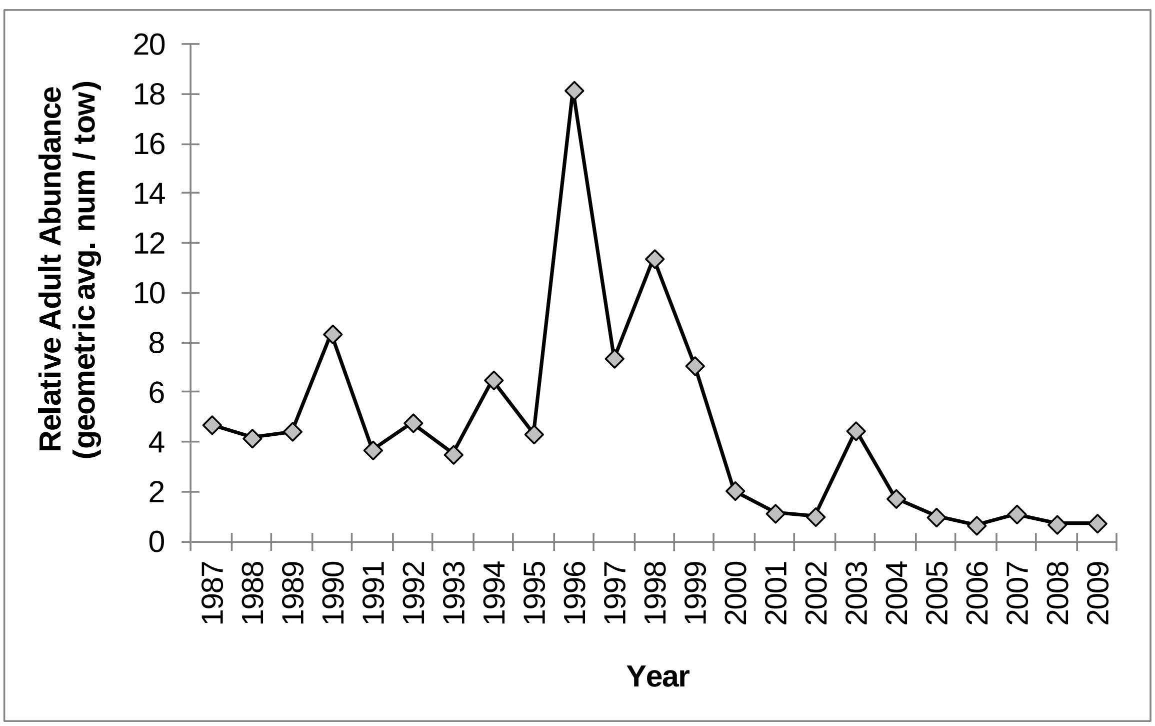


Figure 2.23. Annual index of relative adult abundance for blue crabs collected in the fall from Pamlico Sound by NCDMF Program 195, 1987–2009.

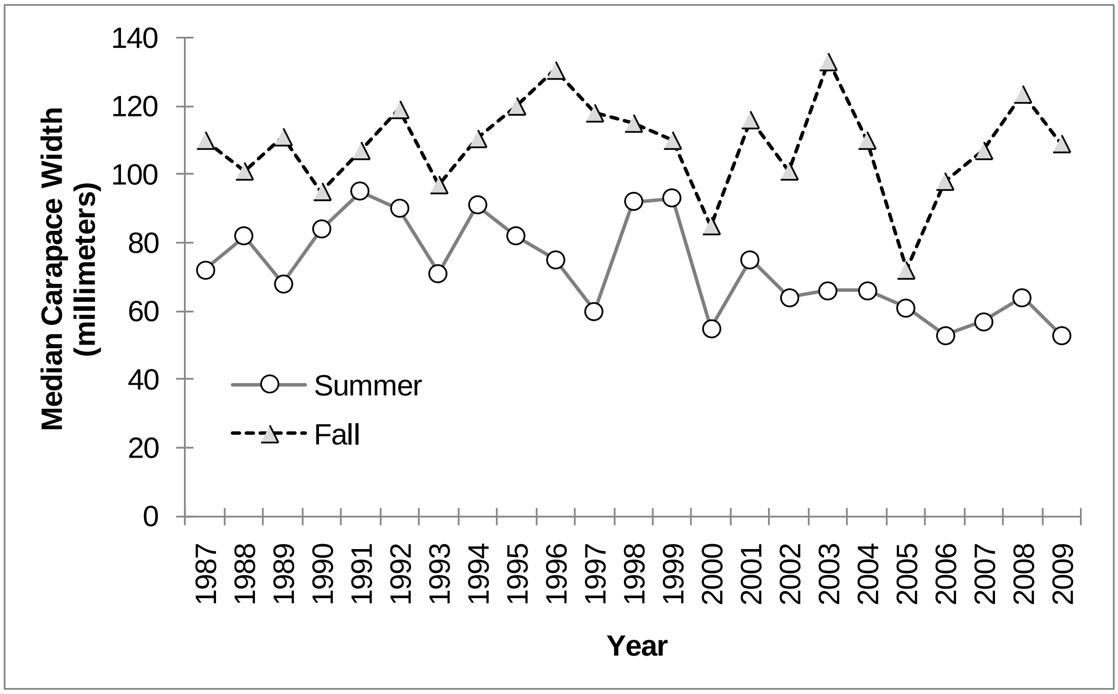

Median Carapace Width (millimeters)
140
120
100
80
60
40
20
0
Summer
Fall
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Year

Figure 2.24. Annual median carapace widths of blue crabs collected from Pamlico Sound by NCDMF Program 195, by season, 1987–2009.

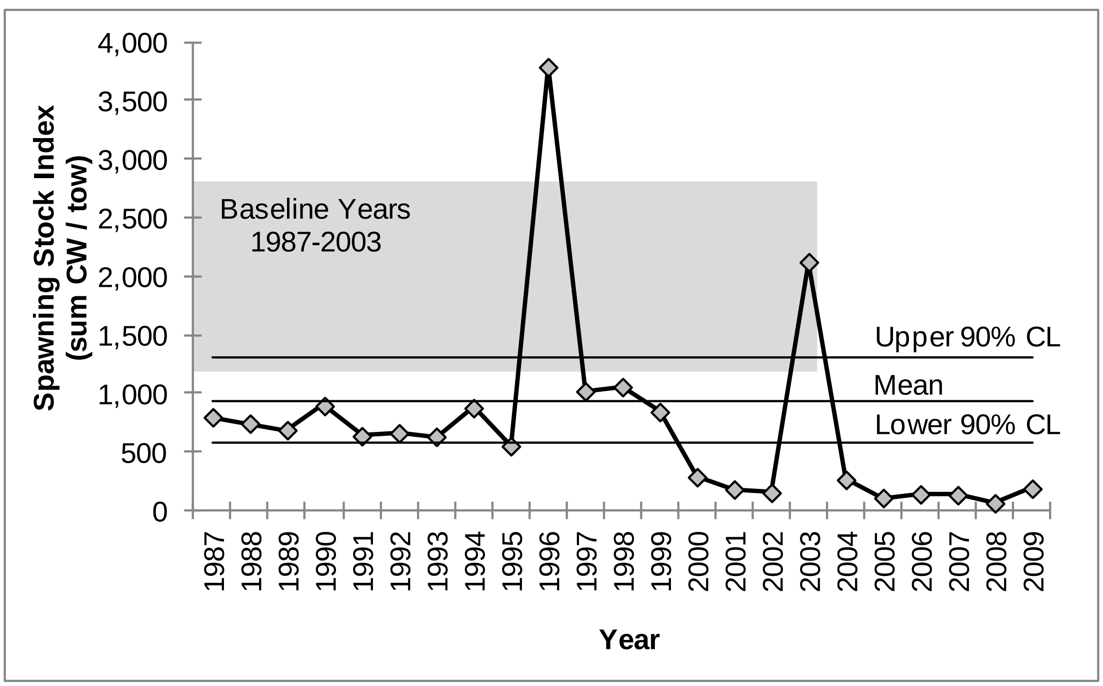


Figure 2.25. Annual spawning stock index for female blue crabs collected from Pamlico Sound by NCDMF Program 195, 1987–2009.

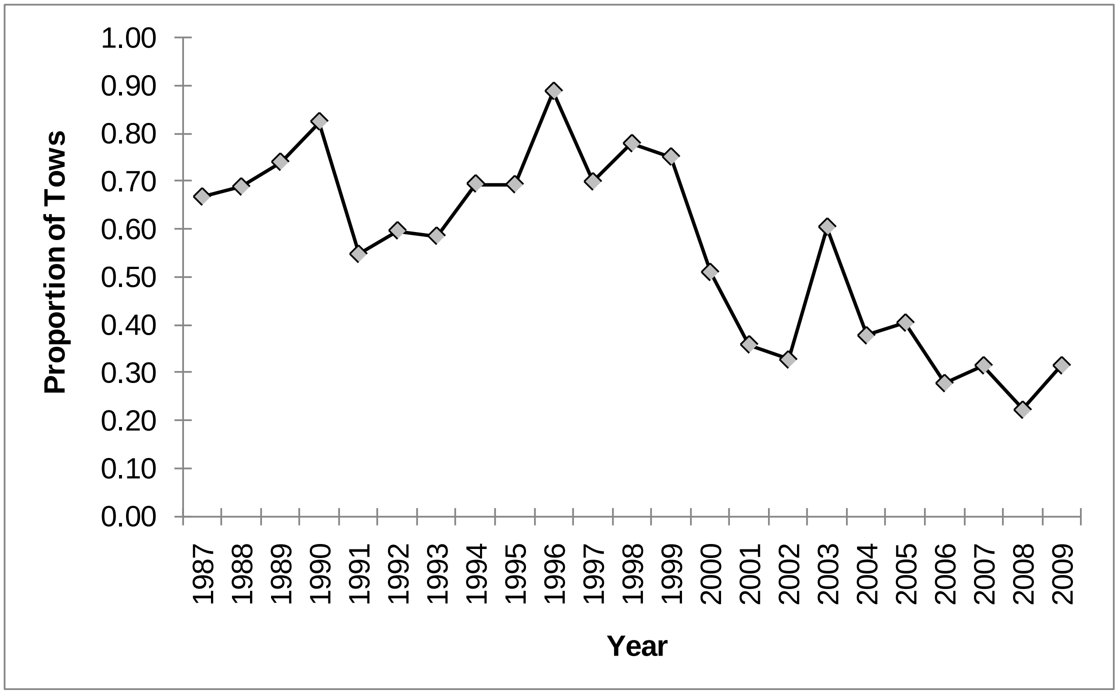


Figure 2.26. Frequency of occurrence of mature female blue crabs collected from Pamlico Sound during the fall by NCDMF Program 195, 1987–2009.

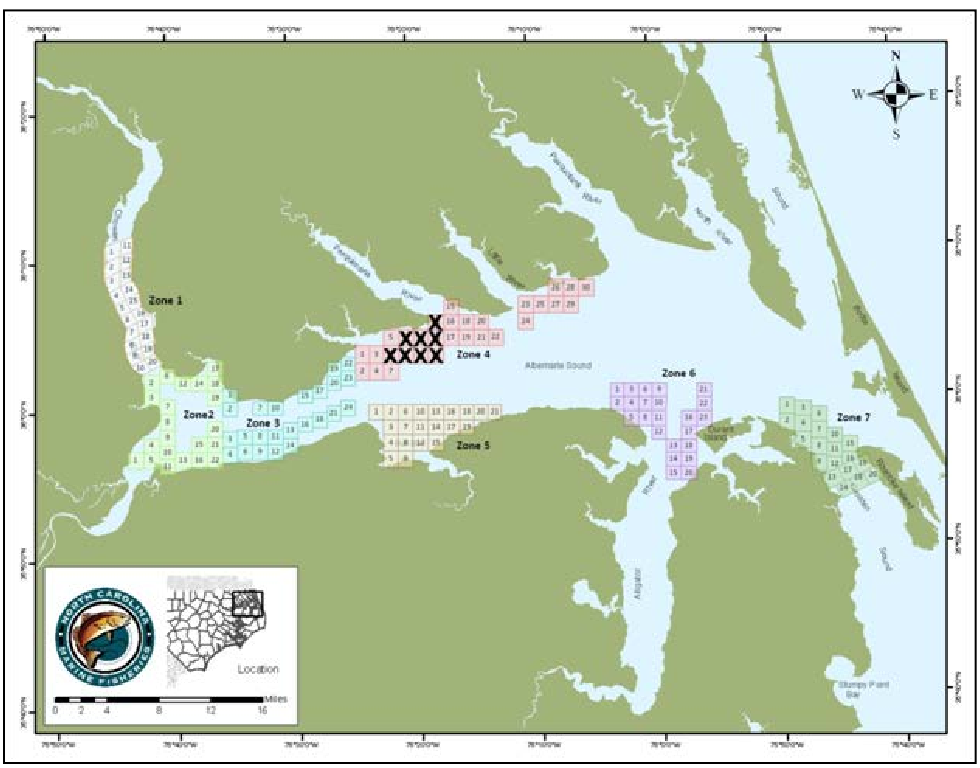


Figure 2.27. Locations of sampling zones and quadrants in Albemarle Sound sampled by NCDMF Program 135.

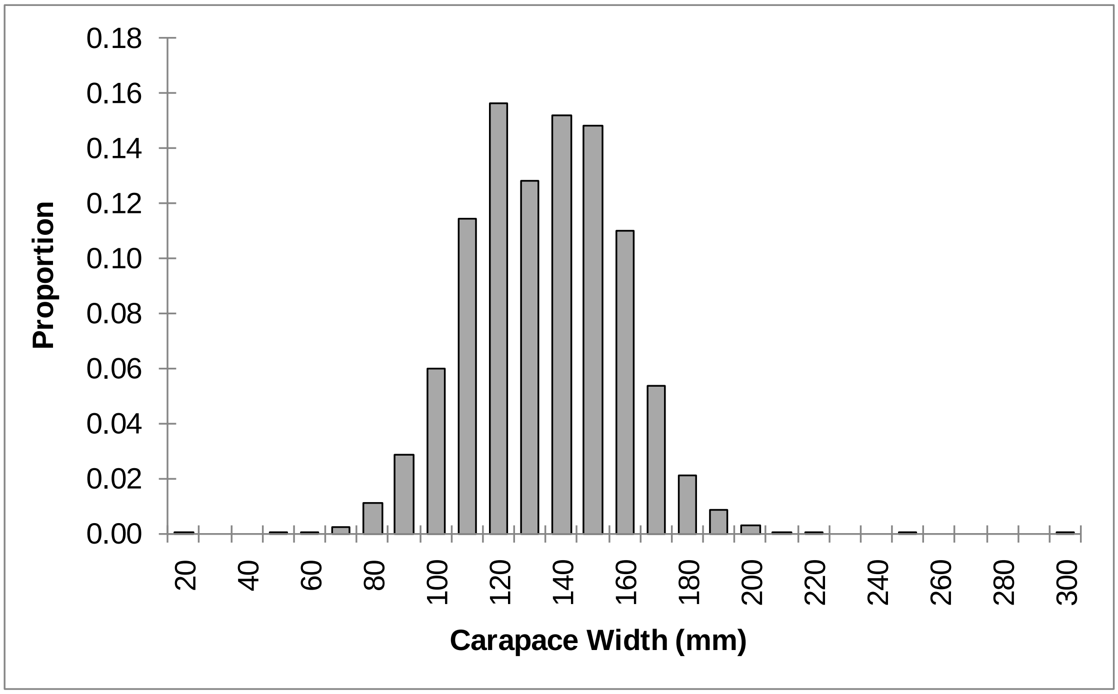


Figure 2.28. Length-frequency distribution of blue crabs collected by NCDMF Program 135, 1991–2008.

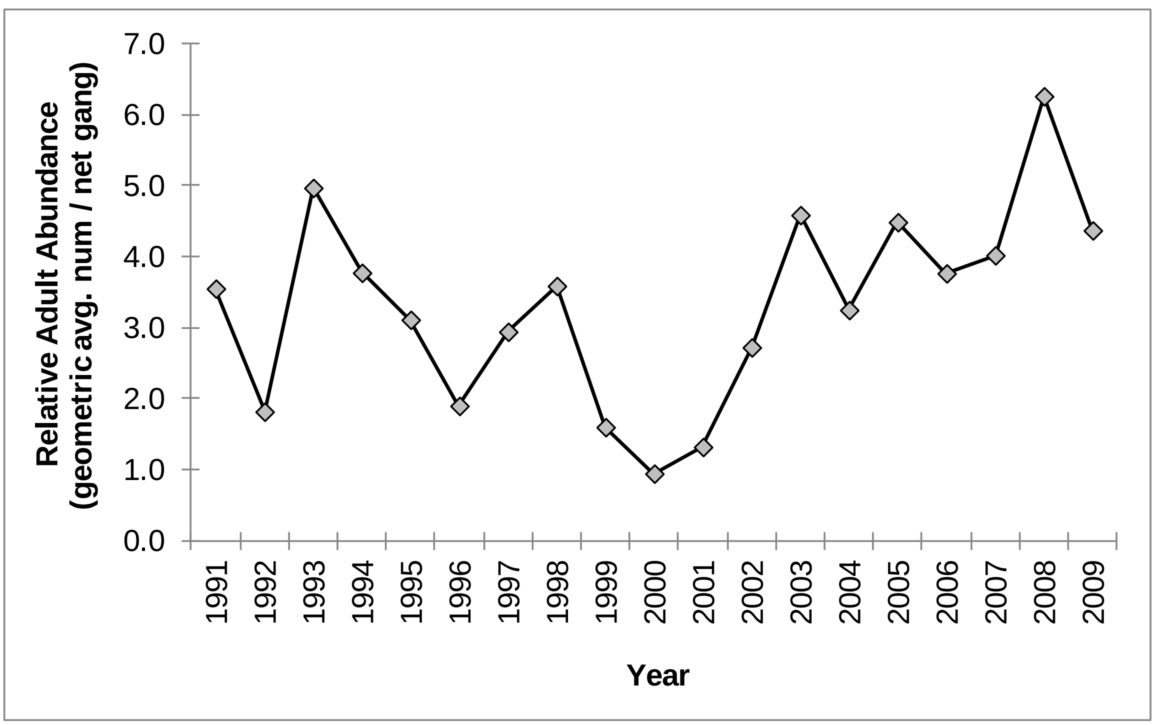


Figure 2.29. Annual index of relative adult abundance for blue crabs collected from Albemarle Sound by NCDMF Program 135, 1991–2009.

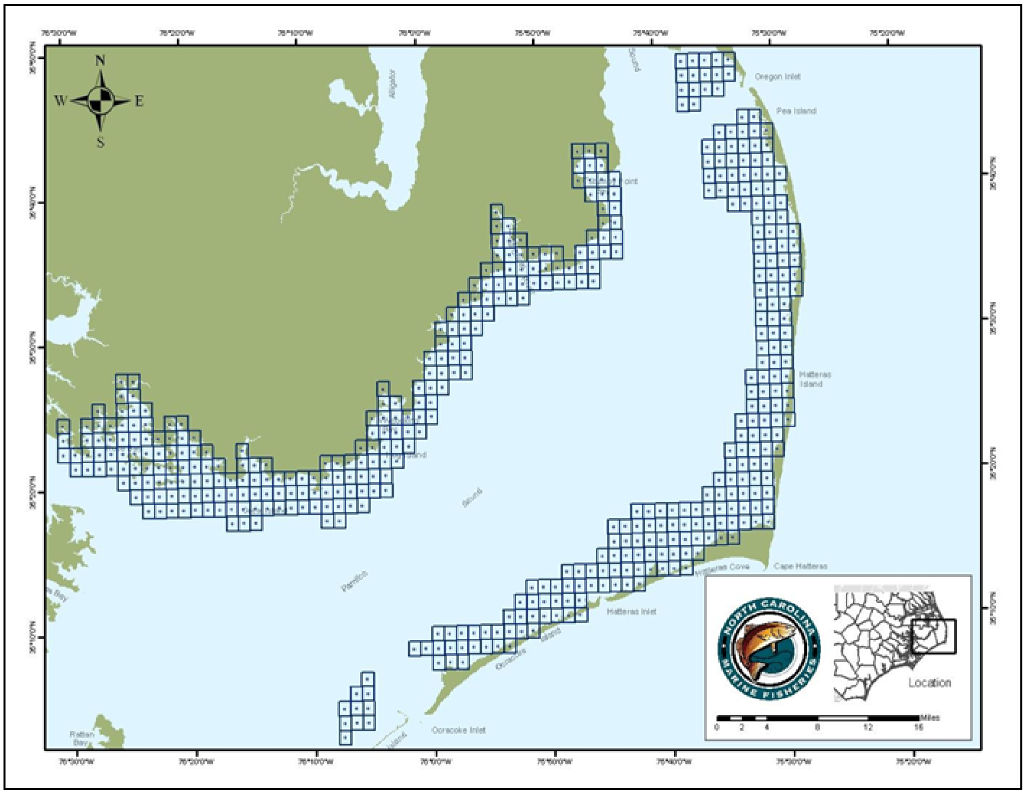


Figure 2.30. The sample regions and grid system for the Pamlico Sound portion of NCDMF Program 915.

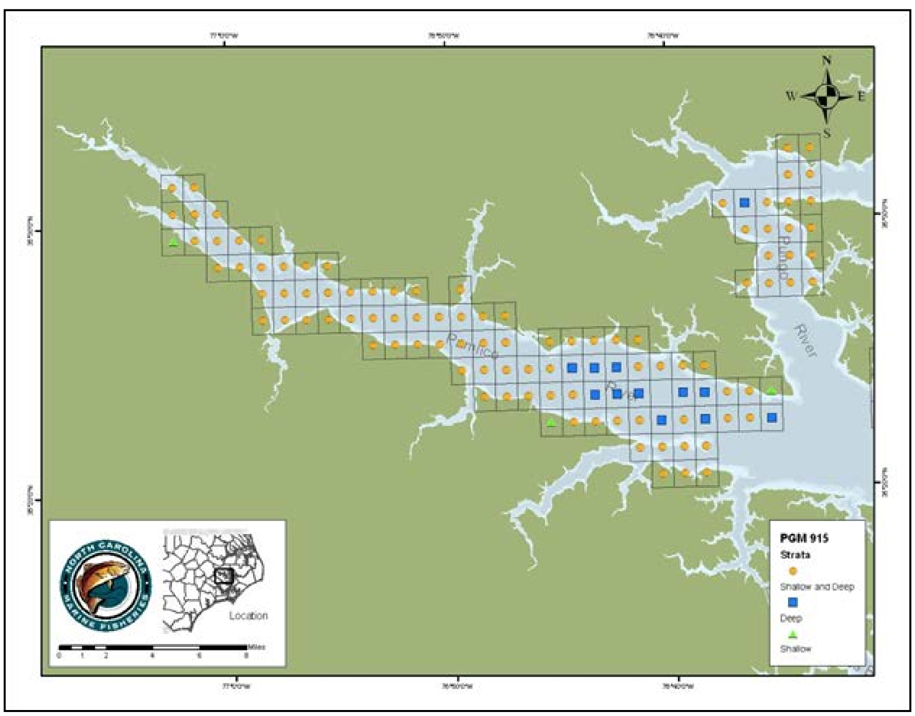


Figure 2.31. The sample regions and grid system for the Pamlico and Pungo river portions of NCDMF Program 915.

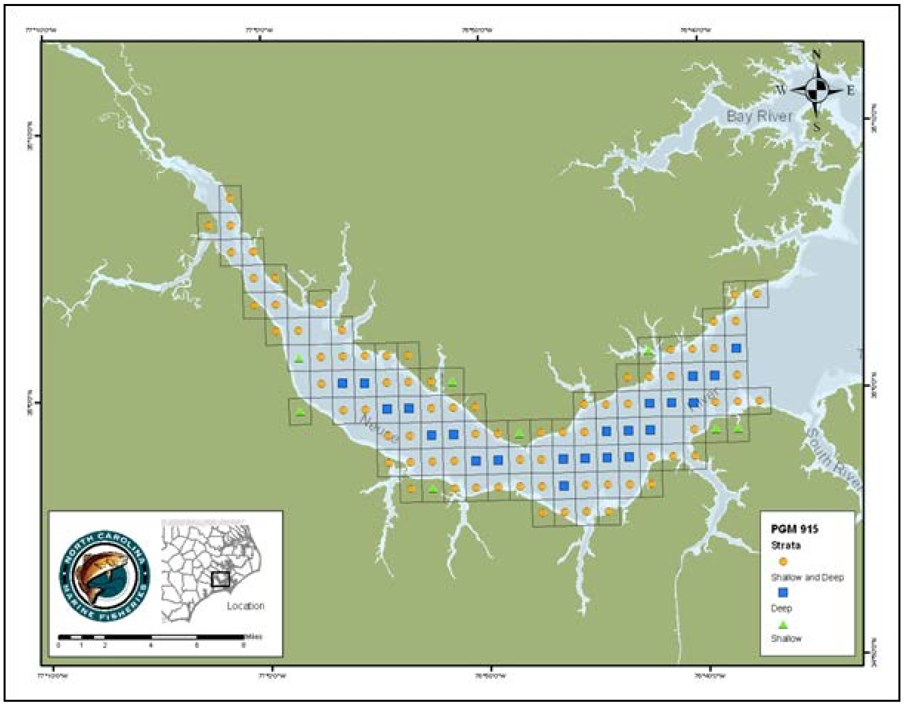


Figure 2.32. The sample regions and grid system for the Neuse River portion of NCDMF Program 915.

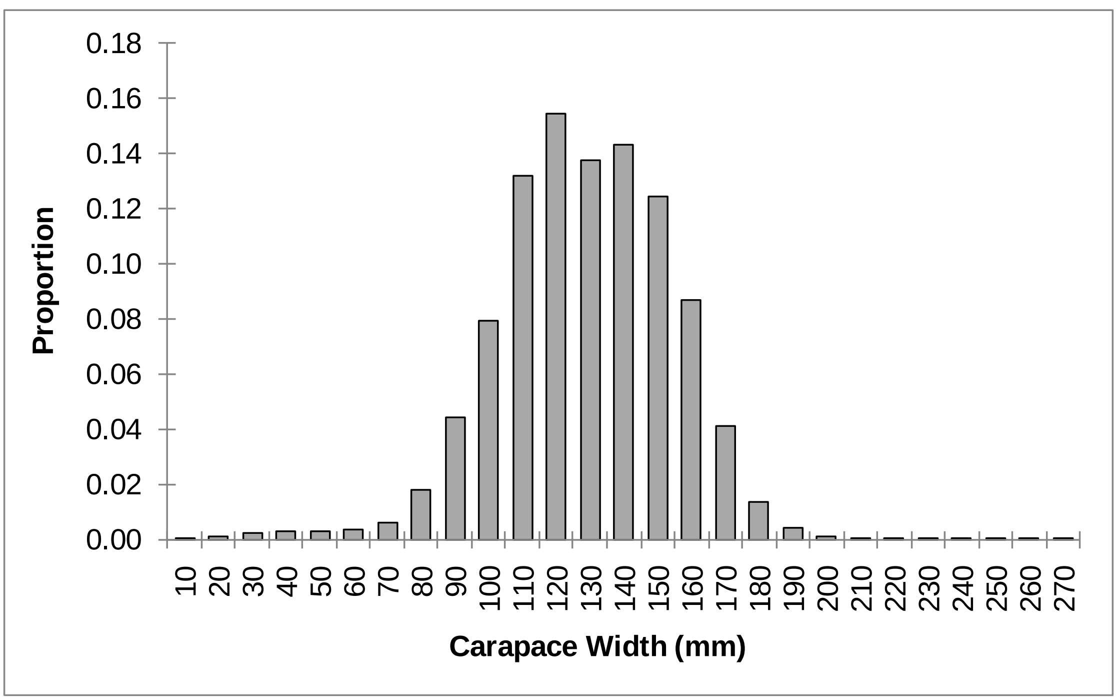


Figure 2.33. Length-frequency distribution of blue crabs collected by NCDMF Program 915, 2001–2009.

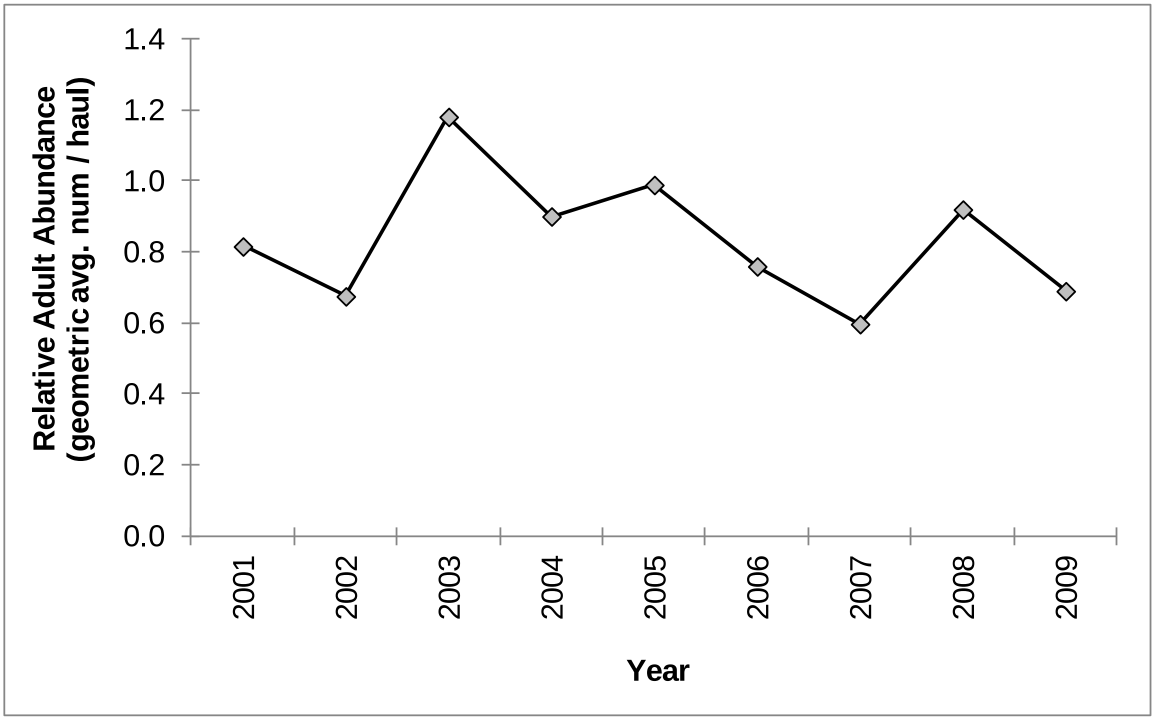


Figure 2.34. Annual index of relative adult abundance for blue crabs collected from Pamlico Sound by NCDMF Program 915, 2001–2009.

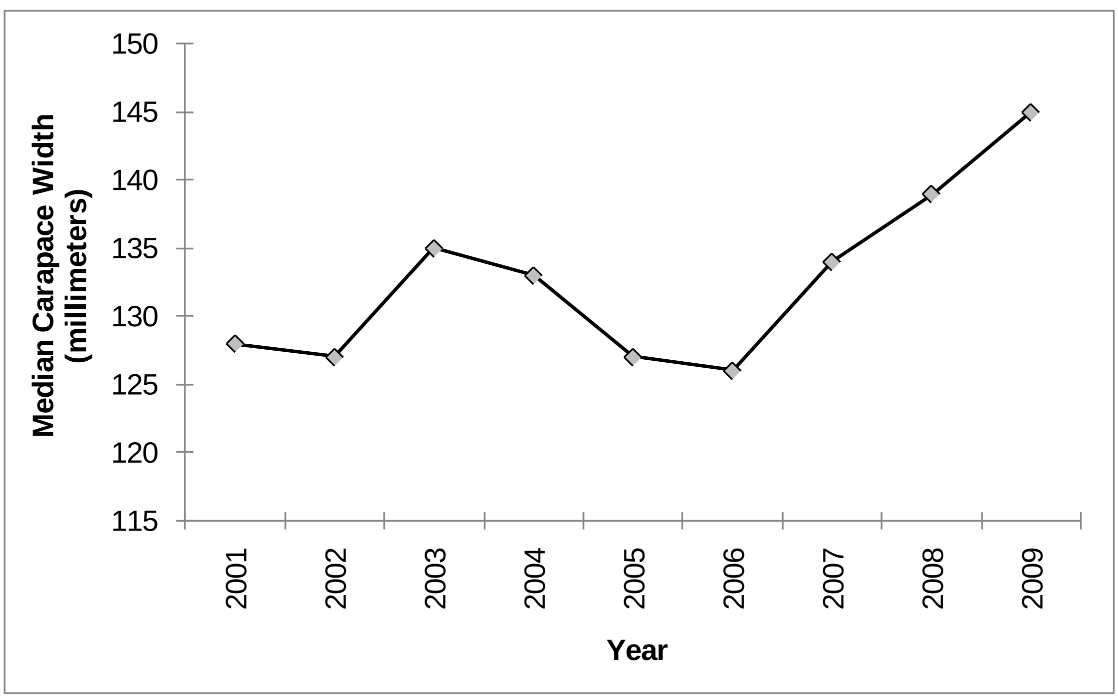


Figure 2.35. Annual median carapace widths of blue crabs collected from Pamlico Sound by NCDMF Program 915, 2001–2009.

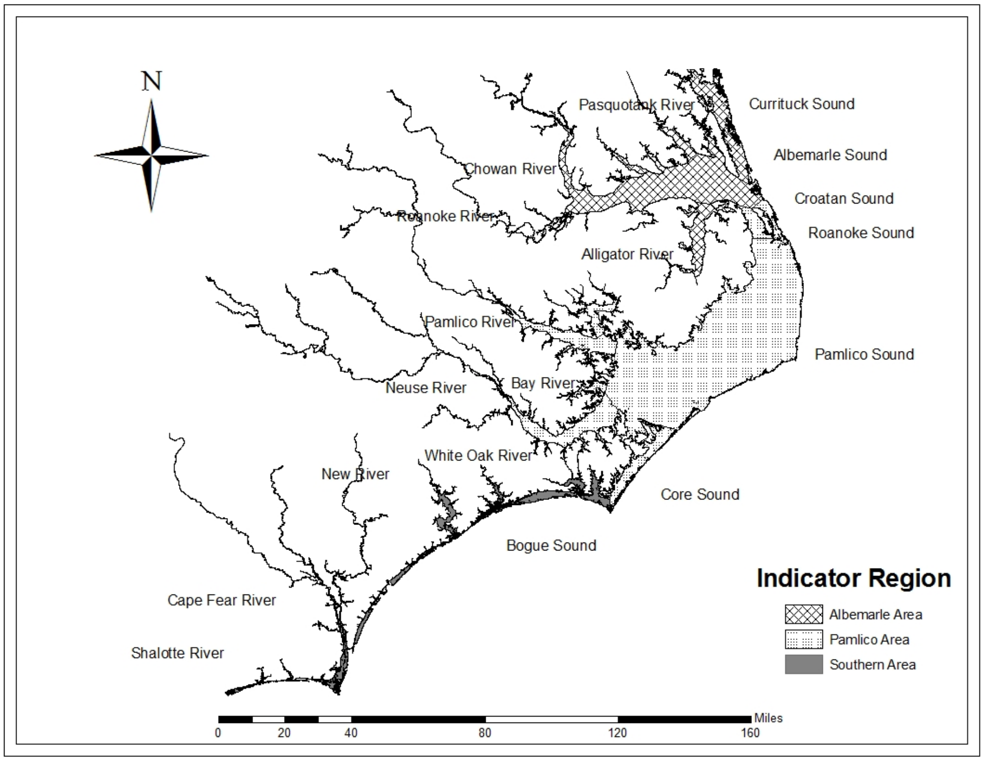

N
Pasquotank River
Currituck Sound
Albemarle Sound
Chowan River
Croatan Sound
Roanoke River
Roanoke Sound
Alligator River
Pamlico River
Pamlico Sound
Bay River
Neuse River
White Oak River
New River
Core Sound
Bogue Sound
Indicator Region
Albemarle Area
Pamlico Area
Southern Area
Cape Fear River
Shalotte River
Miles
0
20
40
80
120
160

Figure 3.1. Map defining regions that were used to spatially group Traffic Light indicators.

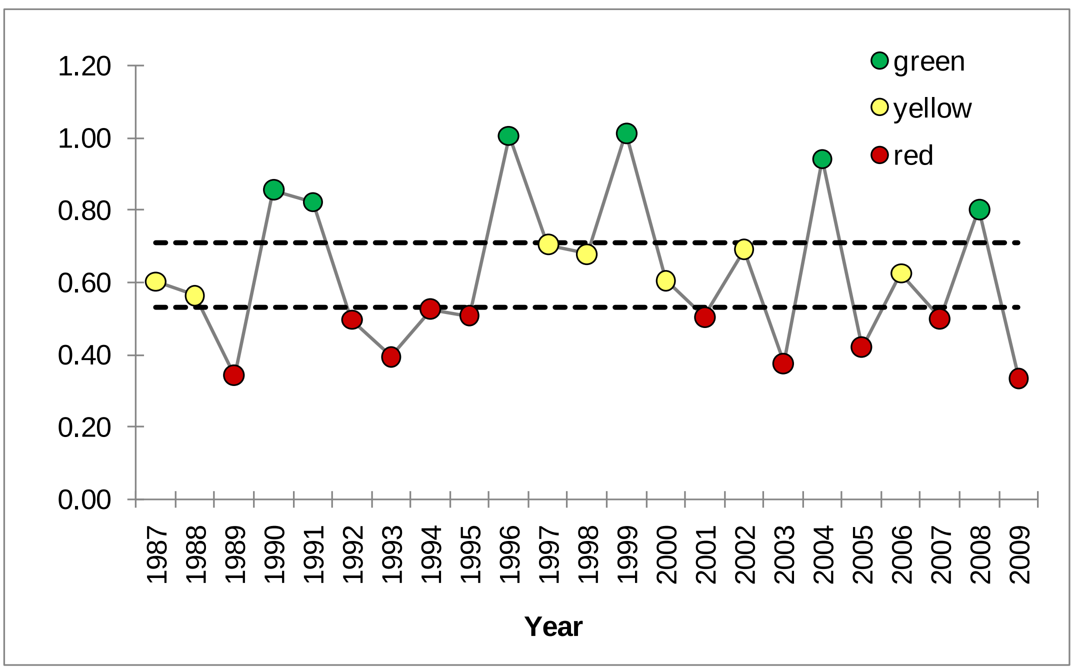


Figure 3.2. Example of the Strict Traffic Light scaling applied to the Program 120 relative index of adult abundance for the Pamlico region. The dotted black lines represent the upper and lower 95% confidence limits of the time-series average.

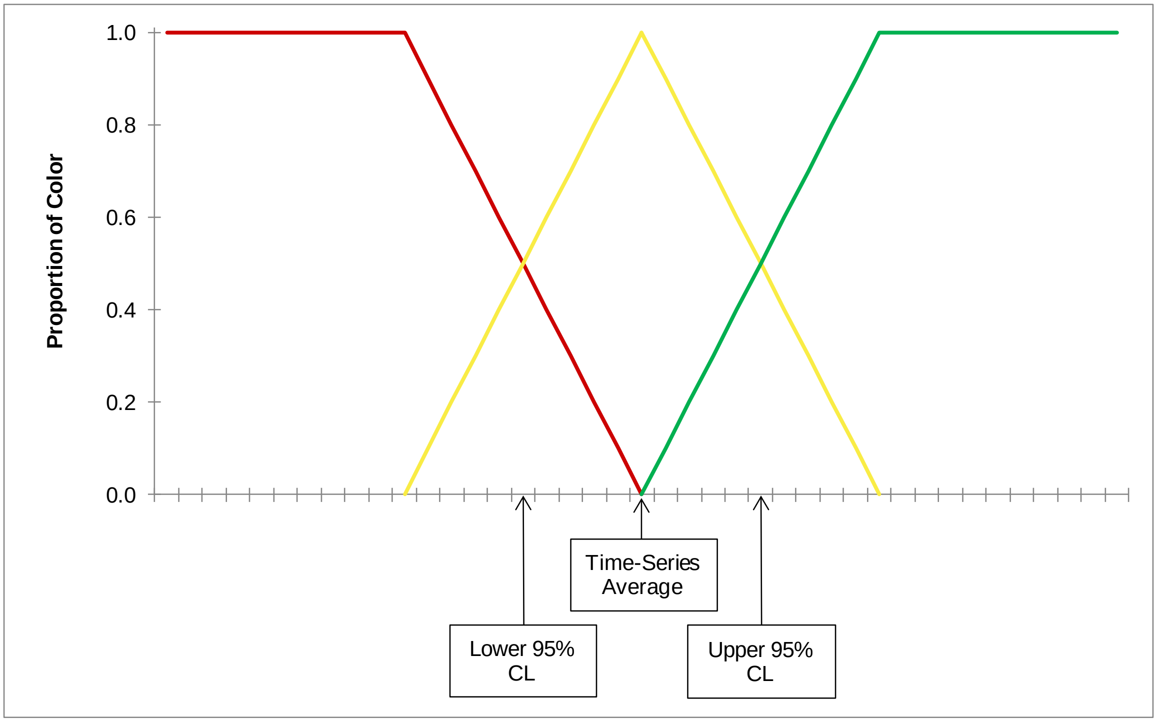


Figure 3.3. Schematic for assignment of Fuzzy Traffic Lights. The x-axis would represent the range of values for the indicator of interest. (Adapted from Halliday et al. 2001)

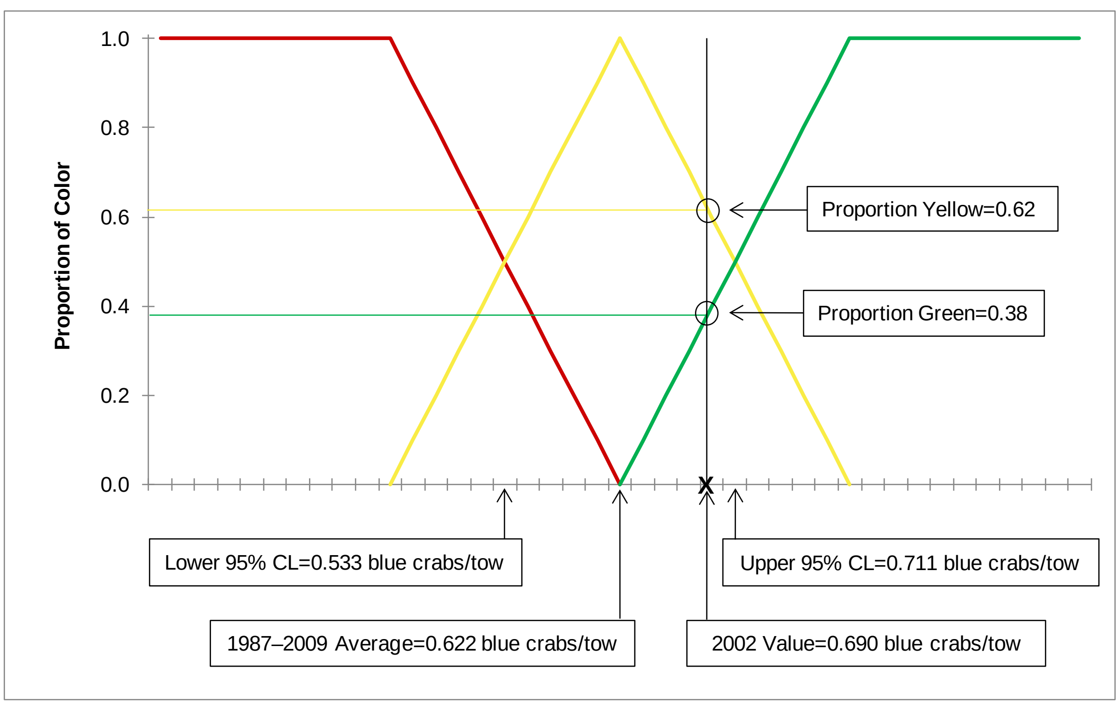


Figure 3.4. Example of Fuzzy Traffic Light scaling applied to the 2002 value of the Program 120 relative index of adult abundance for the Pamlico region. The 2002 value (0.690 blue crabs/tow) is represented by the “X” on the x-axis.

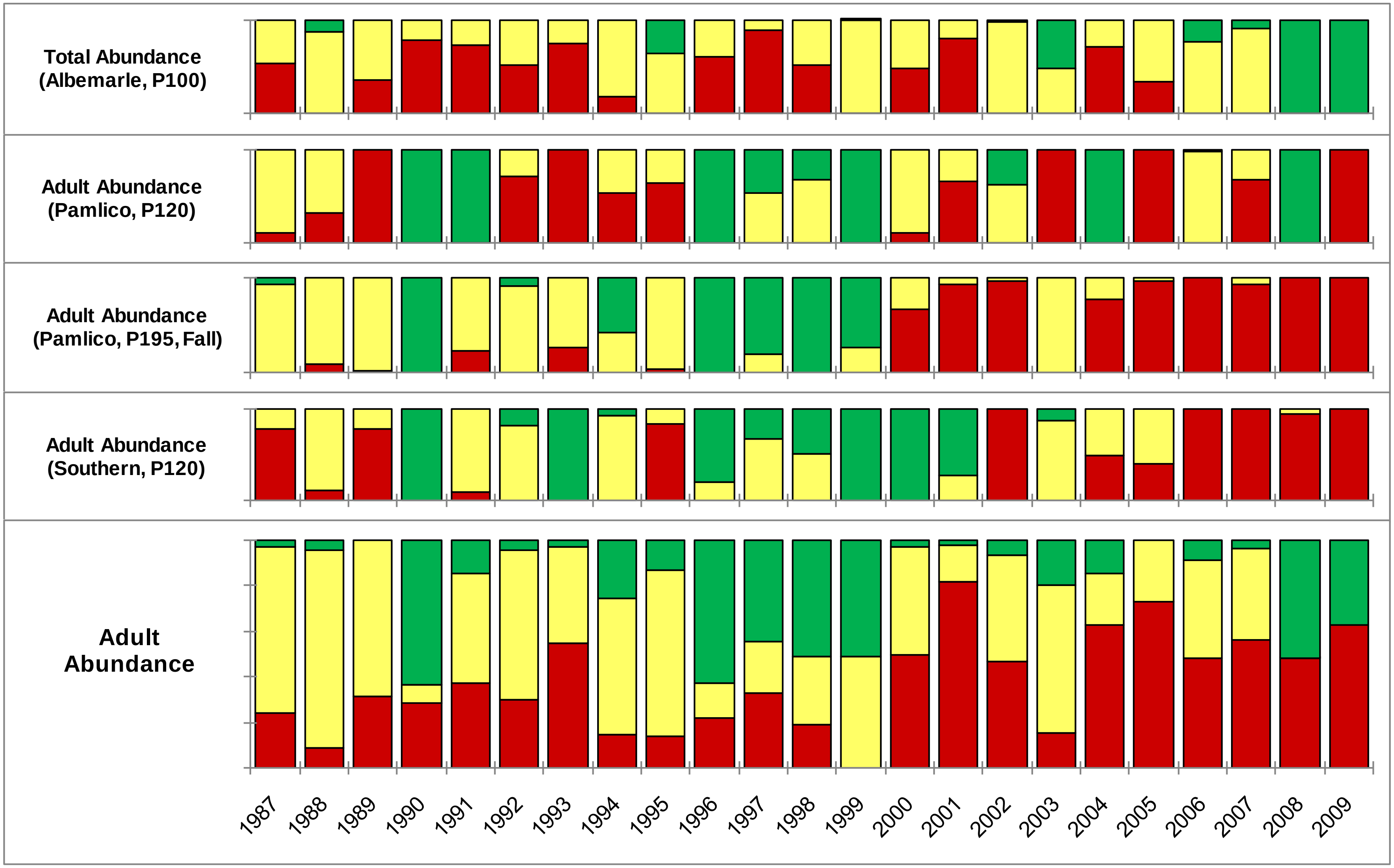


Figure 3.5. Traffic Light representations of individual adult abundance indicators and integrated summary (bottom figure).

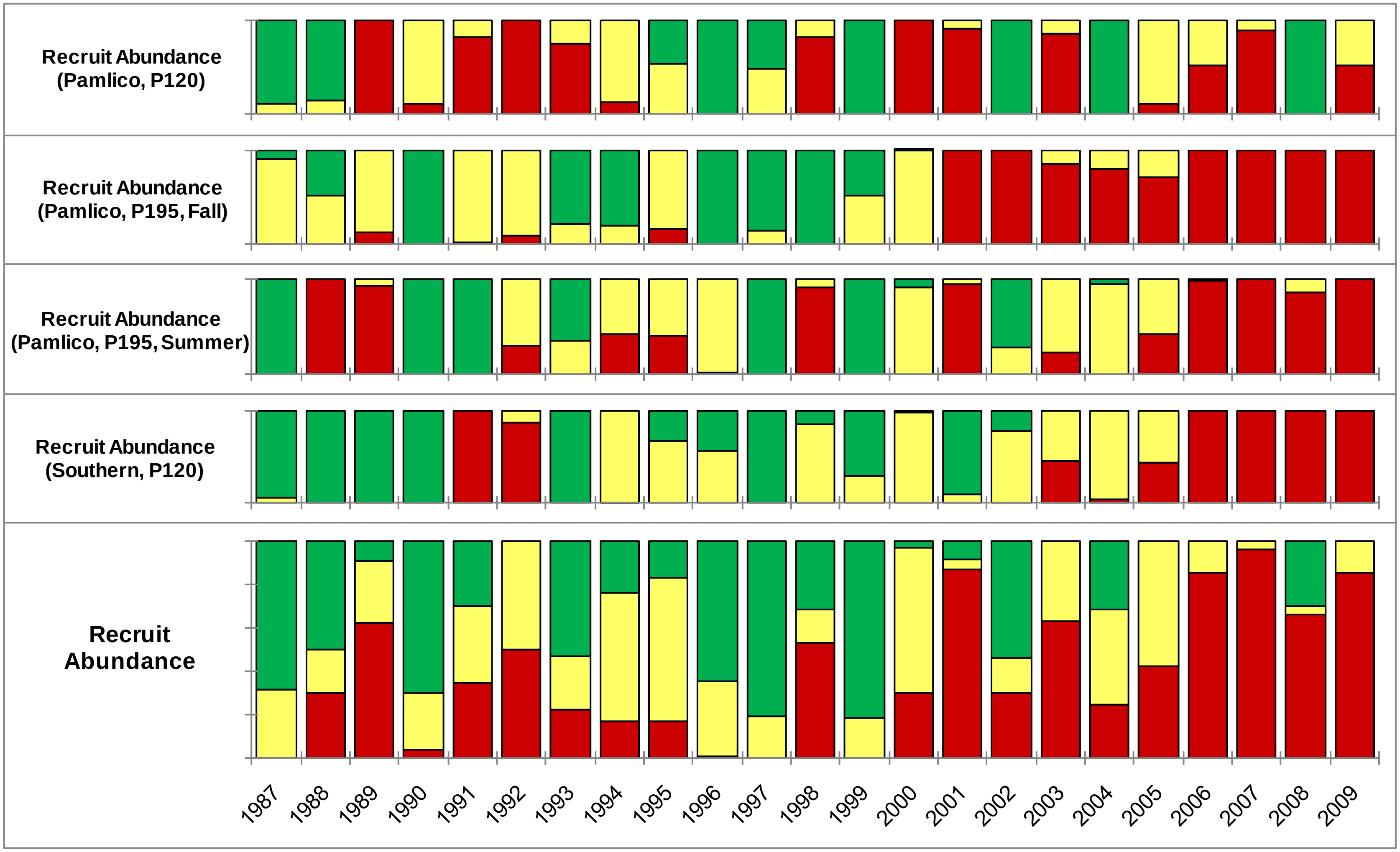


Figure 3.6. Traffic Light representations of individual recruit abundance indicators and integrated summary (bottom figure).

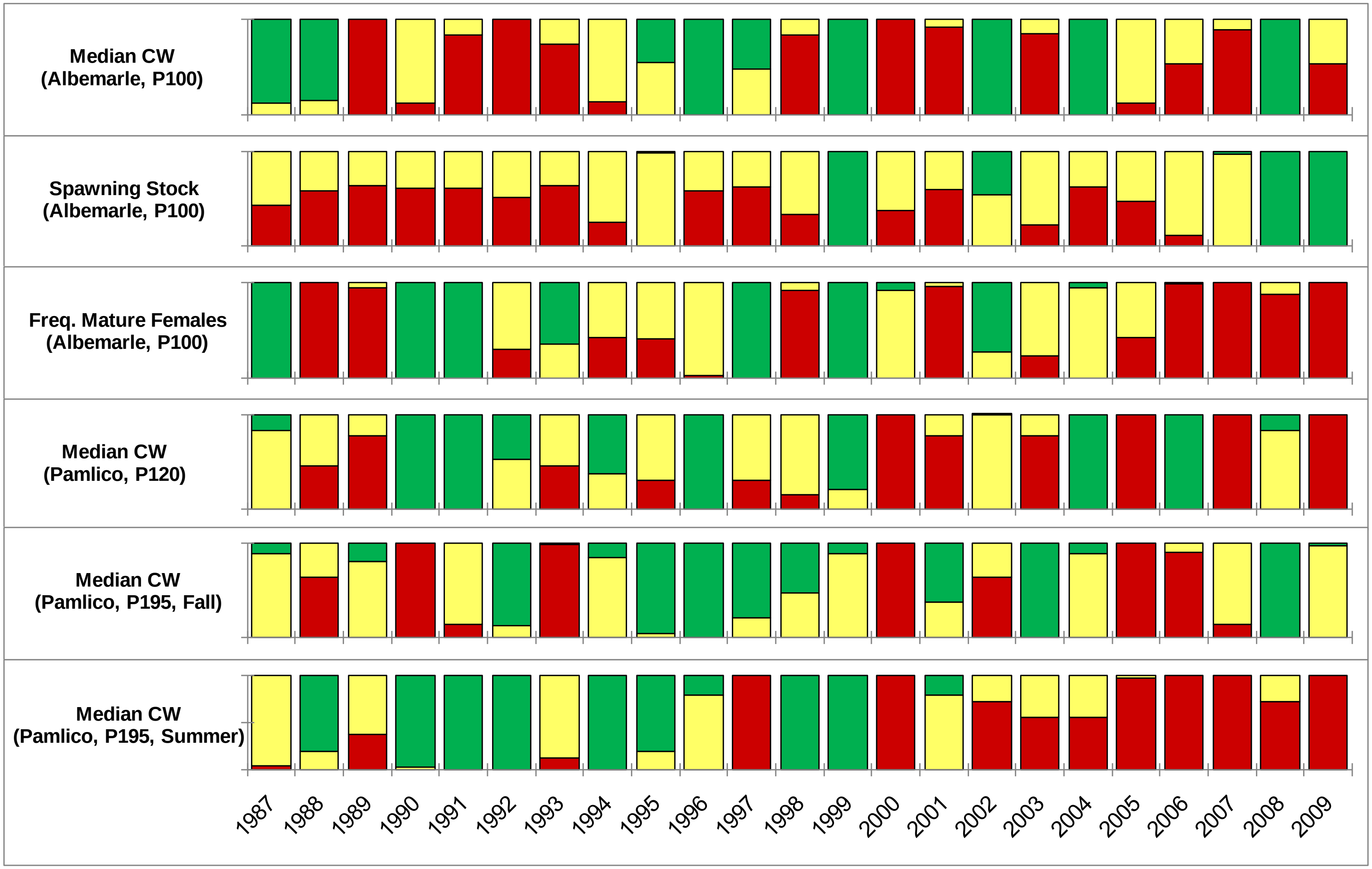


Figure 3.7. Traffic Light representations of individual production indicators and integrated summary (bottom figure).

Figure 3.7 (*cont*.). Traffic Light representations of individual production indicators and integrated summary (bottom figure).

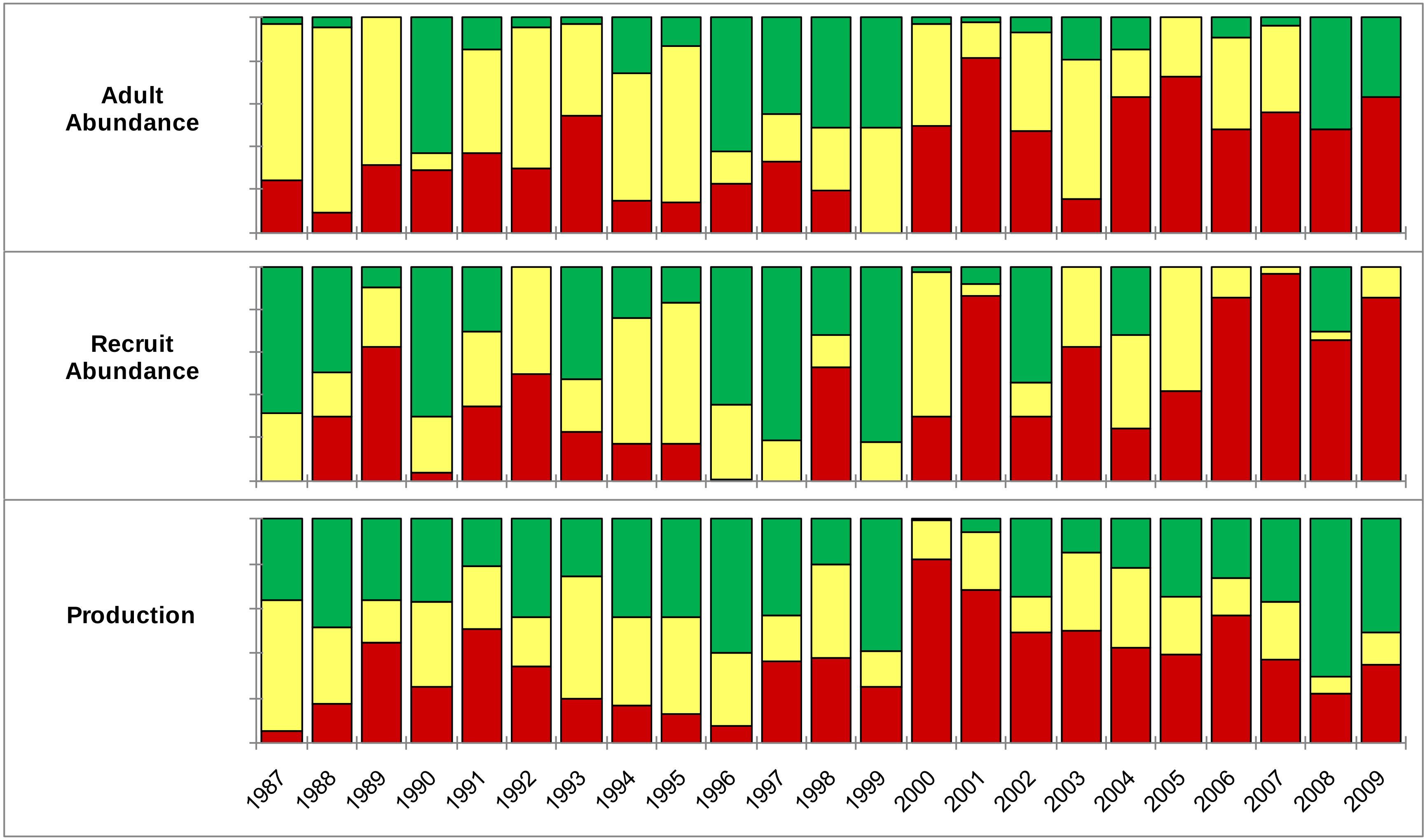


Figure 3.8. Traffic Light representations of adult abundance, recruit abundance, and production characteristic.

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