Coastal Management
ENVIRONMENTAL QUALITY

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MEMORANDUM **CRC-17-08**

TO: N.C. Coastal Resources Commission

FROM: Rebecca Ellin, Coastal Reserve Program Manager

DATE: April 12, 2017

SUBJECT: N.C. National Estuarine Research Reserve Management Plan

The N.C. Coastal Reserve and National Estuarine Research Reserve is updating its management plan for the N.C. National Estuarine Research Reserve (NCNERR). The plan covers 2017-2022 and provides a framework for the Reserve to continue, enhance, and expand its programs and operations to support its sites (Currituck Banks, Rachel Carson, Masonboro Island, and Zeke's Island), better serve NCNERR target audiences and address high priority coastal management issues. The National Oceanic and Atmospheric Administration (NOAA), the Reserve's federal partner in the implementation of the NCNERR, requires each Reserve within the National Estuarine Research Reserve System to prepare a management plan that describes the Reserve's goals, objectives and actions for its education, training, research and stewardship programs; management issues; and plans for public access and visitor use, land acquisition and facilities. The management plan must be approved by NOAA. The initial NCNERR management plan was approved in 1983 with revisions occurring in 1990, 1998, and 2009. The management plan's executive summary provides an overview of the program and the plan's contents and begins on page 2 of the attached draft management plan.

A robust public input process was utilized by the Reserve to inform the management plan update including the following mechanisms: public meetings, local advisory committee focus groups, an online partner survey, and needs assessments for the training and education programs. The local advisory committees for each NCNERR site provided input on the draft strategic plan section and the full draft management plan. The Reserve's education advisory committee and other partners also had the opportunity to provide input on the draft management plan. Feedback on the draft plan has been very positive with no major concerns identified. Minor changes have been

incorporated based on input received from the local advisory committees and partners. More detail on the public input process is provided in Appendix T in the management plan.

As the Coastal Area Management Act states that the Department will consult with and seek advice of the Coastal Resources Commission in its administration of the Coastal Reserve, **the Division is requesting the Commission's support of the draft NCNERR management plan to inform its recommendation to the Department.**

After review by the Department, NOAA will conduct a technical and content review of the plan. A NOAA-required 30-day public comment period will be held on the draft management plan following NOAA's review and prior to its finalization. The comment period will be announced in the Federal Register. Staff will host public meetings during the public comment period in the northern, central and southern regions of the coast to brief stakeholders on the draft management plan. Interested parties will be encouraged to submit comments electronically or at the public meetings held during the comment period.

North Carolina National Estuarine Research Reserve

DRAFT Management Plan
2017 – 2022

This management plan was developed in accordance with NOAA regulations, including all provisions for public involvement. It is consistent with the congressional intent of Section 315 of the Coastal Zone Management Act of 1972, as amended, and the provisions of the North Carolina Coastal Management Program.

DRAFT COPY: April 12, 2017

Executive Summary

The North Carolina National Estuarine Research Reserve (NCNERR) protects approximately 10,500 acres of estuarine habitats in coastal North Carolina for the purposes of research and education. The NCNERR is part of the National Estuarine Research Reserve System (NERRS), a network of protected areas established to promote informed management of the Nation's estuaries and coastal habitats. The NERRS addresses nationally significant and locally relevant issues through national and local research, education, and stewardship programs. The NERRS currently consists of 29 Reserves in 24 states and territories, protecting over one million acres of estuarine land and water.

The NCNERR is managed as a federal-state partnership between the National Oceanic Atmospheric Administration's (NOAA) Office for Coastal Management (OCM) and the North Carolina Department of Environmental Quality's (DEQ) Division of Coastal Management (DCM). OCM implements the National Coastal Zone Management Program and the NERRS with authorization from the Coastal Zone Management Act of 1972 (CZMA). OCM provides funding, technical assistance, and national coordination and oversight to Reserves within the NERRS. The DCM carries out the state's Coastal Area Management Act, the Dredge and Fill Law and the federal CZMA in the 20 coastal North Carolina counties, using rules and policies of the N.C. Coastal Resources Commission. As the state partner, the DCM has delegated authority from the state of North Carolina to manage the NCNERR sites and provides staff, programming, and matching funds for implementation of the NCNERR. The DCM is well suited as NCNERR's state partner as both organizations have similar missions of protecting coastal resources and are able to take advantage of respective programmatic expertise in planning, permitting, scientific research, educational translation, and coastal land management to form a complementary and comprehensive coastal management program as originally envisioned by the CZMA.

Coastal North Carolina is unique in that it includes both the Virginian and Carolinian biogeographic regions. The NCNERR was established as a multi-site Reserve to take advantage of this unique biogeography and is comprised of four geographically disparate sites representing diverse estuarine habitats:

1. The 965-acre Currituck Banks Reserve located in Currituck County, just north of the village of Corolla at the end of North Carolina (N.C.) 12;
2. The 2,315-acre Rachel Carson Reserve located in Carteret County between the town of Beaufort, Harkers Island and Cape Lookout National Seashore;
3. The 5,653-acre Masonboro Island Reserve, an undeveloped barrier island, situated in New Hanover County between the towns of Wrightsville Beach and Carolina Beach; and
4. The 1,635-acre Zeke's Island Reserve, encompassing tracts in both New Hanover and Brunswick counties, reached via United States (U.S.) 421 south of Kure Beach.

The Currituck Banks, Rachel Carson, and Zeke's Island Reserves were designated in 1985 and the Masonboro Island Reserve was designated in 1991.

The NCNERR mission is *to practice and promote informed management and appreciation of North Carolina's coastal and estuarine ecosystems and provide protected sites for research, education, and stewardship*. The NCNERR accomplishes this mission and its purposes identified in the N.C. Administrative Code (15A 07O) through its education, research, training and stewardship programs, each of which is devoted to fostering that aspect of the program, under the guidance of the Reserve Program Manager and according to this management plan.

- The education program increases awareness of the importance of coastal and estuarine ecosystems and inspires protection of these ecosystems for K-12 students and teachers, educators and the general public through its programs and materials.
- The Coastal Training Program promotes informed decisions regarding coastal resources by providing target audiences, such as local officials, realtors, state agency staff, resources managers, non-profit organizations and others, with science-based training opportunities on a variety of coastal topics.
- The research and monitoring program conducts, promotes and facilitates research at Reserve sites focused on ecosystem dynamics, coastal hazards resilience and human influences on estuarine systems and also provides long-term data on water quality, weather, biological communities, habitat and land-use and land-cover characteristics through its System-Wide Monitoring Program (SWMP).
- The stewardship program maintains and protects the natural integrity of Reserve sites by integrating science, community input and volunteer monitoring efforts to ensure suitable environments for research and education and to protect and restore coastal and estuarine species and habitats of environmental, economic and traditional use value to North Carolina.

Each program utilizes the four sites of the NCNERR to implement its respective activities, promoting site-based management and program implementation of the Reserve.

The OCM requires each Reserve within the NERRS to prepare a written management plan that describes the Reserve's goals, objectives and management issues, and identifies the Reserve's intended actions for its education, training, research, and stewardship programs as well as for public access and visitor use, land acquisition, and facilities. The plan must be approved by OCM and periodically updated. The initial NCNERR management plan was approved in 1983 with revisions in 1990, 1998, and 2009. This document is the fourth revision of that plan.

The 2017-2022 NCNERR management plan provides a framework for the Reserve to continue, enhance, and expand its programs and operations to better serve NCNERR target audiences and address high priority coastal management issues to promote healthy estuaries and coastal watersheds. The management plan addresses themes identified during the public input process (Appendix T) including program visibility, visitor use, research awareness, and partnerships. The plan also addresses threats and stressors of concern to the NCNERR sites: overarching threats and stressors include invasive species, water quality, visitor use and sea level rise and storms, and site-specific challenges include feral species, marine debris, and shoreline change and sedimentation.

The following four goals and resultant objectives and actions will guide Reserve implementation during 2017-2022:

1. Education and training inspire target audiences to protect coastal and estuarine ecosystems.
2. Research and monitoring advance understanding of coastal and estuarine ecosystems and inform coastal management.
3. Stewardship of protected sites contributes to the study and appreciation of coastal and estuarine ecosystems.
4. The NCNERR is recognized as a leader in coastal and estuarine ecosystem research, training, education and stewardship through effective administration and communication strategies.

To strengthen alignment of NCNERR programs and efforts with NERRS Strategic Goals and address public input, the NCNERR selected three topical areas of national, regional, state, and local importance: water quality, coastal and estuarine protection, and coastal hazards resilience. These priority coastal management issues were identified and informed by current work and input from Reserve staff, public and local advisory committee meetings, partner surveys, and education and training needs assessments. The topical areas will serve as additional focus and investment for the NCNERR management plan and will be addressed through a strategic and integrated process utilizing the capacity of the NCNERR programs and leveraging its partnerships.

The management plan details how each program will address the relevant goals and topical areas. The plan also identifies the types of projects the NCNERR will undertake in an effort to address the threats, stressors and coastal management issues facing its sites and N.C. coastal communities. The successful implementation of this management plan will rely on a coordinated approach involving OCM and DCM, the Reserve's diverse network of partners, local advisory committees and volunteers.

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Appendix B: Coastal Zone Management Act
Appendix C: State Assignment of Management Responsibilities
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Acronyms and Abbreviations

AOWG: American Oystercatcher Working Group
APNEP: Albemarle-Pamlico National Estuary Partnership
BMP: Best Management Practice
CAMA: Coastal Area Management Act
C-CAP: NOAA's Coastal Change Analysis Program
CCFHR: NOAA's Center for Coastal Fisheries and Habitat Research
CCVATCH: Climate Change Vulnerability Assessment Tool for Coastal Habitats
CDMO: Centralized Data Management Office
CMS: University of North Carolina Wilmington's Center for Marine Science
CMST: North Carolina State University's Center for Marine Sciences and Technology
COE: U.S. Army Corps of Engineers
CTP: Coastal Training Program
CZMA: Coastal Zone Management Act
DCM: North Carolina Division of Coastal Management
DEQ: North Carolina Department of Environmental Quality
DMF: North Carolina Division of Marine Fisheries
DPR: North Carolina Division of Parks and Recreation
DUML: Duke University Marine Laboratory
FOR: Friends of the Reserve
GIS: Geographic Information System
HUC: Hydrologic Unit Code
ICW: Atlantic Intracoastal Waterway
IMS: University of North Carolina's Institute of Marine Sciences
ISS: International Shorebird Survey
KEEP: K-12 Estuarine Education Program
LAC: Local Advisory Committee
LID: Low Impact Development
MOU: Memorandum of Understanding
N.C.: North Carolina
NCCOS: NOAA's National Centers for Coastal Ocean Science
NCCR: North Carolina Coastal Reserve
NCNERR: North Carolina National Estuarine Research Reserve
NCSSC: North Carolina Sentinel Sites Cooperative
NERRS: National Estuarine Research Reserve System
NPS: National Park Service

NOAA: National Ocean and Atmospheric Administration
OCM: NOAA's Office for Coastal Management
ORV: Off-road vehicle
PAR: Photosynthetically active radiation
RTK: Real-time kinematic
SEANET: Seabird Ecological Assessment Network
SET: Surface elevation table
SLR: Sea level rise
SSAM 1: Sentinel Site Application Module 1
SWMP: System-Wide Monitoring Program
TOTE: Teachers on the Estuary
UAS: unmanned aerial system
UNCW: University of North Carolina Wilmington
U.S.: United States
USDA-WS: U.S. Department of Agriculture Wildlife Services program
WRC: N.C. Wildlife Resources Commission

Acknowledgements

This management plan was produced by the North Carolina National Estuarine Research Reserve staff including:

- Lori Davis, Education Coordinator
- Rebecca Ellin, Reserve Program Manager
- Elise Gilchrist, Communications Specialist
- Paula Gillikin, Central Sites Manager
- Rodney Guajardo, GIS Specialist
- Whitney Jenkins, Coastal Training Program Coordinator
- Kate Jones, Northern Sites Manager
- Brandon Puckett, Research Coordinator
- Hope Sutton, Stewardship Coordinator and Southern Sites Manager
- Byron Toothman, Research Specialist
- Woody Webster, Buckridge Site Manager
- Heather Wells, Research Specialist

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I. Introduction

Introduction to the National Estuarine Research Reserve System

The National Estuarine Research Reserve System (NERRS) was created by the Coastal Zone Management Act (CZMA) of 1972, as amended, to augment the National Coastal Zone Management Program which is dedicated to comprehensive, sustainable management of the nation's coasts.

The Reserve System is a network of protected areas representative of the various biogeographic regions and estuarine types in the United States. Reserves are established for long-term research, education and interpretation to promote informed management of the Nation's estuaries and coastal habitats. (15 C.F.R Part 921.1(a)) The Reserve System currently consists of 29 reserves in 24 states and territories, protecting over one million acres of estuarine lands and waters (Figure 1).

The Reserve System is a partnership program between the National Oceanic and Atmospheric Administration (NOAA) and the coastal states. NOAA provides funding, national guidance and technical assistance. The state partner manages reserve resources on a daily basis working collaboratively with local and regional partners.

Figure 1. National Estuarine Research Reserve System Sites Map

National Estuarine Research Reserve System Strategic Goals

Estuaries are biologically rich, economically valuable, and highly vulnerable ecosystems. The vision and mission of the Reserve System reflect the importance of these systems within our communities.

Vision: Resilient estuaries and coastal watersheds where human and natural communities thrive.

Mission: To practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas.

The program goals, per Federal regulations 15 C.F.R. Part 921.1(b), outline five specific goals for the Reserve System:

1. Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve resources;
2. Address coastal management issues identified as significant through coordinated estuarine research within the system;
3. Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
4. Promote Federal, state, public and private use of one or more Reserves within the System when such entities conduct estuarine research; and
5. Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

These foundational goals are complemented by those that are systematically set by the program every five years. Strategic planning has been an integral part of the National Estuarine Research Reserve System for nearly twenty years. The planning process is designed to bridge national program direction with local coastal management needs through a representative and participatory process that supports NOAA's mission of science, service, and stewardship. The 2011-2016 Reserve System Strategic Plan focuses reserve core strengths of research, education, and training on three core issues: climate change, habitat protection, and water quality.

The Reserve System Strategic Plan Goals are:

1. **Protected Places:** Estuaries and coastal watersheds are better protected and managed by implementing place-based approaches at reserves.
2. **Science:** National Estuarine Research Reserve System scientific investigations improve understanding and inform decisions affecting estuaries and coastal watersheds.
3. **People:** National Estuarine Research Reserve System education and training increases participants' environmental literacy and ability to make science-based decisions related to estuaries and coastal watersheds.

Biogeographic Regions and Boundaries of the National Estuarine Research Reserve System

NOAA has identified eleven distinct biogeographic regions and 29 subregions in the United States, each of which contains several types of estuarine ecosystems (Appendix A). When complete, the Reserve System will contain examples of estuarine hydrologic and biological types characteristic of each biogeographic region. As of 2017, the Reserve System includes 29 reserves and one state in the process of designating a reserve.

Reserve boundary size will vary greatly depending on the nature of the ecosystem. Boundaries must include an adequate portion of the key land and water areas of the natural system to approximate an ecological unit and to ensure effective conservation. Reserve boundaries encompass areas for which adequate state control has or will be established by the managing entity over human activities occurring within the reserve. Reserve boundaries include a "core" area which is comprised of key land and water encompassing natural resources representative of the total ecosystem, which if compromised could endanger the research objectives of the reserve, as well as a "buffer" area designed to protect the core area and provide additional protection for estuarine-dependent species, including those that are rare or endangered. Buffer areas may also include areas necessary for facilities required for research and interpretation. Additionally, buffer areas are identified to accommodate a shift of the core area as a result of biological, ecological or geo-morphological change which reasonably could be expected to occur. (15 C.F.R. Part 921.11 (c)(3))

National Estuarine Research Reserve Administrative Framework

The process for federal designation of a National Estuarine Research Reserve has many steps and involves many individuals and organizations. While each reserve is a partnership program between NOAA and a coastal state, there are many entities that collaborate to support designation of a reserve. Other partners include federal and state agencies, non-profit groups, universities and members of the local community. For more information on the designation process see nerrs.noaa.gov/about/designation-process.

Upon designation, the reserve implements the approved management plan and is eligible for NOAA financial assistance on a cost-share basis with the state. A reserve may apply to NOAA for funds to help support implementation of the management plan largely funding operations, research, monitoring, education/interpretation, training, stewardship, development projects, facility construction, and land acquisition. Management plans provide a vision and framework to guide reserve activities during a five-year period and enable the reserves and NOAA to track progress and realize opportunities for growth. Each management plan contains the reserve goals, objectives, and strategies supported by programs focused on research and monitoring, education and outreach, training, and stewardship. They also outline administration, public access, land acquisition and facility plans and needs, as well as restoration and resource manipulation plans, if applicable. Reserves are increasingly confronted with complex questions regarding new uses in or near reserves that may or may not be compatible with the Reserve System's mission. A thoughtful and

comprehensive management plan provides a foundation for addressing these challenges to protect and manage reserve resources wisely and ensure the public and coastal decision makers value and protect coastal resources.

NOAA administers the Reserve System and establishes standards for designating and operating reserves, provides support for reserve operations and system-wide programming, undertakes projects that benefit the Reserve System, and integrates information from individual reserves and programs to support decision-making at the national level. Additionally, NOAA periodically evaluates reserves for compliance with federal requirements and with the individual reserve's federally approved management plan, as mandated under Section 312 of the Coastal Zone Management Act (15 C.F.R. Part 921.40, Appendix B).

NOAA currently provides leadership and support for three system-wide programs including the System-Wide Monitoring Program, the K-12 Estuarine Education Program (KEEP), and the Coastal Training Program (CTP), as well as the NERRS Science Collaborative. They also provide support for initiatives focused on the Reserve System's priorities: climate change, water quality and habitat protection.

Introduction to the North Carolina National Estuarine Research Reserve

Establishment of the Reserve and State Management Framework

The North Carolina General Assembly passed the Coastal Area Management Act (CAMA) in 1974 in response to the Federal CZMA. As the regulatory and planning programs of CAMA were implemented by the now-North Carolina Department of Environmental Quality's (DEQ) Division of Coastal Management (DCM) in the late 1970s, it became apparent that an effective, comprehensive coastal management program must include a land acquisition program. CAMA was amended to include the beach access program in 1981. In 1982 North Carolina received its first federal award to establish a multi-site National Estuarine Research Reserve in the state. Four properties were selected to become sites within the North Carolina National Estuarine Research Reserve (NCNERR) and together, they protect approximately 10,500 acres of coastal and estuarine habitat from the northern, central, and southern regions of coastal North Carolina, covering two biogeographic regions:

1. The 965-acre Currituck Banks Reserve located in Currituck County just north of the village of Corolla at the end of N.C. 12;
2. The 2,315-acre Rachel Carson Reserve located in Carteret County between Beaufort, Harkers Island, and the Cape Lookout National Seashore;
3. The 5,653-acre Masonboro Island Reserve, an undeveloped barrier island, situated in New Hanover County between the towns of Wrightsville Beach and Carolina Beach; and

4. The 1,635-acre Zeke's Island Reserve, encompassing tracts in both New Hanover and Brunswick counties, near Fort Fisher and south of Kure Beach.

The NCNERR is a federal-state partnership between NOAA and DCM (Appendix D). Three of the sites were designated in 1985 (Currituck Banks, Rachel Carson, and Zeke's Island Reserves) and Masonboro Island Reserve was designated in 1991. The four Reserve sites are owned in fee simple by the State of North Carolina. Management of the sites is delegated by the N.C. Department of Administration to DCM.

The NCNERR's success in protecting coastal and estuarine habitats for research and education inspired the State to protect additional coastal and estuarine habitats thereby creating the North Carolina Coastal Reserve (NCCR), which was incorporated into CAMA by amendment in 1989 (G.S. 113A-129.1-.3; Article 7). The CAMA amendment complements and reinforces the Federal NERRS regulations by declaring that management of the NCNERR, as part of the Coastal Reserve, is state policy (Appendix E). The 1989 statute establishes the basic Coastal Reserve purpose:

> *Important public purposes will be served by the preservation of certain areas in an undeveloped state. Such areas would thereafter be available for research, education, and other consistent public uses. These areas would also continue to contribute perpetually to the natural productivity and biological, economic, and aesthetic values of North Carolina's coastal area [G.S. 113A-129.1(b)].*

This purpose is further articulated in G.S. 113A-129.2-.3, providing additional detail regarding the mechanics of the Coastal Reserve and its coordination with the NERRS and State Nature Preserve program.

The DEQ promulgated rules in 1986 for Coastal Reserve sites within the North Carolina Administrative Code (T15: 7O). These rules were established to further define the purpose, responsibilities, functions, components, and use requirements for the Reserves (Appendix F).

The Coastal Reserve includes the four NCNERR sites (Currituck Banks, Rachel Carson, Masonboro Island, and Zeke's Island) and six state sites: Kitty Hawk Woods (Dare County), Buxton Woods (Dare County), Buckridge (Tyrrell and Hyde Counties), Permuda Island (Onslow County), Bald Head Woods (Brunswick County), and Bird Island (Brunswick County) (Figure 2).

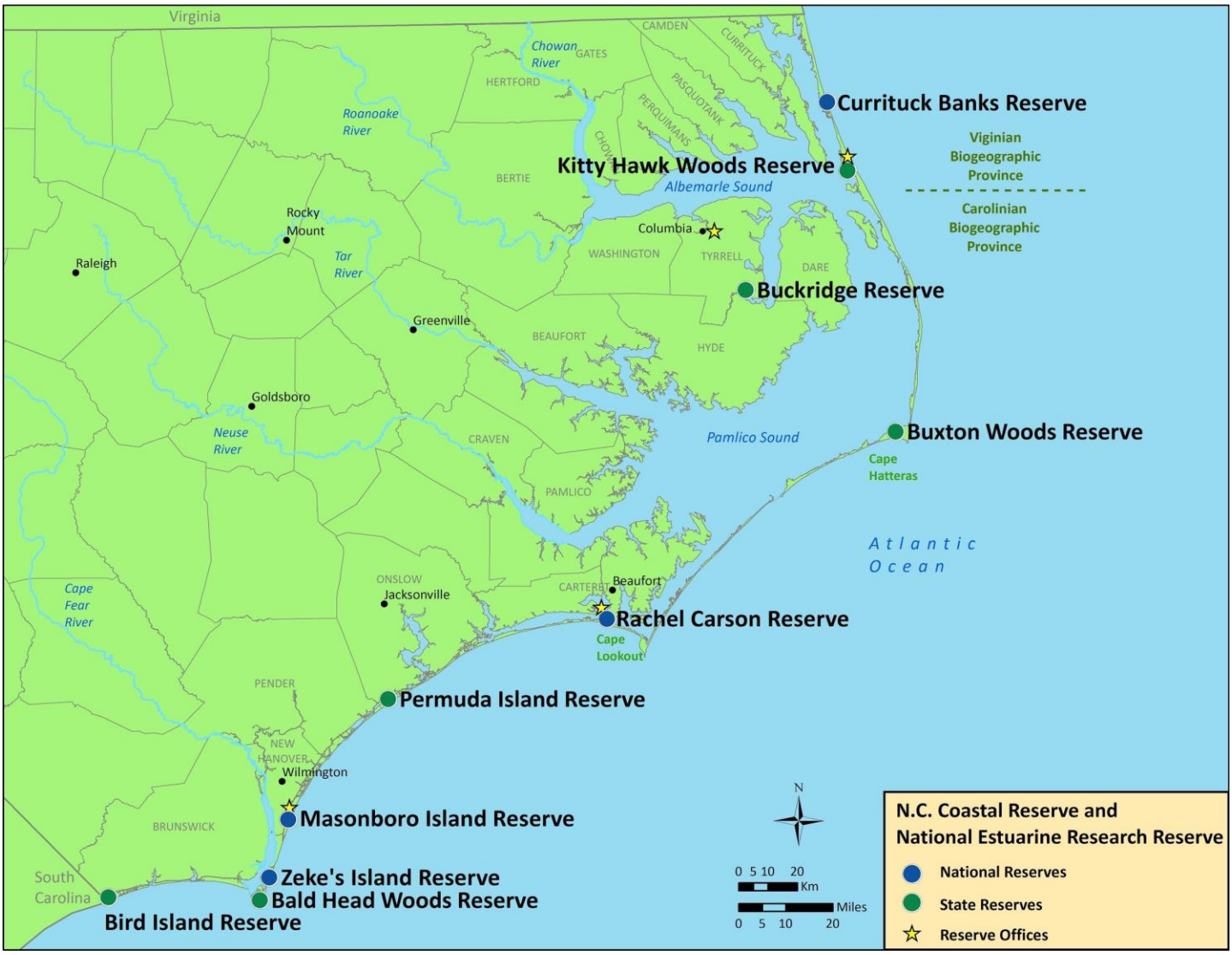

Figure 2. North Carolina National Estuarine Research Reserve Sites Map

The NCNERR sites are also designated as State Nature Preserves, which are limited use areas that serve to preserve and portray the natural features unique to the region (Appendix G). Some NCNERR sites are also subject to county and municipal zoning designations and ordinances (Appendix H).

Refer to the Administration Plan for more information about the administrative framework of the Reserve. Additional information about Reserve management authority and stewardship policies is located in the Stewardship Program chapter. More detailed descriptions of the sites are provided in the Site Descriptions at the end of this chapter.

North Carolina National Estuarine Research Reserve Strategic Plan

Reserve Vision

Healthy coastal watersheds and estuaries support thriving ecosystems and human communities

Reserve Mission

To practice and promote informed management and appreciation of North Carolina's coastal and estuarine ecosystems and provide protected sites for research, education, and stewardship

NCNERR Programs

The NCNERR is a network of protected coastal sites established for long-term research, education and stewardship. The sites provide essential habitat for wildlife; offer educational opportunities for students, teachers and the public; serve as living laboratories for scientists; and provide public enjoyment. The NCNERR accomplishes the Reserve Vision and Mission through the integrated work of its four programs.

Education Program

The education program offers activities for K-12 students, teachers and the general public. Programs include public and school field trips, summer camps, professional training opportunities for teachers, and outreach events. These activities are designed to enhance public awareness of the importance of coastal and estuarine ecosystems and inspire protection of these ecosystems through hands-on, interactive experiences.

Coastal Training Program

The Coastal Training Program promotes informed decisions regarding coastal resources by providing professionals with science-based training opportunities. Local officials, realtors, state agency staff, resource managers, non-profit organizations and others benefit from access to new scientific research and training on a variety of coastal topics presented by local experts.

Research and Monitoring Program

The research program conducts, promotes and facilitates research and monitoring at Reserve sites. Reserve research is focused on ecosystem dynamics, coastal hazards resilience and human influences on estuarine systems. The System-Wide Monitoring Program (SWMP) provides long-term data on water quality, weather, biological communities, habitat and land-use and land-cover characteristics of coastal and estuarine ecosystems for the purpose of informing coastal management.

Stewardship Program

The stewardship program is dedicated to protecting and restoring the natural integrity of Reserve sites to ensure suitable environments for research and education. Stewardship programs integrate science, community input and volunteer monitoring efforts to protect and restore coastal and estuarine species and habitats of environmental, economic and recreational value to North Carolina.

Goals, Objectives and Actions

Goal 1: Education and training inspire target audiences to protect coastal and estuarine ecosystems

Objectives:

1.1 Two hundred fifty educators receive information on North Carolina's coastal and estuarine ecosystems and are able to apply curricula within their instruction.
Action 1: Conduct hands-on and field-based educator workshops, including Coastal Explorations and Teachers on the Estuary (TOTE).
Action 2: Update workshops and curricula based on current techniques and topics identified through the 2014 needs assessment as well as future surveys.
Action 3: Incorporate Reserve research and stewardship activities and monitoring data into workshops and curricula.
Action 4: Engage educators through partner-hosted education programs and events.
Action 5: Maintain and enhance partnerships for program implementation and seek input from the NCNERR education advisory committee.

1.2 Five thousand students receive information on North Carolina's coastal and estuarine ecosystems and are able to describe an estuary and its benefits.
Action 1: Conduct educational field trips for K-College students, focusing each field trip on the grade's standards.
Action 2: Work with partners to offer the Masonboro Island Explorer Program.
Action 3: Present coastal and estuarine concepts and curricular activities to students through classroom visits.
Action 4: Conduct summer programs for students and incorporate new curricular activities.

1.3 N.C. citizens and visitors understand the value of coastal and estuarine ecosystems and how the NCNERR protects these resources.
Action 1: Conduct public outreach programs at Reserve sites.
Action2: Enhance partnerships with government agencies delivering public programming at Reserve sites.
Action 3: Participate in community events such as Earth Day festivals and National Estuaries Day.
Action 4: Encourage program participants to make a commitment to protect estuaries.
Action 5: Recruit and train volunteers to support education activities.

1.4 Annually, 90% of participants state that they intend to apply the science-based knowledge and skills relevant to coastal management grained through CTP activities.

Action 1: Coordinate core trainings for decision-makers in collaboration with program partners.
Action 2: Coordinate new training events in response to the 2014 needs assessment and emerging policy issues in collaboration with program partners.
Action 3: Incorporate coastal and estuarine science into trainings.

1.5 Annually, at least two partners will receive technical assistance from the CTP to address mutual priorities relative to NCNERR topical areas.

Action 1: Establish collaborative relationships with local communities within Reserve watersheds and determine communities' technical assistance needs.
Action 2: Connect with existing or new partners to address mutual priorities relative to NCNERR topical areas.
Action 3: Provide technical assistance to local communities and partners to address needs relative to NCNERR priorities, applying for external funding as need and available.

Goal 2: Research and monitoring advance understanding of coastal and estuarine ecosystems and inform coastal management.

Objectives:

2.1 Research and monitoring is conducted within Reserve sites and associated watersheds.

Action 1: Prioritize research on coastal management topics annually through interactions with researchers, coastal decision-makers, and Reserve staff.
Action 2: Conduct research that addresses research priorities and NCNERR Strategic Plan Topical Areas.
Action 3: Continue implementation of the NERRS SWMP to assess change in abiotic and biotic indicators and habitat distribution.
Action 4: Explore opportunities to expand abiotic and biotic components of SWMP monitoring to additional Reserve sites.
Action 5: Continue implementing the Sentinel Site Application Modules as resources are available to detect and understand the effects of sea level change on estuaries.
Action 6: Analyze and synthesize Reserve research and monitoring data to evaluate trends and patterns of local, regional, and national significance.

2.2 Research and monitoring datasets, results, and products are communicated to target audiences (e.g., coastal decision-makers, research community, Reserve program participants) to address relevant coastal and estuarine topics.

Action 1: Describe the Reserve's research and monitoring datasets, results and products to coastal decision-makers and other end users through 10 or more forums annually.

Action 2: Provide high-quality data that is accessible by all interested parties through the NERRS' Centralized Data Management Office's website.
Action 3: Highlight research and monitoring projects on the Reserve's website.
Action 4: Collaborate with education and training staff to package and integrate research and monitoring data into education and training programs.

2.3 Reserve sites are promoted as place-based research platforms and Reserve's long-term datasets are promoted as a research tool.
Action 1: Facilitate, promote, and participate in research conducted at Reserve sites, particularly research that supports the Reserve's mission and informs coastal management.
Action 2: Review 12 or more research permit applications from external researchers annually, evaluate the percentage of applicants using the Reserve's long-term datasets for research, and maintain the NCNERR portion of the NERRS' research database.
Action 3: Support and promote the Coastal Research Fellowship in collaboration with N.C. Sea Grant to provide opportunities for graduate students to conduct research within Reserve boundaries.

2.4 Research partnerships are enhanced through collaboration with the Reserve research program.
Action 1: Provide advisory services to research community by serving on at least one graduate student committee and at least two science committees annually.
Action 2: Develop at least 2 collaborative research proposals annually seeking external funds to support Reserve research priorities.

Goal 3: Stewardship of protected sites contributes to the study and appreciation of coastal and estuarine ecosystems.

Objectives:

3.1 Coastal and estuarine ecosystems are managed and protected.
Action 1: Monitor general site condition at least monthly.
Action 2: Respond to issues on sites, coordinating with law enforcement, state and federal agencies, and partner organizations.
Action 3: Manage species of interest by conducting survey and monitoring activities, protecting critical habitat areas and implementing management actions to address concerns and support state, federal and regional recommendations or initiatives.
Action 4: Manage, enhance and restore habitats by implementing activities to support the natural integrity of sites, working with partners and contributing to state and regional initiatives.
Action 5: Manage invasive, non-native and feral species by conducting survey, monitoring and treatment activities on sites and in coordination with partners as appropriate.

Action 6: Support efforts to assess and update rules and policies to respond to site conditions and ensure the Reserve's mission is fulfilled and local, state and federal laws are upheld.
Action 7: Document and maintain natural history records by developing a centralized online database, populating it with existing geographic and photographic species records, and continuing to document observances on sites.
Action 8: Enhance partnerships with natural resource management agencies and organizations by providing advisory services and developing collaborative projects that support protection of ecosystems.

3.2 Access is accommodated for site uses that maintain protection of natural resources and are compatible with research and education activities.

Action 1: Provide for public access to sites by installing and maintaining structures, signage, and trails to guide and inform visitors.
Action 2: Work with local partner agencies and governments to support efforts to provide access facilities for local communities to engage in nature-based recreational use of the sites.
Action 3: Provide information to specific user groups to promote safe and appropriate use of the sites while preserving natural integrity and minimizing impacts by providing information about site resources and guidance for minimizing impacts during use of sites.
Action 4: Inspire current and potential site users to appreciate and engage in the stewardship of estuarine and coastal ecosystems by providing opportunities for active participation in Reserve activities on the sites.
Action 5: Engage researchers, educators, and commercial operators as active participants in stewardship of the sites by encouraging them to provide information about site observances and their use of the sites.
Action 6: Assess and characterize use of the sites to inform balanced management between access and resource protection and to reduce potential conflicts between user groups by monitoring uses, engaging user groups, and implementing management actions.

3.3 Trained volunteers contribute to and benefit from supporting stewardship activities.

Action 1: Recruit volunteers to support stewardship activities by engaging students, community members, and civic groups and utilize volunteers to accomplish and enhance stewardship activities.
Action 2: Advance volunteers' skills and knowledge of stewardship of coastal and estuarine natural resources by providing mentoring, training, and hands-on field experiences.
Action 3: Provide a safety briefing at each volunteer training or activity.
Action 4: Facilitate management of volunteers to support Reserve programs by maintaining effective tracking and communication tools and providing current volunteer resources and materials.

3.4 Boundary expansion and acquisition opportunities are explored to protect Reserve resources.

Action 1: Evaluate acquisition of inholding and adjacent properties from willing sellers to expand boundaries to parcels that meet NERRS definitions for core and buffer areas as appropriate.

Action 2: Maintain and enhance relationships with adjacent and inholding property owners.

Action 3: Explore opportunities for assessing future acquisitions based on prioritization of habitat protection and ecosystem resilience needs.

Goal 4: The NCNERR is recognized as a leader in coastal and estuarine ecosystem research, training, education, and stewardship through effective administration and communication strategies.

Objectives:

4.1 Rules and policies assist in fulfilling the Reserve's mission and local, state, and federal laws.

Action 1: Evaluate and update rules through the Rules Review Process.

Action 2: Update policies as needed based on program and site conditions.

Action 3: Inform rule and policy updates with program and site assessment information.

4.2 Reserve core partnerships are enhanced.

Action 1: Strengthen relationship with OCM through annual cooperative agreements and performance reports, and by addressing federal evaluation recommendations, participating in national meetings and contributing to system-wide initiatives.

Action 2: Strengthen relationship with DCM by providing technical expertise on education, training, research, and stewardship, and collaborating on mutually beneficial activities and topics.

Action 3: Strengthen relationship with UNCW and CCFHR through regular communication with partner administrations, finalization and implementation of memoranda of understanding, participation in facility committees, and collaboration on mutually beneficial activities.

Action 4: Maintain and strengthen education, training, research, and stewardship activities through formal and informal partnerships.

4.3 Reserve operations support the implementation of the mission.

Action 1: Utilize a collaborative decision-making process and effective internal communication mechanisms to provide direction for the Reserve, foster understanding regarding decision-making and ensure that programs are appropriately supported.

Action 2: Ensure the Reserve's organizational structure supports staff and programs, including addressing staffing needs as resources are available.

Action 3: Utilize appropriate databases and performance measures to track and evaluate program achievement, natural resources and site use.
Action 4: Maintain and enhance file and data storage and sharing methods and infrastructure to meet current and future needs.
Action 5: Practice excellent workplace safety for staff, volunteers and visitors through effective procedures and appropriate equipment, supplies, and signage.
Action 6: Demonstrate sustainable and best management practices through use of appropriate supplies, materials and methods.
Action 7: Strengthen community and partner involvement in Reserve programs through local advisory committees (LAC).
Action 8: Leverage state and federal investments in the Reserve through internal and external funding opportunities to address needs and advance Reserve initiatives.

4.4 Staff are recognized as valued experts in their fields.

Action 1: Provide professional development opportunities annually to enhance and expand staff skills through appropriate means such as trainings and attendance at professional meetings.
Action 2: Encourage staff participation in local, state, regional and national committees and workgroups.
Action 3: Encourage staff to provide technical assistance to target audiences.
Action 4: Continue to promote Reserve programs through presenting at conferences, conducting public field trips, participating in partner events, and hosting volunteer activities.
Action 5: Organize and host a symposium to deliver NCNERR program highlights to a variety of target audiences.
Action 6: Provide students with skills to advance NCNERR programs and to inspire stewardship of coastal and estuarine ecosystems through a structured mentoring program.

4.5 Reserve communications are enhanced to increase audience engagement and program visibility and share important information.

Action 1: Brand the Reserve through consistent messaging and product format.
Action 2: Develop messages and products that highlight site research and relevant coastal and estuarine topics.
Action 3: Share Reserve accomplishments, upcoming activities, publications, data and resources on relevant coastal and estuarine topics to target audiences through the Reserve newsletter, website and social media.
Action 4: Share rules and policies that encourage safety and promote responsible use of sites by visitors.

Action 5: Increase Reserve presence in local media by connecting with reporters to share Reserve accomplishments, program information and opportunities.
Action 6: Enhance engagement and improve Reserve online communication by incorporating more visuals, creating infographics and exploring additional digital media.
Action 7: Use online tools to evaluate audience engagement.

NCNERR Topical Areas

To strengthen alignment of NCNERR programs and efforts with NERRS Strategic Goals and address stakeholder input, the NCNERR selected three topical areas of national, regional, state, and local importance: water quality, coastal and estuarine protection, and coastal hazards resilience. These areas were informed by current work and input from Reserve staff, public and local advisory committee meetings, partner surveys, and education and training needs assessments. There are a number of overarching threats and stressors that impact all sites of NCNERR such as invasive species, water quality issues, increased visitor use and sea level rise and storms. In addition to these overarching issues, individual Reserve sites face specific local challenges, including feral species, marine debris and shoreline change and sedimentation. By focusing on the three topical areas, many of these threats and stressors will be addressed and mitigated through the work of NCNERR programs. The topical areas will serve as focus and investment for the NCNERR Strategic Plan and will be addressed through a strategic and coordinated process. The NCNERR is uniquely positioned to address these topical areas using an integrated approach via its education, training, research, and stewardship programs and network of protected sites. Objectives and actions are outlined for each topical area to build on the current strengths of the NCNERR, address NCNERR needs, and advance work in the topical areas across geographic scales.

Water Quality

Maintaining and improving water quality at the NCNERR sites begins with understanding the present condition of our waters. The Reserve is uniquely positioned to access and translate the best available data on the condition of water quality by following NERRS SWMP protocols and using the network of water quality monitoring stations at Reserve sites. These monitoring data can be used by scientists, educators, managers, and commercial and recreational users for a variety of purposes. Additionally, the Reserve's ability to couple long-term monitoring data with management practices on Reserve sites and in adjacent coastal watersheds provides an opportunity to study the effectiveness of different management practices. The Reserve will integrate relevant research into education and training efforts targeted to a wide range of audiences including the general public, students, and key decision-makers and will explore opportunities for mutually beneficial partnerships with entities that most directly influence water quality.

Objectives:

T1.1 Increase knowledge of short and long-term water quality trends using data collected through SWMP and other water quality monitoring methods.
Action 1: Research staff continues SWMP monitoring and explores opportunities to expand SWMP monitoring.
Action 2: Research staff helps to advance Reserve staff understanding of water quality concepts and the utility of SWMP and water quality data through professional sharing opportunities.
Action 3: Research staff and partners analyze and synthesize SWMP data to identify locally, regionally, and nationally significant trends and patterns.
Action 4: Research staff networks with existing partners and forge new partnerships to integrate SWMP data into local and state-wide water quality monitoring programs.

T1.2 Integrate water quality concepts and Reserve water quality research into Reserve programs and products to improve understanding and awareness.
Action 1: Education and training staff works with research staff to incorporate water quality concepts and SWMP and water quality data into curricular activities, workshops for professionals, and other education programs.
Action 2: Research staff collaborates with other Reserve staff to develop communications products designed to increase awareness of water quality concepts, the Reserve's role in monitoring water quality and available data.
Action 3: Reserve staff engages participants in field-based stewardship activities that promote the importance of water quality and its protection.

T1.3 Improve water quality in Reserve site watersheds.
Action 1: Reserve staff collaborate with partners on projects that promote stormwater management, habitat restoration, living shorelines and low impact development.
Action 2: CTP staff delivers trainings and technical assistance on water quality best management practices.
Action 3: Reserve staff incorporate watershed concepts and impacts of human choices into program activities.

Coastal and Estuarine Ecosystem Protection

North Carolina has 2.2 million acres of biologically rich coastal and estuarine ecosystems that function as nurseries for commercially important fish and shellfish and offer protection for human communities from stormwater runoff, storm surge, and flooding by buffering wave energy and filtering pollutants. Because North Carolina's shallow sounds, rivers and creeks comprise one of the largest estuarine systems in the United States, it's important to monitor stressors affecting the health of these systems. Sea level rise (SLR), invasive species, and coastal development are just a few of the threats that can result in loss and alterations to habitat

and ecosystem function. The NCNERR is well suited to address these stressors through mapping and monitoring habitat change and developing, testing, and implementing methods for coastal and estuarine ecosystem protection. Reserve research and monitoring methods, along with best management practices that focus on protecting these ecosystems, can be shared through the Reserve's coastal training and community education programs and volunteer opportunities.

Objectives:

T2.1 Improve understanding of Reserve ecosystems, including the ecosystem services they provide, the threats they face, and how to best protect them.

Action 1: Research and stewardship staff generate baseline data on Reserve ecosystems and potential stressors and document change through habitat mapping, monitoring programs, and natural history records.

Action 2: Research staff communicates Reserve research needs relevant to quantifying estuarine ecosystem services to partners and research community and works with them to quantify estuarine ecosystem services and how services are impacted by stressors.

Action 3: Research and stewardship staff collaborate to design studies that address ecosystem protection and inform restoration and management projects.

Action 4: Reserve staff work with organizations involved in landscape-scale initiatives to further the protection and understanding of coastal and estuarine ecosystems.

T2.2 Inform target audiences about the importance of protecting coastal and estuarine ecosystems to inspire protection.

Action 1: Education staff collaborates with research and stewardship staff to inspire K-College audiences to appreciate and protect coastal and estuarine ecosystems through program offerings such as field trips, classroom visits and educational programs and materials.

Action 2: Reserve staff participates in efforts to educate the general public and site users by providing educational materials through the Reserve website, public presentations and events and interpretive signage.

Action 3: Stewardship staff engages community volunteers in species monitoring, research and protection projects, such as marine debris removal, habitat mapping, marsh grass planting and other activities.

Action 4: Training and education staff provide teachers and professionals with training on issues relevant to ecosystem protection such as low impact development, living shorelines, and coastal wetlands.

Action 5: Training and stewardship staff collaborate on training opportunities for the natural resource community to share information and tools to improve management of coastal and estuarine ecosystems.

Coastal Hazards Resilience

The natural geography and topography of North Carolina's coastline make it vulnerable to coastal hazards, such as flooding, coastal storms, shoreline erosion, and SLR. Assessing the vulnerability of coastal and

estuarine ecosystems at Reserve sites is accomplished through existing monitoring programs like SWMP, natural species surveys, habitat mapping, and elevation data. The NCNERR's ability to monitor and characterize these processes and changes is increasingly important when it comes to understanding and planning for coastal hazards to our ecosystems and coastal communities. The Reserve is equipped to improve the knowledge of coastal communities about the necessity of establishing long-term resilience through education, training, research, and stewardship activities that promote monitoring programs and the importance of natural infrastructure for coastal resilience.

Objectives:

T3.1 Assess vulnerability of Reserve natural resources to coastal hazards and use results to inform management decisions.

Action 1: Research and stewardship staff continue to implement SWMP, sentinel site and natural resource monitoring to understand vulnerability of species, habitats and/or geographic areas.

Action 2: Reserve staff and a collaborative team of land managers, researchers, and other relevant stakeholders identify and prioritize Reserve natural resources for vulnerability assessments.

Action 3: Reserve staff plans and implements strategies to improve resilience based on vulnerability assessments as resources are available.

T3.2 Increase understanding and communicate knowledge of the importance of natural infrastructure (e.g., oyster reefs, marsh, living shorelines) to coastal resilience.

Action 1: Research staff continues to conduct and explore opportunities to expand the Sentinel Sites for Sea Level Rise and Inundation application module of SWMP to assess the resilience of marshes to SLR.

Action 2: Research staff continues working with partners to evaluate the performance of living shorelines over time and during storms, and assess the impact of shoreline hardening on marshes.

Action 3: Reserve staff uses vulnerability assessments and resilience strategies to educate communities and coastal decision-makers on what coastal hazards are and the importance of natural infrastructure for coastal resilience through educational materials, research presentations, training events and hands-on stewardship activities.

Action 4: Training staff delivers training on natural infrastructure including living shorelines and coastal wetlands.

Action 5: Training staff assists coastal communities to implement actions that increase their resilience to coastal hazards through technical assistance.

T3.3 Increase understanding of sea level rise implications for Reserve sites and coastal and estuarine ecosystems by participating in local, regional, and state initiatives.

Action 1: Reserve staff advance the work of the NCSSC through participation in its Core Management Team and research and training activities.

Action 2: Reserve staff support DCM initiatives to address sea level monitoring and resilience planning.

Environmental Setting

North Carolina lies midway along the United States (U.S.) eastern seaboard. The total area of the State is 52,669 square miles, of which 48,843 square miles are land and 3,826 square miles are water (State Library of North Carolina 2008). The state is divided into three distinct geographic regions (the Coastal Plain, the Piedmont, and the Mountains) and two unique biogeographical provinces (the Virginian and Carolinian).

North Carolina's coastal plain extends out from the east coast of the United States into the Atlantic Ocean and the Gulf Stream. The land and water areas of the coastal plain comprise nearly half the area of the State. The coastline is further subdivided into three distinct regions (Northern, Central and Southern) based on geomorphological and ecological features. Each region has a unique geologic framework that results in distinctive types of barrier islands, inlets, and estuaries influenced by different wave and tidal processes (Pilkey et al. 1998). The underlying geology leads to distinguishing coastal habitat types with different biological and anthropogenic influences. The NCNERR was established as a multi-site Reserve to include sites in both the Virginian and Carolinian biogeographic region as well as the three regions of the coastal plain. As a consequence, the Reserve is made up of four geographically disparate sites consisting of unique representative coastal and estuarine ecosystems.

North Carolina's 2.2 million acres of estuarine waters make it one of the largest estuarine systems in the United States. The North Carolina coast includes over 10,500 miles of estuarine shoreline, with a wide range of habitats. Estuaries and the lands surrounding them are places of transition from land to sea, and from fresh to saltwater. Estuarine environments are influenced by the tides yet are protected from the full force of ocean waves by barrier islands, reefs, or sand formations on the seaward boundary. Estuaries are among the most productive environments on earth and contain many different habitat types.

Coastal and estuarine ecosystems are subject to hazards that are unique to their position in the landscape. North Carolina's geography makes it prone to strikes by tropical and coastal storm systems. Coastal storms bring tremendous amounts of wind and rain to the coastal region and are capable of causing significant shoreline erosion and flooding. From 1851 to 2014, North Carolina had more direct hurricane landfalls (48 hurricanes) than any other state on the east coast, except for Florida (141 hurricanes) (N.C. Climate Office). These impacts are of consequence coast-wide as well as for the four NCNERR sites which are coastal barriers or estuarine islands located at the interface between the ocean and land. Increasing storm intensity and frequency will cause degradation of water quality and coastal and estuarine ecosystems caused by flooding, erosion, and runoff (Global Climate Change Impacts in the United States 2009). Sea level rise is also occurring along the coast. According to the N.C. Sea Level Rise Assessment Report, if existing trends continue for the next 30 years, sea level will be expected to rise between approximately 2 and 6 inches across the North Carolina coast, with the highest sea levels expected in Dare County in the northeast and the lowest along New Hanover and Brunswick counties to the south (2015 N.C. Sea Level Rise Assessment Report). Higher sea levels may lead to loss of marsh and other estuarine habitats and enhance shoreline erosion at Reserve sites.

In addition to having impacts on coastal and estuarine ecosystems, more frequent and severe flooding, storm events, and rising water levels can also affect North Carolina's coastal economy in several ways. Tourism and real estate are at risk to flooding and storms (N.C. Coastal Habitat Protection Plan 2015). Tourism and recreation are two industries that fuel the economy in North Carolina. In 2012 the GDP for tourism and recreation industries was over 1 billion dollars, over half of the total GDP for all ocean industries in North Carolina (NOAA Digital Coast 2012). Many residents along the coast live in homes located within the FEMA floodplain and are at risk of flooding. Within the four counties in which Reserve sites are located, the percentage of the total population living in a floodplain are as follows: 52% in Currituck County, 33% in Carteret County, 18% in New Hanover County, and 25% in Brunswick County (NOAA Digital Coast 2012). Because of the risks associated with coastal hazards, educating local communities about coastal resilience and resilient infrastructure is increasingly important.

Reserve Site Descriptions

The diverse range of habitats in North Carolina noted above make it an ideal location for a National Estuarine Research Reserve. The multi-site NCNERR, through its Currituck Banks, Rachel Carson, Masonboro Island and Zeke's Island Reserves, represents and protects a broad range of coastal and estuarine ecosystem diversity present in the State.

There are a variety of unique characteristics that are taken into account in the management of and implementation of programs at the four NCNERR sites. The following site descriptions explain the history, local management, location, and social attributes that are unique to each of the four NCNERR sites. The physical and environmental characteristics specific to each Reserve site, including geography, geology, hydrology, biological resources, climate, weather, and key habitat and species, are also defined to convey both the similarities and differences between the four sites. Understanding the existing site conditions and anthropogenic and environmental stressors is imperative to the management and support of each site's natural resources in adapting to changing conditions. Site-specific threats and stressors are addressed in each site description, along with a brief statement explaining how these threats impact the site. Threats and stressors that are common to all sites include water quality, sea level rise and storms, invasive species, and visitor use.

Reserve boundaries encompass two areas, core and buffer, which are also described and depicted for each site in the descriptions below. Core and buffer areas are established to ensure adequate control by the managing entities over human activities occurring within all areas of the Reserve boundary; definitions for core and buffer areas are provided in the NERRS regulations and are discussed previously in the National Estuarine Research Reserve Administrative Framework section. Core areas within the Reserve boundaries are comprised of estuarine habitats. Buffer areas are comprised of ocean beach, palustrine, and upland habitats. Core and buffer areas were updated based on the most recent habitat mapping assessment using 2010

imagery. As a result, the core and buffer area boundaries and acreages have shifted slightly over time due to refinements in mapping technologies and changes in habitat distribution. Habitat maps for each site depict intertidal and supratidal habitat; subtidal habitats have not been mapped. More information about habitat mapping protocols can be found in the Research Program Chapter in the Management Plan.

Currituck Banks Reserve

Site Description and Location

The Currituck Banks Reserve, designated in 1985, is the northernmost site within the NCNERR and the only site located in the Virginian biogeographic province (Figure 2). Currituck Banks Reserve is included in the NCNERR because it serves as an excellent example of an undisturbed cross-section of a barrier island in a low-salinity estuarine system.

Currituck Banks Reserve encompasses 965 acres in the northeastern corner of North Carolina in Currituck County on the Outer Banks. The site is ten miles south of the Virginia border and a mile north of the unincorporated village of Corolla. The Nature Conservancy and U.S. Fish and Wildlife Service properties bound Currituck Banks to the north, the Atlantic Ocean to the east, the Currituck Sound to the west, and private subdivisions of Corolla to the south (Figure 3).

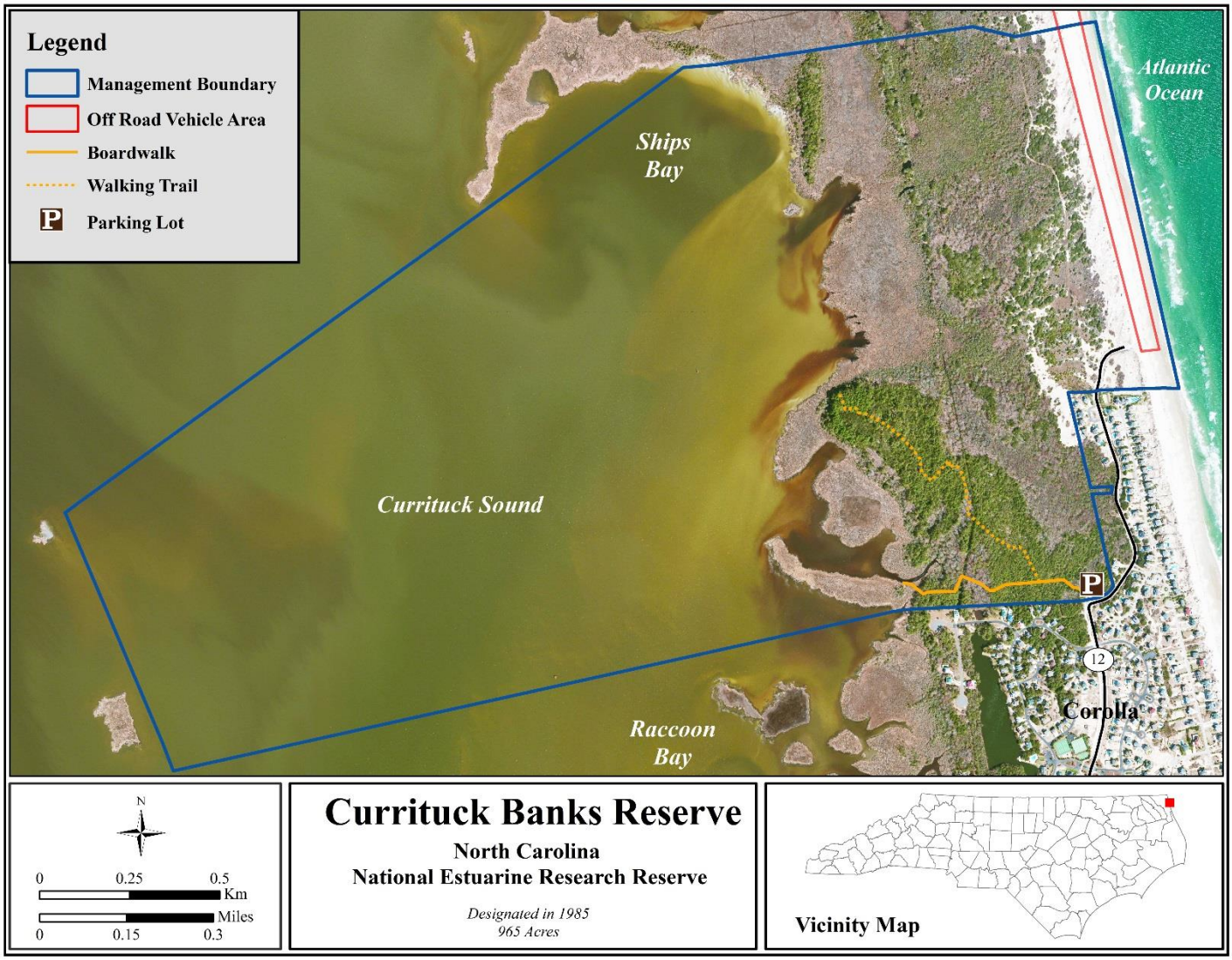

Figure 3. Currituck Banks Reserve Boundary Map

The delimited portion of Currituck Sound and the associated marshes constitute the 713 acres of estuarine habitats in the Currituck Banks Reserve core area. The sound waters contain extensive mud and sand flats covered in some areas by submerged aquatic vegetation. Ocean (18 acres), palustrine (89 acres), and upland habitats (145 acres) comprise the 252 acres of buffer area including ocean beaches, dunes, shrub thickets, maritime forests, and interdune ponds. The 1/3-mile boardwalk, 3/4 mile walking trail and parking lot are located in the buffer area of Currituck Banks Reserve (Figure 4).

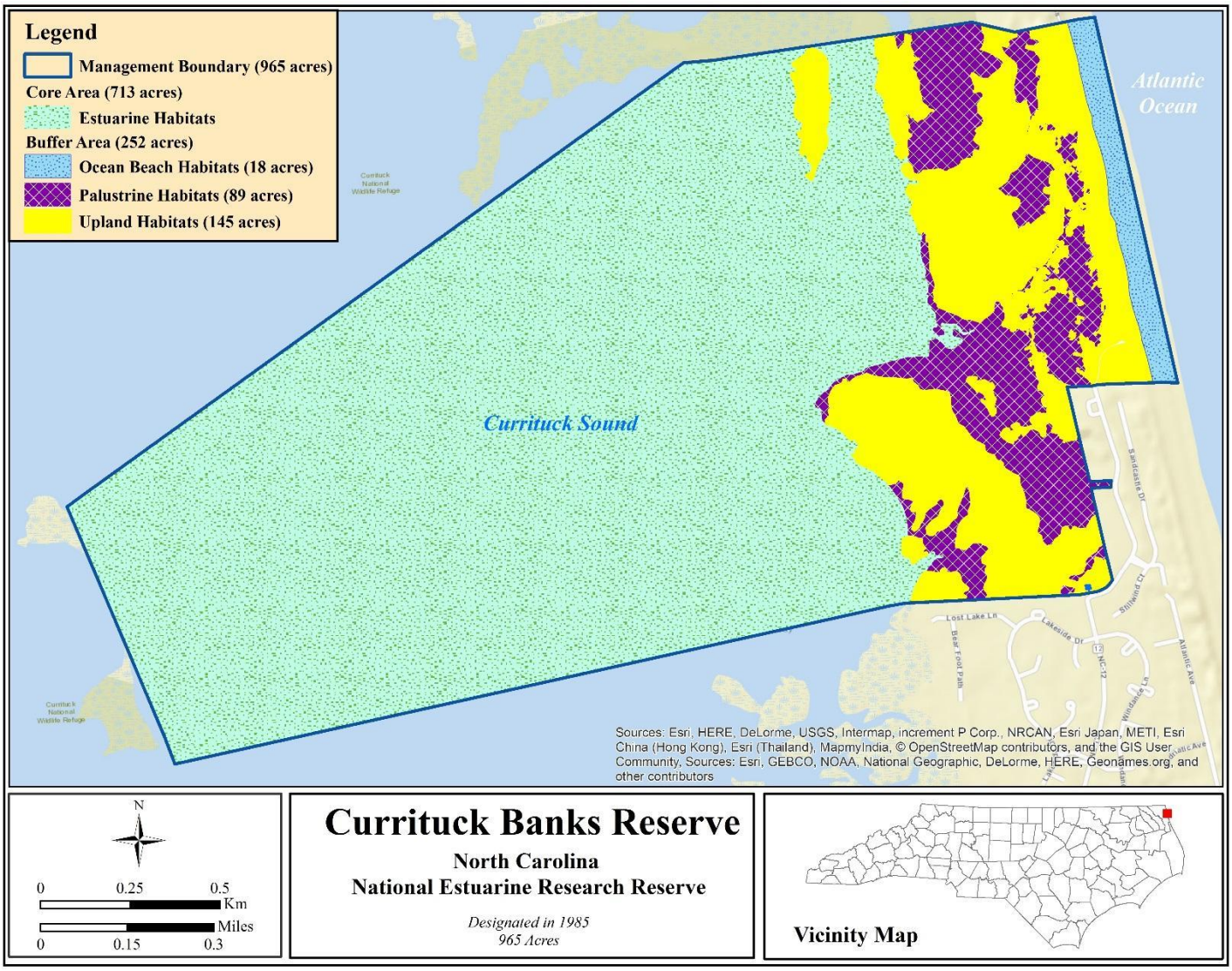

Figure 4. Currituck Banks Reserve Core and Buffer Map

The Currituck Banks Reserve is owned by the State of North Carolina and management of the site is delegated by the State to DCM. Several access easements are held on the Currituck Banks Reserve including two by Currituck County along the southeast boundary of the site for pedestrian access and one by Dominion Power for underground power lines that run parallel to the beach just behind the main dune line (Appendix I). The Nature Conservancy placed a conservation easement on one of the two tracts purchased that comprise the Currituck Banks Reserve prior to the State of North Carolina taking ownership of the Reserve. The conservation easement has since been transferred to the U.S. Fish and Wildlife Service.

The Currituck Banks Reserve is managed by the Northern Sites Manager based out of the Northern Sites Reserve office, located 20 miles south of the site in Kitty Hawk, N.C. The Northern Sites Manager conducts regular site maintenance and other management activities with assistance from seasonal interns, university

volunteers, and local community volunteers. Land management and species monitoring activities are conducted in cooperation with various state and federal agencies and local partner organizations, including The Nature Conservancy, N.C. Wildlife Resources Commission (WRC), and U.S. Fish and Wildlife Service. Enforcement activities are conducted by the Currituck County Sheriff's Office and State law enforcement agencies on behalf of and in coordination with the NCNERR.

Currituck Banks Reserve is used as a resource for educational and research activities led by Reserve staff and partners. Reserve staff and the WRC provide environmental education programs for the general public on the interpretive boardwalk and visitor trail. Long-term research and monitoring by Reserve staff at Currituck Banks Reserve includes the habitat mapping component of the System-wide Monitoring Program (SWMP) and monitoring long-term changes in marsh surface elevation. Scientists and students from academic and research institutions, resource management agencies, and environmental and conservation organizations investigate a wide array of coastal topics at the site.

Currituck County is located in the Pasquotank River Basin and has approximately 813 miles of estuarine shoreline (Figure 5, part of Albemarle Hydrologic Unit Code: 03010205) (Estuarine Shoreline Mapping Analysis Report 2012). Land uses vary between the mainland and barrier island regions of Currituck County. The northeastern portion of the county on the barrier island where Currituck Banks Reserve is located is dominated by vast expanses of wetlands on the sound side of the barrier island and also contains the villages of Corolla and Carova, both of which are experiencing development. These communities bracket the Currituck Banks Reserve and The Nature Conservancy and U.S. Fish and Wildlife Service properties to the north of the Reserve. The mainland portion of the county, which is farthest from the Reserve, is used agriculturally. In addition to continued residential development, construction of vacation rental homes is steadily increasing in the county (Census.gov 2014).

Currituck Banks Reserve: Pasquotank River Basin, 2010 Land Cover
Data from NOAA CCAP

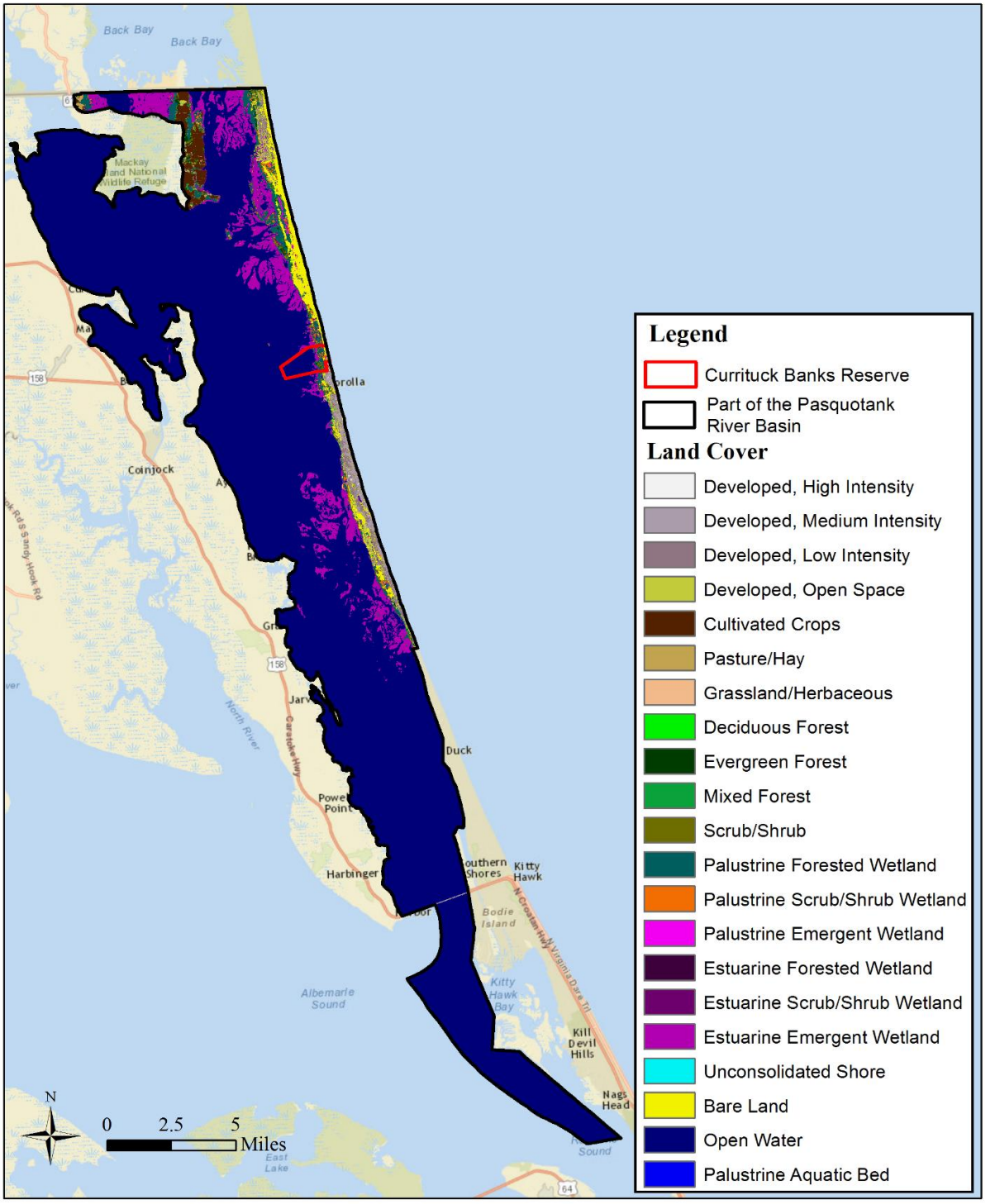

Figure 5. Currituck Banks Reserve Watershed Map

In 2014, the population of Currituck County was nearly 24,980. Of the total population, 50.3% were females and 49.7% were males (Census.gov 2014). The county population is made up of: 90.4% White, 6.1% Black, 3.7% Hispanic or Latino (Census.gov 2014). Census data from 2013 shows the average household income within the county was just under $67,600, and an estimated 6.4% of the population was living below the poverty line (Census.gov 2013). Industries that boast the most employment in Currituck County include trade, transportation, educational services, manufacturing, retail trade, and financial activities (Census.gov 2013).

The Currituck Banks Reserve is accessible by foot traffic and boat. The nearest public boat ramp is located next to the Currituck Lighthouse in Corolla and is managed by Currituck County. Use of the ramp is limited to smaller vessels and kayaks due to extremely shallow waters at the ramp. Two walking trails exist at the southern portion of the site just off N.C. 12 where public parking and handicap access is available. The ocean beach portion of the Reserve is accessible by four-wheel drive along the beach corridor after N.C. 12 terminates at the beach access ramp. This area of the Reserve is heavily used by the public to access the beaches north of the Reserve and the village of Carova.

The Currituck Banks Reserve is used regularly by the public for traditional activities such as nature-based recreation, hunting, and fishing. Popular recreational activities at the site include hiking and wildlife observation which are largely restricted to the ocean beach area and walking trails because of the mosaic of dense or seasonally wet habitats at the site. Other recreational activities include fishing, crabbing, birdwatching, and kayaking. Hunting is permitted during the fall and winter months.

Geomorphology, Hydrology, Climate, and Weather

Throughout recent geologic time, the barrier landform that includes Currituck Banks has been very dynamic. It has migrated inland in response to sea level changes, and several inlets have opened and closed. Currently, the landform consists of a solid barrier spit that extends about 70 miles from Virginia Beach, V.A., to Oregon Inlet, N.C. This limits sound to ocean exchange and because of the distance to the Oregon Inlet, Currituck Sound is a predominately oligohaline body of water with wind driven tides. The sediments that comprise the barrier spit are very similar to those that make up the rest of the Outer Banks. They consist of both Recent (less than ~11,550 years old) and Pleistocene (~1.8 million to ~11,550 years before present) sediments. The Pleistocene sediments represent ancient sand shoals that have been pushed landward by oceanic processes (Atkinson et al 1998).

Currituck Sound is approximately 35 miles long, varies from 4 to 15 miles wide, and is extremely shallow, averaging 5 feet. Water movement in Currituck Sound is driven primarily by wind. This means that the water levels in Currituck Sound can change dramatically and rapidly in response to changes in the wind pattern. North winds tend to blow water out of the sound and southerly winds tend to force water into the sound. Because of this relationship between wind direction and water level, water levels tend to be highest in summer when winds blow mostly from the south-southwest, and tend to be lowest in the winter when winds predominately blow from the north-northeast (Caldwell 2001).

The shallower regions of Currituck Sound contain vast meadows of submerged aquatic vegetation. Marshes border the sound. Habitats found within the core area are influenced by brackish sound waters with seasonal ranges in salinity from 0 - 5 ppt, with occasional spikes in salinity that rarely exceed 10 ppt. Lunar tides determine the water level on the ocean beach. The waters of Currituck Sound are designated as "SC" by the N.C. Division of Water Resources, which means they are protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife.

The weather of Currituck Banks is typical of a maritime climate on the Outer Banks with the ocean having a strong moderating effect on air temperature compared to the mainland areas. Climatologically, Currituck Banks is classified as subtropical with humid, warm summers and mild winters. The mixing of the warm Gulf Stream and the cool Labrador Current off Currituck Banks creates a climate where northern species reach the southern limit of their ranges and southern species reach the northern limit of their ranges. As a result, a diversity of species from both regions is found within the site's boundary.

Key Habitats and Species

Habitats in the core area include subtidal soft bottoms and tidal flats with submerged aquatic vegetation, emergent marsh and scrub-shrub wetlands (Figure 6). The marsh is primarily composed of giant cordgrass (*Spartina cynosuroides*), black needlerush (*Juncus roemerianus*), and cattails (*Typha spp.).* Habitats found within the buffer area of Currituck Banks Reserve consists ocean beach, sand dunes, grasslands, shrub thickets, and mature deciduous and evergreen maritime forests that are primarily composed of live oak (*Quercus virginiana*), loblolly pine (*Pinus taeda*), longleaf pine (*Pinus palustris*), red maple (*Acer rubrum*) and common persimmon (*Diospyros virginiana*). The mature maritime deciduous forest within the site's boundaries is one of the rarest habitat types on the U.S. east coast (Schafale & Weakley 1990). The interior uplands of Currituck Banks are characterized by dense woody vegetation intermingled with numerous seasonal wetlands.

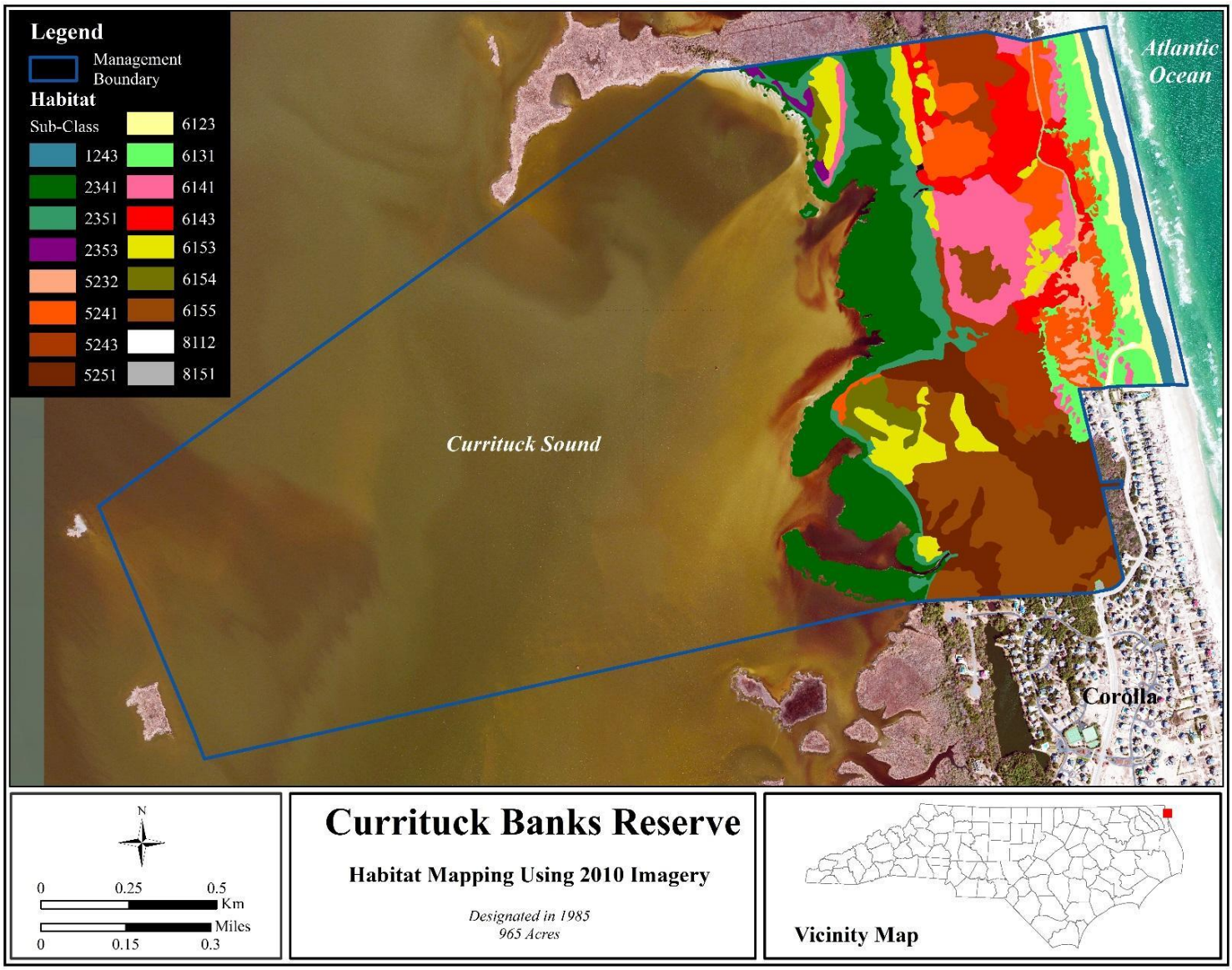

Figure 6. Currituck Banks Reserve Habitat Map

Habitat	Subsystem		Class		Sub-Class		COLOR
Marine	1200	Intertidal	1240	Unconsolidated Shore	1243	Sand	
Estuarine	2300	Supratidal Haline	2340	Emergent Wetland	2341	Persistent	
			2350	Scrub Shrub Wetland	2351	Broad Leaf Deciduous	
					2353	Broad Leaf Evergreen	
Palustrine	5200	Intermittent or Saturated	5230	Emergent Wetland	5232	Persistent	
			5240	Scrub Shrub Wetland	5241	Broad Leaf Deciduous	
					5243	Broad Leaf Evergreen	
			5250	Forested Wetland	5251	Broad Leaf Deciduous	
Upland	6100	Supratidal Upland	6120	Unconsolidated Upland	6123	Sand	
			6130	Herbaceous Upland	6131	Grassland	
			6140	Scrub Shrub Upland	6141	Broad Leaf Deciduous	
					6143	Broad Leaf Evergreen	
			6150	Forested Upland	6153	Broad Leaf Evergreen	
					6154	Needle Leaf Evergreen	
					6155	Mixed	
Cultural Land Cover	8100	Developed Upland	8110	Impervious Cover	8112	Paved Roadway	
			8150	Unconsolidated Cover	8151	Dirt/Gravel Lot	

Table 1. Currituck Banks Reserve Habitat Map Legend

There is a rich community of both commercial and game fish species in the sound, such as largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), pumpkinseed (*Lepomis gibbosus*), blue-spotted sunfish (*Enneacanthus gloriosus*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus),* American eel (*Anguilla rostrata*), and channel catfish (*Ictalurus punctatus*). Other fish include tidewater silverside (*Menidia peninsulae*), white perch (*Morone americana*), common carp (*Cyprinus carpio*), hickory shad (*Alosa mediocris*), and herring (*Alosa aestivalis*).

The dense forest canopy, shrub thickets, and marsh provide useful habitat for a variety of birds that include raptors, songbirds, wading birds, and shorebirds that utilize the Reserve throughout the year. Birds found in the area that are of special concern include the bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), black skimmer (*Rynchops niger*), least tern (*Sterna antillarum*), common tern (*Sterna hirundo*), and tri-colored heron (*Egretta tricolor*). Piping plover (*Charadrius melodus*), a federally protected threatened species, and Wilson's plover (*Charadrius wilsonia*), a state species of special concern, exist at the Currituck Banks Reserve (NC Natural Heritage Program 2016). Currituck Sound is located within the Atlantic Flyway and the Reserve site is especially important for migrating waterfowl.

Feral horses (*Equus caballus*), feral pigs (*Sus scrofa*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canus latrans*), gray fox (*Urocyon cinereoargenteus*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), and marsh rabbit (*Sylvilagus palustris*) are common mammals found at the Reserve. Red fox (*Vulpes vulpes*) have recently been observed within site boundary as well.

Threats and Stressors

Feral Species

The presence of feral pig and horse populations impact estuarine productivity and alter natural ecosystem processes at the site through foraging and rooting, trampling of vegetation, and excretion of waste. Control efforts for feral pigs are underway through a trapping program in partnership with The Nature Conservancy and U.S. Department of Agriculture and pigs are also hunted by permit at the site. Currituck Banks Reserve is within the Currituck County-designated Wild Horse Management Area for the Currituck County feral horses. The horses roam the area and are not owned or managed by the State, but have been granted special status by the State due to their cultural significance even though they are considered an introduced species. The Northern Sites Manager serves on the Currituck County Wild Horse Advisory Board, which meets quarterly with partners to implement the 2014 Wild Horse Management Agreement.

Invasive Species

Invasive plant species can alter habitats by outcompeting native vegetation. Several invasive species are currently a threat to the Currituck Banks Reserve. Various olive species (*Elaeagnus sp.)* are continuously introduced to the Reserve due to landscaping on surrounding properties that serve as seed sources. Alligator weed (*Alternanthera philoxeroides*) has been observed, but the extent of its presence is unknown at this time. Eurasian water milfoil (*Myriophyllum spicatum*) is present at the site and throughout Currituck Sound. Common reed (*Phragmites australis)* is also present and poses a risk to native marsh plant communities. Over time, invasion by additional species, such as hydrilla (*Hydrilla verticillate*) or pampas grass (*Cortaderia selloana*), may take place as range expansion occurs or new species are introduced to the region.

Visitor Use

Currituck Banks Reserve's location near the terminus of N.C. 12 and access point to the northern Currituck County beaches has resulted in increased public use in recent years. The small parking lot at the Reserve is the northernmost parking lot on N.C. 12 and thus, this area experiences an exceptional amount of traffic in the summer months. The parking lot is sufficient for boardwalk and hiking trail users but is often beyond capacity due to inappropriate use by commercial entities and public individuals who use it to access areas north of the Reserve, which is accessible only by four-wheel drive vehicles. This impacts the ability of visitors, researchers, and Reserve staff to access the site by means of the boardwalk or hiking trail. The proposed construction of the Mid-Currituck Bridge connecting mainland Currituck County to the Currituck Outer Banks south of the Reserve will provide easier access to the area and likely increase use at the site. The Reserve regularly promotes responsible visitor use of the site through signage, various communication initiatives, and social media to help maintain a balance between resource protection and public enjoyment and safety. Enforcement of Reserve rules and policies as well as State and local laws is provided by partner agencies which often have limited time and resources to devote to this effort.

Water Quality

Historically, Currituck Sound has fluctuated between a saline and a freshwater environment, depending on the presence of an inlet opening in the barrier island. The last inlet closed in 1828. Since then, the system had been predominantly fresh water, but human-induced landscape alterations such as the Albemarle and Chesapeake Canal connecting the Chesapeake Bay to Currituck Sound may be a source of salinity entering Currituck Sound (Caldwell, 2001). Ecological conditions in and around Currituck Sound in northeastern North Carolina and southeastern Virginia have changed noticeably since at least the 1980s. Fish population surveys have indicated a decrease in freshwater species and an increase in estuarine species. These changes are attributed to an increase in salinity in the sound (Southwick and Norman, 1991). A decline in submerged aquatic vegetation beds has been attributed to a decline in water quality due to a decrease in submerged aquatic vegetation root systems and underwater biomass resulting in increased resuspension of fine sediments and associated nutrients during wind events (U.S. Army Corps of Engineers, 2001). Anthropogenic and natural causes may have led to a general reduction in water quality that is causing impacts on species diversity and community composition (USGS, 2016).

Sea Level Rise and Storms

Barrier islands ecosystems are subject to forces such as sea level rise and storms that move sediment, cause changes in topography and geomorphology, and require constant adaptation by vegetation communities. As sea level rises, barrier islands retreat landward. Large storms such as nor'easters and hurricanes redistribute sediment across the barrier beach, and sediment from the water column is deposited on the surface of the marsh, though accretion rates in the marsh are not well understood. The 2015 N.C. Sea Level Rise Report Update shows the highest amount of sea level rise occurring in the northern regions of the coast. Over the next 30 years, a mean increase of 5.4 inches in sea level rise is predicted in Duck, N.C., which is roughly 15 miles south of Currituck Banks Reserve. Sea level rise and storms have the potential to result in significant change to the site's natural resources, particularly if water levels change at a greater rate than accretion is occurring.

Rachel Carson Reserve

Site Description and Location

The Rachel Carson Reserve, designated in 1985, is named for Rachel Louise Carson (1907-1964), a federal scientist and naturalist, who conducted research at the site in the 1940s. The Rachel Carson Reserve is part of the NCNERR because of its extensive pristine salt marshes and intertidal and subtidal flats. The site also represents a typical Mid-Atlantic coast intertidal estuarine-marsh system that is strongly influenced by both river and inlet dynamics. The site is located within the Carolinian biogeographic province (Figure 2).

The site is located between the mouths of the Newport and North Rivers in southern Carteret County, directly across Taylor's Creek from Beaufort, N.C. The 2,315-acre site consists of a complex of several small islands: Carrot Island, Town Marsh, Bird Shoal, Horse Island, and Middle Marshes, which is located across North River

Channel from the other four islands. The Morehead City State Port is located 2.75 miles to the west-northwest. The site is bounded to the north by Taylor's Creek and Beaufort, to the east by Back Sound, to the south by Shackleford Banks (Cape Lookout National Seashore) and Beaufort Inlet, and to the west by Pivers and Radio Islands (Figure7).

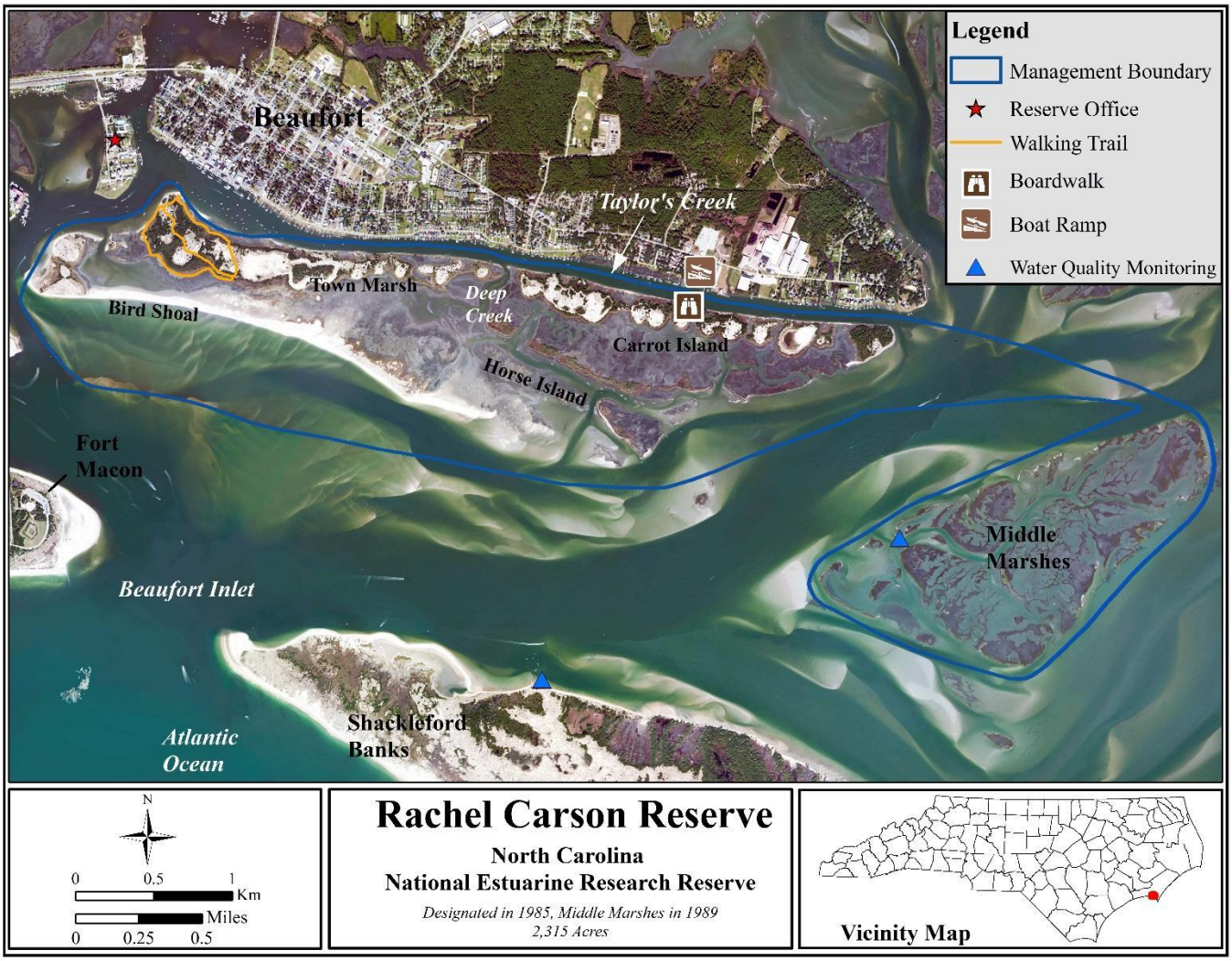

Figure 7. Rachel Carson Reserve Boundary Map

The Rachel Carson Reserve core area includes 2,134 acres and consists of sound waters, tidal flats, creeks, and marshes that occur within the five islands that comprise the site. The buffer area totals 181 acres and includes dredge material deposits, beaches, dunes, shrub thickets, and a remnant of maritime forest (Figure 8).

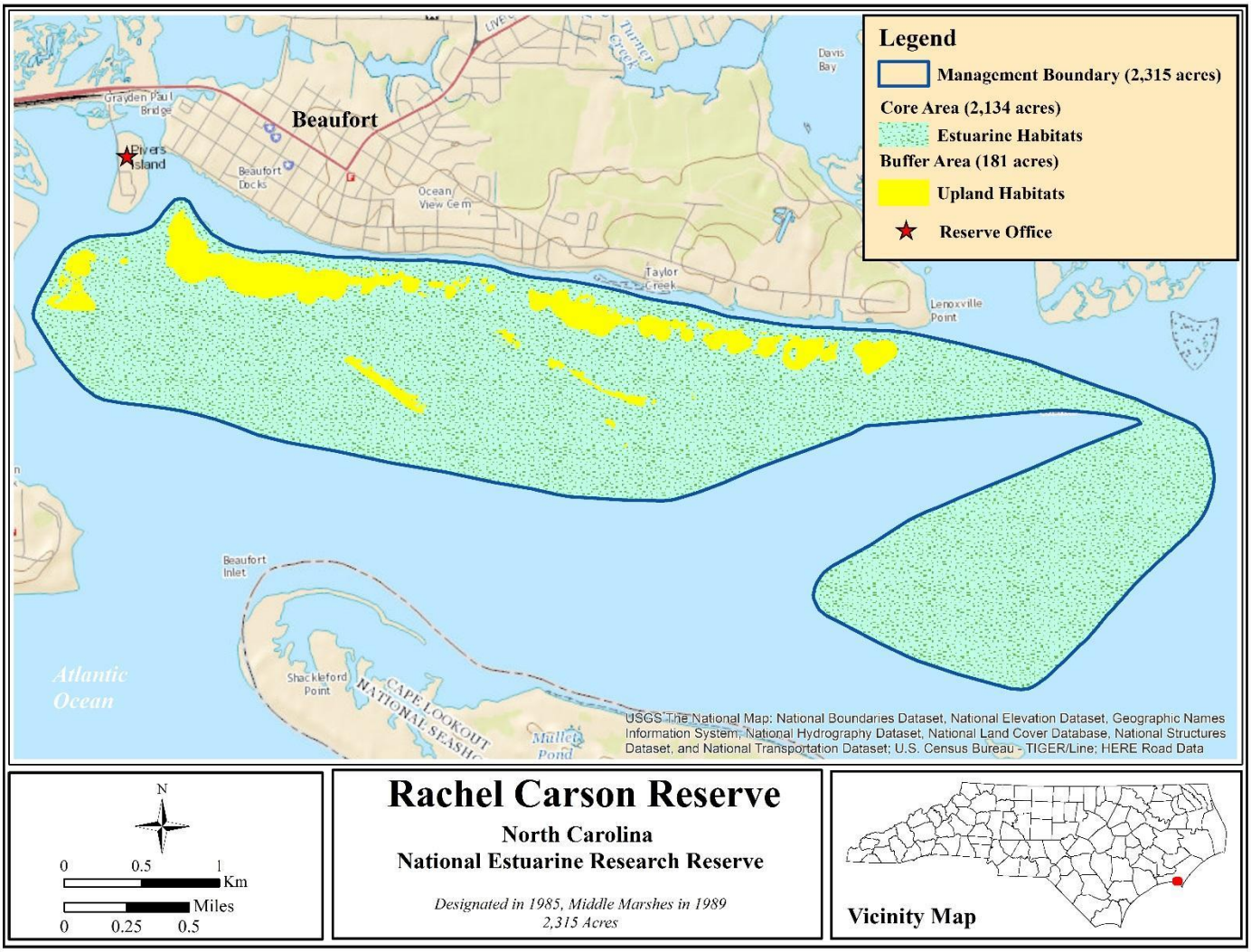

Figure 8. Rachel Carson Reserve Core and Buffer Map

The Rachel Carson Reserve is owned by the State of North Carolina and management of the site is delegated by the State to DCM. The site was added to the NCNERR following the efforts of the local community to prevent residential development on Carrot Island. The State acquired Town Marsh, Carrot Island, Horse Island, and Bird Shoal in 1985, with the addition of Middle Marshes in 1989. The western portion of the Reserve is within Beaufort's city limits. Parts of Town Marsh and Bird Shoal are designated as part of the Beaufort Historic District that is part of the National Register of Historic Places. This designation was formalized in 1974, in part, to protect Beaufort's waterfront viewscape and the potential for the islands to yield archaeological resources. The U.S. Army Corps of Engineers holds an easement along the north side of Town Marsh and Carrot Island for dredge material deposition within designated cells. The site is managed by Reserve staff at the Beaufort office located at the NOAA Beaufort Lab. Seasonal staff and volunteers conduct and support

management activities. Land management and species monitoring activities are conducted in cooperation with various State and Federal agencies, as well as local partner organizations. Enforcement activities are conducted by local and State law enforcement agencies on behalf of and in coordination with the Reserve.

The site is located in the White Oak River Basin (Figure 9, part of Bogue-Core Sound Hydrologic Unit Code: 03020106). In Carteret County, there are over 1,530 miles of estuarine shoreline and land use varies by region: east, central, and west (Estuarine Shoreline Mapping Analysis Report 2012). The eastern part of the county is dominated by vast expanses of wetlands and agriculture interspersed with several small communities. The central area (including the Rachel Carson Reserve) comprises the population centers of Beaufort, Morehead, and Newport, all of which are experiencing population growth and development. The western portion of the county contains the largest population base and is experiencing the most development. In addition to residential development, scattered commercial and industrial development continues to occur throughout the county (Carteret County 2005 Land Use Plan). The main industries in the area include management, business, science, arts, sales, and office occupations (Census.gov 2013). The 2014 population estimate in Carteret County is just over 68,800 (Census.gov 2014). Of that 68,000, 49.3% were male and 50.7% were female. (Census.gov 2014). The county population is comprised of: 89.7% White, 6.2% Black, 4.3% Hispanic or Latino (Census.gov 2014). In 2013, the average household income was $61,663 and the percentage of the population living below the poverty line was 14.4% (Census.gov 2013).

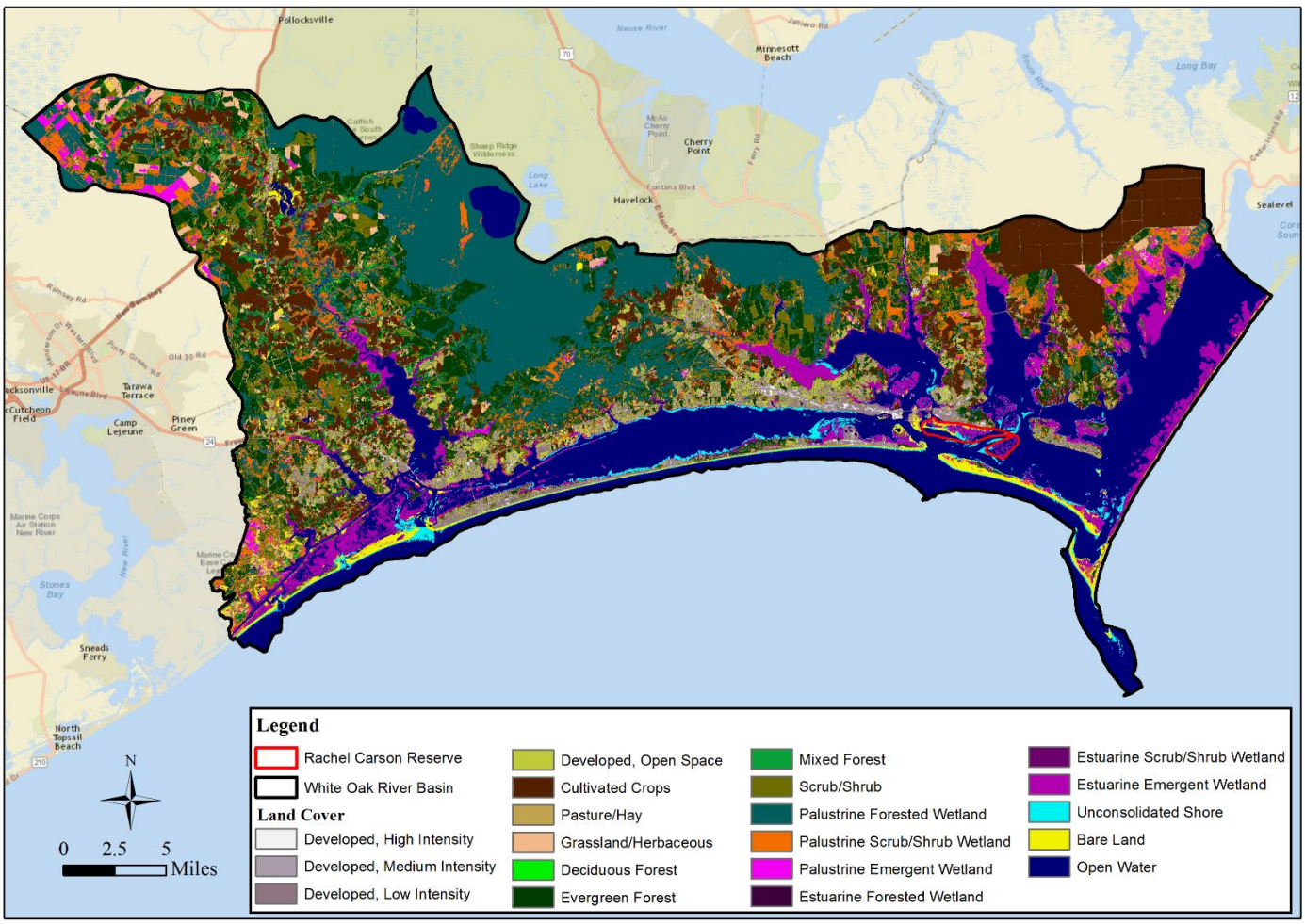

Figure 9. Rachel Carson Reserve Watershed Map

The site is located in a nationally and internationally recognized marine science and education community that has been in existence for over one hundred years. Duke University Marine Laboratory (DUML), the University of North Carolina's Institute of Marine Sciences (IMS), and North Carolina State University's Center for Marine Sciences and Technology (CMST) are located in the area, as is NOAA's Center for Coastal Fisheries and Habitat Research (CCFHR), the N.C. Division of Marine Fisheries (DMF), and DCM.

The Rachel Carson Reserve serves as an outdoor classroom for teachers, students, and the general public. The site also serves as a living laboratory for coastal research. Reserve staff offer educational programs at the site that focus on exploring local habitats and understanding the importance of estuaries spring through fall. Additionally, partner organizations occasionally offer similar field trips to the Reserve. Long-term research and monitoring is conducted by Reserve staff at the site and includes SWMP-like water quality monitoring,

biological monitoring of emergent marsh vegetation, habitat mapping, and monitoring long-term changes in marsh surface elevation. Partner organizations and university students and researchers investigate a wide array of coastal topics at the site.

The site is accessed by a variety of user groups including scientists, students, recreational users, and commercial businesses (ferries and tour groups). The site can only be reached by boat. The WRC operates a public boat ramp and parking lot along Taylor's Creek at the intersection of Front Street and Lennoxville Roads. Several private ferry and tour companies offer access to the Reserve from Beaufort. Interpretive walking trails, approximately one mile each, are available on the west end of Town Marsh, and a boardwalk with interpretive signs is located on the east end of Carrot Island across from the boat ramp.

The Rachel Carson site is used regularly by the public for traditional activities such as nature-based recreation, commercial and recreational fishing and hunting. The creeks, marshes, and waters within the site's boundary are used extensively by motorized and non-motorized vessels for boating, tours, and fishing. Sunbathing, swimming, and general beach-going along the shoreline are common activities. Hunting occurs in the marshes and dredge material deposition occurs in areas outside of Beaufort's city limits.

Geomorphology, Hydrology, Climate, and Weather

Carteret County is located in the south-central part of the North Carolina coastal plain. In general, the county's land surface is a plain representing a former sea floor that has been elevated above sea level in the relatively recent geologic past. Unlike the other sites that make up the NCNERR, Rachel Carson is not a true barrier island. The underlying sediments are a relict flood tide delta from a now closed inlet. These sediments raised the estuarine bottom enough to produce several shoals and small islands. The islands and tidal flats comprising Rachel Carson consist of Recent (less than ~11,550 years old) and Pleistocene (1.8 million to ~ 11,550 years ago) sediments (Atkinson et al. 1998). Over time this area was colonized by marsh plants which stabilized the sediments. During the early 1900s the U.S. Army Corps of Engineers placed material from the dredging of Taylor's Creek on areas of these low lying marshes and shoals. These dredge material deposition areas now make up the upland portions of the Reserve, which provide habitat for many upland plant and animal species.

The waters around Rachel Carson are generally less than 6 feet in depth except for a few deep sloughs and Taylor's Creek that is periodically dredged by the U.S. Army Corps of Engineers. Tides in the Rachel Carson area average about 3 feet and are semidiurnal in nature and average salinity of the surrounding waters is around 30 ppt. The Reserve is located in the convergence zone of several bodies of water: the Newport River, North River, Back Sound, and Bogue Sound. Currents in the region are highly influenced by the adjacent Beaufort Inlet. Waters in different areas of the site are assigned specific surface water designations by the N.C. Division of Water Resources. The waters of Taylor's Creek are designated as "SC" which means they are protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife. Waters south of

Taylor's Creek that are included in north Back Sound are designated as High Quality Waters and waters that are located along the southern shore of the site through Middle Marshes are designated as Outstanding Resource Waters.

The weather of the Rachel Carson Reserve is typical of a southeastern coastal climate where the ocean has a strong moderating effect on air temperature, thus resulting in subtropical conditions. The site is especially susceptible to tropical storm and hurricane impacts because of the geography of the region. This part of the coast extends out into the Atlantic Ocean in an east-west orientation. Thus, the area is prone to impact by northward moving storms. Tropical cyclones regularly impact the site through storm surges and freshwater introductions. During winter, nor'easters periodically move through the area, often causing shoreline erosion in some areas and accretion in others.

Key Habitats and Species

Primary habitat types found at the Rachel Carson Reserve are subtidal flats, tidal creeks, submerged aquatic vegetation, salt marshes, oyster reefs, dredge material deposition areas, and maritime shrub. There are also areas of beaches, dunes and a few small stands of maritime forest on Carrot Island (Figure 10).

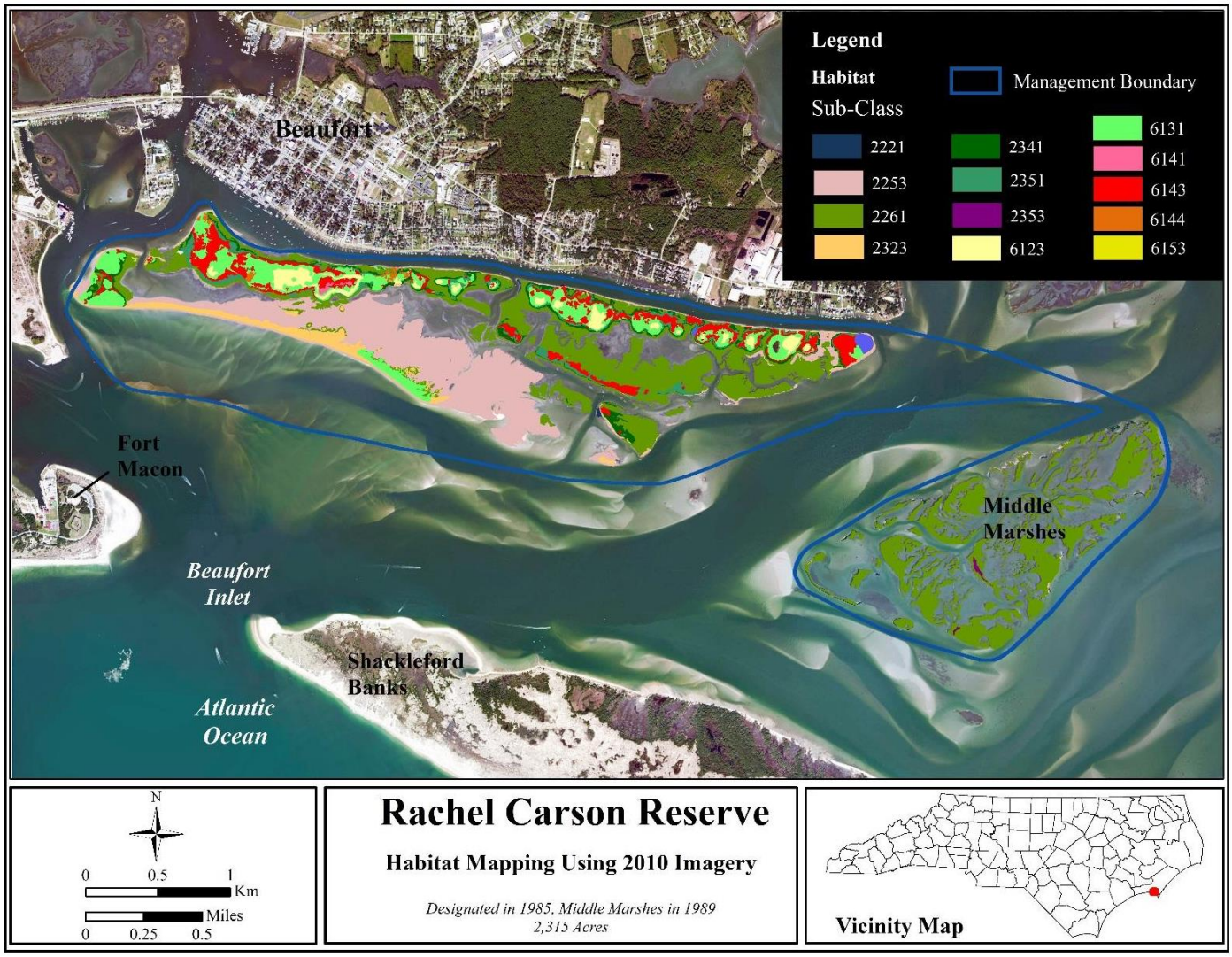

Figure 10. Rachel Carson Reserve Habitat Map

Habitat	Subsystem		Class		Sub-Class		COLOR
Estuarine	2200	Intertidal Haline	2220	Reef	2221	Mollusk	
			2250	Unconsolidated Shore	2253	Sand	
			2260	Emergent Wetland	2261	Persistent	
	2300	Supratidal Haline	2320	Unconsolidated Bottom	2323	Sand	
			2340	Emergent Wetland	2341	Persistent	
			2350	Scrub Shrub Wetland	2351	Broad Leaf Deciduous	
					2353	Broad Leaf Evergreen	
Upland	6100	Supratidal Upland	6120	Unconsolidated Upland	6123	Sand	
			6130	Herbaceous Upland	6131	Grassland	
			6140	Scrub Shrub Upland	6141	Broad Leaf Deciduous	
					6143	Broad Leaf Evergreen	
					6144	Needle Leaf Evergreen	
			6150	Forested Upland	6153	Broad Leaf Evergreen	

Table 2. Rachel Carson Reserve Habitat Map Legend

The Rachel Carson Reserve provides a diverse array of habitats that are home to various estuarine species, many of which are protected. The site is located within the Atlantic Flyway and is an important feeding area for Wilson's plover (*Charadrius wilsonia*) in the summer and red knot (*Calidris canutus*) and piping plover (*Charadrius melodus*) in the winter. Middle Marshes provides nesting habitat for American oystercatcher (*Haematopus palliatus*), Forster's tern (*Sterna forsteri*), and various species of egret and heron. Bird Shoal provides sandy habitat for seabeach knotweed (*Polygonum glaucum*), beach morning-glory (*Ipomoea imperati*) and small patches of seabeach amaranth (*Amaranthus pumilus*). The marshes and creeks of the site are home to the estuarine dependent diamondback terrapin (*Malaclemys terrapin*), which is a state species of special concern. Dredge material deposition areas on the west end of the site are home to the significantly rare crystal skipper butterfly (*Atrytonopsis quinteri*).

Commonly found mammals include feral horses (*Equus caballus*), gray fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), and marsh rabbit (*Sylvilagus palustris*). The Atlantic bottlenose dolphin (*Tursiops truncatus*), green sea turtle (*Chelonia* mydas) and loggerhead sea turtle (*Caretta caretta*) utilize the waters around the island. Common fish species found at the site include southern flounder (*Paralichthys lethostigma*), red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), weakfish (*Cynoscion regalis*), kingfish (*Menticirrhus* spp.), striped mullet (*Mugil cephalus*), pinfish (*Lagodon rhomboides*), pigfish (*Orthospristis chrysotera*) and many more.

Threats and Stressors

Shoreline Change

Shoreline change is occurring in several locations throughout the Rachel Carson Reserve due to its location in the vicinity of the dynamic Beaufort Inlet system and the complex interaction of natural and anthropogenic influences in the area. A living shoreline was installed at the southeast shoreline of Carrot Island in 2012 as part of a collaborative estuarine shoreline stabilization project to test the efficacy of this type of structure in a highly erosive environment (shoreline is eroding at a rate of 3 feet per year). Shoreline and elevation change along Bird Shoal and the western portion of the Reserve is of concern as these sandy inlet-facing areas provide habitat for protected species, protect against storm surge, and are used for recreational purposes. Due to the low elevation of Bird Shoal, overwash events are not uncommon and most often occur during higher than average high tides and storm events. Erosion is also a concern on the edges of the marsh complex at Middle Marshes. Reserve staff are currently undertaking efforts to understand shoreline change across the Reserve and specific to Bird Shoal. These efforts include analyzing erosion and accretion in this area using historical and current imagery, and conducting shoreline elevation studies to better understand short- and long-term shoreline change.

Water Quality

The largest point source discharge impact to the Rachel Carson Reserve is the Beaufort Wastewater Treatment Plant. The outfall pipe discharges into Taylor's Creek directly across from Deep Creek. Because of the potential

for a wastewater spill from this outfall and stormwater runoff and boat head discharge concerns, the waters of Taylor's Creek and four of the site's islands (Town Marsh, Carrot Island, Bird Shoal, and Horse Island) are permanently closed to shellfishing.

Invasive Species

Invasive plant and animal species found on the islands of the Rachel Carson site include tamarisk tree (or salt cedar, *Tamarix* sp.), Japanese honeysuckle (*Lonicera japonica*), red algae (*Gracilaria vermiculophylla*), Asian shore crab (*Hemigrapsus sanguineus*), feral horse (*Equus caballus*), and others. The tamarisk tree is monitored through long-term mapping efforts. Over time, invasion by additional species such as lionfish (*Pterois*) or organisms introduced via ballast water may take place as range expansion occurs or new species are introduced to the region.

Feral Horses

The Rachel Carson Reserve is home to a resident population of feral horses, which are considered to be an introduced species, but are allowed to roam the islands due to their cultural significance. These horses descend from a population placed on the islands in the late 1940s and are managed by Reserve staff through a humane birth control and monitoring program. The herd is maintained at approximately 30 individuals and due to their isolation on the islands, provide an opportunity to study their impact on a coastal island ecosystem.

Visitor Use

In recent years, use of the Rachel Carson Reserve by visitors and commercial enterprises (i.e., ferries and tour groups) has increased due to growth in tourism and the local coastal population. Although most visitors leave little to no trace of their presence, inappropriate activities and excessive or irresponsible visitor use can result in damage to habitats and disturbance of wildlife as well as reduce the overall visitor experience. The most common visitor related challenges are dogs off leash; approaching and/or harassing wild horses; leaving trash and/or personal property behind; vandalism of Reserve property; and camping. The Reserve regularly promotes responsible visitor use of the site through signage, various communication initiatives, and social media to help maintain a balance between resource protection and public enjoyment and safety. Enforcement of Reserve rules and policies as well as State and local laws is provided by partner agencies which often have limited time and resources to devote to this effort. Enforcement of visitor use issues is further complicated because the site can only be reached by boat.

Vessel Groundings

Throughout the year and particularly during storm events, improperly secured vessels that are anchored or moored in Taylor's Creek wash ashore on the site. The vessels primarily ground in wetland habitats such as marsh and oyster reef. Removal operations often noticeably disturb these sensitive habitats, sometimes with large portions of sediment and marsh grass being sloughed from the shoreline.

Marine Debris

Marine debris is a continuous problem at the site, more so than user-generated debris. Since 2007, staff and volunteers have removed over 15,000 pounds of debris, which is primarily comprised of plastic and wood from docks, boats, and construction. Marine debris can release toxins, cover and damage habitats, and harm wildlife through entanglement or ingestion. Additionally, debris is unsightly and can pose safety hazards to visitors. Efforts are ongoing to understand the composition of debris, its effects on habitats, and accumulation rates.

Sea Level Rise and Storms

Barrier island and estuarine island ecosystems are subject to forces, such as sea level rise and storms, which move sediment, cause changes in topography and geomorphology, and require constant adaptation by vegetation communities. The Rachel Carson Reserve has characteristics of both estuarine island and barrier island ecosystems given the site's close proximity to Beaufort Inlet and direct contact with the Atlantic Ocean. Generally, as sea level rises, barrier islands and some estuarine islands retreat landward and/or have the potential to become submerged. Large storms such as nor'easters and hurricanes redistribute sediment, resulting in erosion and accretion in different areas. At the Rachel Carson Reserve, erosion and accretion, particularly along the southern edge of the site, are obvious after these large storm events. The 2015 N.C. Sea Level Rise Report Update shows that the sea level in Beaufort, N.C., will increase an average of 3.2 inches in the next 30 years. Sea level rise and storms have the potential to result in significant change to the site's natural resources, particularly if water levels change at a greater rate than accretion is occurring.

Masonboro Island Reserve

Site Description and Location

The Masonboro Island Reserve was designated as the fourth site of the NCNERR in 1991 and is the largest of the four NCNERR sites. The site is located within the Carolinian biogeographic province. It is included in the NCNERR because it is the largest undisturbed barrier island along the southern coast of North Carolina, providing an excellent location for the study of natural barrier island systems, including sediment movement and its effect on biological communities (Figure 2).

The site is located in New Hanover County between the barrier island towns of Wrightsville Beach and Carolina Beach. Comprised of the barrier island known as Masonboro Island, as well as the associated dredge material islands and surrounding salt marsh and tidal creek system, the Masonboro Island Reserve is bounded by Masonboro Inlet to the north, the Atlantic Ocean to the east, Carolina Beach Inlet to the south, and the Atlantic Intracoastal Waterway (ICW) to the west. The city of Wilmington lies approximately five miles to the northwest (Figure 11).

Figure 11. Masonboro Island Reserve Boundary Map

The island is approximately 8.4 miles long and the management boundary encompasses 5,653 acres. The back-island sounds plus associated tidal creeks and salt marshes are included in the core area, totaling 4,163 acres. Masonboro Island proper and dredge material islands along the ICW constitute the buffer area, totaling 1,490 acres consisting of ocean beach (868 acres) and upland (622 acres) habitat. The buffer area also includes 50 acres owned by the University of North Carolina Wilmington (UNCW) located across the ICW from the island. Part of the Campus for Research, Entrepreneurship, Service and Teaching, the UNCW Center for Marine Science (CMS) houses the Reserve office for the Masonboro Island and Zeke's Island Reserves (Figure 12).

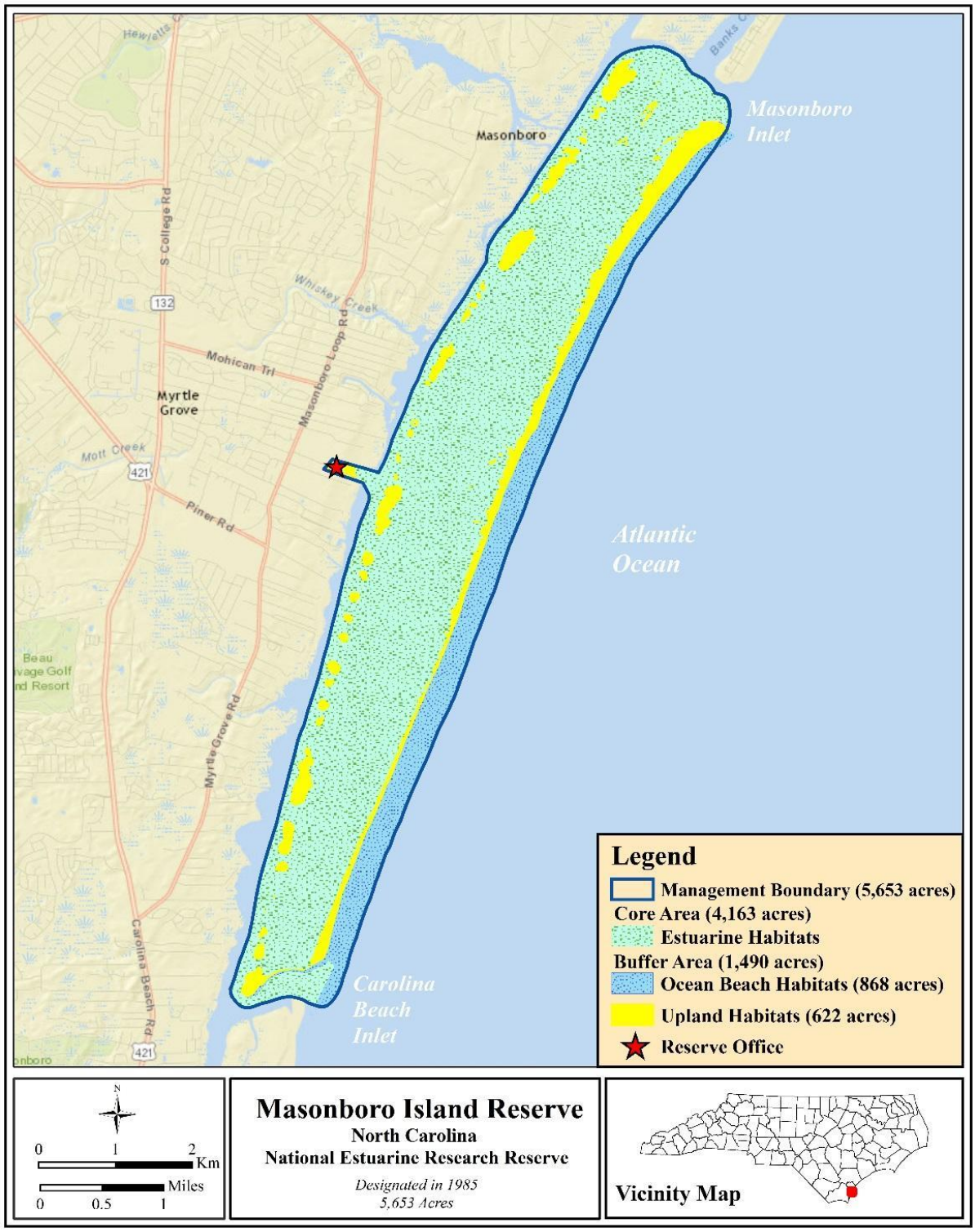

Figure 12. Masonboro Island Reserve Core and Buffer Map

The site was added to the NCNERR following the efforts of the local community to prevent commercial and recreational development on Masonboro Island Reserve. The site is owned by the State of North Carolina, except for a small number of remaining privately owned inholdings, and management of the site is delegated by the State to DCM. The Division of Parks and Recreation retains authority over the 150-acre Masonboro Island State Natural Area located within the management boundary. The U.S. Army Corps of Engineers holds a linear easement near the western boundary that includes areas of historic, current, and potential future dredge material disposal cells. The Masonboro Island Reserve is the only NCNERR site that has privately-owned parcels within the management boundary. There are 12 remaining privately owned properties totaling approximately 17 acres of Masonboro Island proper, as well as two sections of dredge material deposition islands that are privately held. The site is managed by staff located at the CMS. Seasonal staff and university interns are utilized to support management activities. Land management and species monitoring activities are conducted in cooperation with various State and Federal agencies, as well as local partner organizations. Enforcement activities are conducted by local and State law enforcement agencies on behalf of and in coordination with the Reserve.

The Masonboro Island Reserve serves as an outdoor classroom for teachers, students, and the general public. Reserve staff occasionally offer programs at the site that focus on coastal and estuarine ecosystems. A self-guided nature trail provides the public with the opportunity to learn about site features and coastal ecology.

Long-term research and monitoring is conducted at Masonboro Island Reserve by staff and includes SWMP water quality and meteorological monitoring, biological monitoring of emergent marsh vegetation, and habitat mapping. NCNERR research staff are also monitoring long-term changes in marsh surface elevation. Partner organizations and university students and researchers regularly use the site for research projects addressing a wide array of coastal topics.

Land cover in both New Hanover County and the City of Wilmington is primarily developed for residential and commercial uses, with pockets of open space scattered throughout. Agriculture and industrial uses are very minor land cover types. The site is located in the Cape Fear River Basin (Figure 13, part of New Hydrologic Unit Code: 03030001). The total population estimate of New Hanover County in 2014 was 216,298; 48% male, 52% female (Census.gov 2014). The population is comprised of 81.3% White, 14.6% Black, 5.4% Hispanic or Latino (Census.gov 2014). 16.5% of the population was living below the poverty level and the average household income was $69,443 (Census.gov 2013). The main occupations in 2013 were management, business, science, arts, and sales (Census.gov 2013). The top industries were educational services, health care and social assistance, arts, entertainment, recreation, accommodation, and food services (Census.gov 2013).

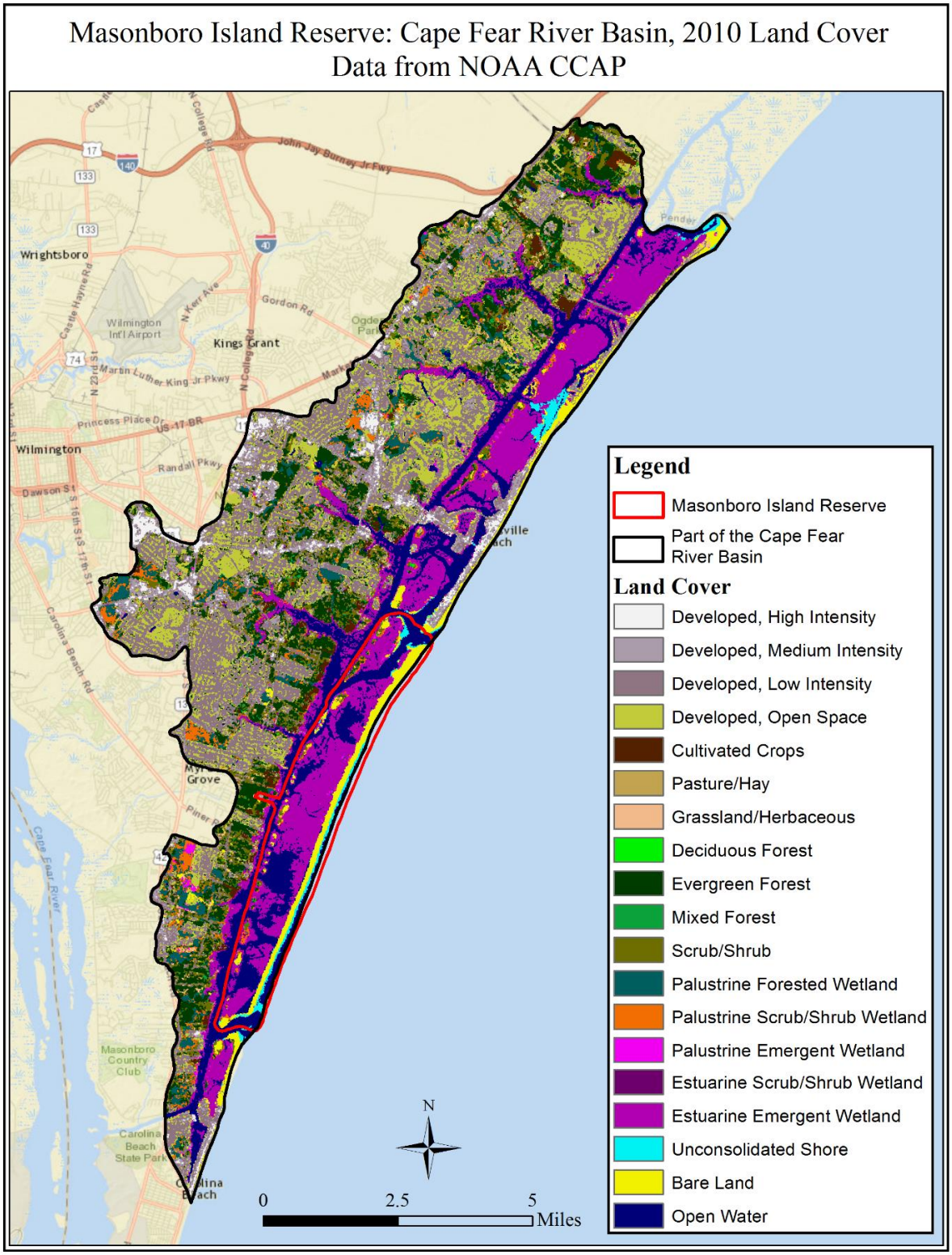

Figure 13. Masonboro Island Reserve Watershed Map

Masonboro Island Reserve is only accessible by boat. Public boat ramps owned by the WRC are located at Wrightsville Beach and Carolina Beach and are approximately 3 miles and 1.5 miles from the site. The Trails End Park, a New Hanover County park, is located just across the ICW from the site. Although the majority of visitors travel to the island via private motorized and non-motorized boats, private commercial operators also provide fee-based ferry service to the site. Most visitors land on the sound side of the northern and southern ends of the island where there are large sandy beaches. Other natural landing areas on the sound side of the Reserve are accessible only during the higher portion of the tidal cycle. No boat landing or anchoring infrastructure exists on the site.

Masonboro Island Reserve is used extensively by the public for traditional activities such as nature-based recreation, hunting, and fishing. Visitors enjoy access to both the ocean and sound beaches, utilizing a number of primitive trails to cross from the sound side landing areas to the ocean beach. Recreational activities at the site that are primarily associated with Masonboro Island proper, include beach walking, sunbathing, motorized and non-motorized boating, surfing, paddle boarding, birdwatching, and surf fishing. Hunting and fishing, both recreational and commercial, occur throughout the marshes and waters within the boundary, as well as on the dredge material islands. This site is the only site within the NCNERR where primitive camping is permitted.

Geomorphology, Hydrology, Climate, and Weather

Masonboro Island Reserve consists of Recent (less than ~11,550 years old) and Pleistocene (~1.8 million to ~11,550 years before present) sediments (Atkinson et al. 1998, Moorefield 1978). The upland areas include natural and dredge material built areas. These are mostly found on the back side of the island and along the western boundary adjacent to the ICW. Masonboro Inlet is stabilized by jetties on the southern end of Wrightsville Beach and the northern end of Masonboro Island Reserve. Portions of Masonboro Island proper's ocean beach periodically receive sand deposits during inlet maintenance activities conducted by the U.S. Army Corps of Engineers due to a study that indicated a sand deficit associated with the jetty structure's disruption of natural sediment flows. Carolina Beach Inlet, at the southern end, is an artificial waterway created to enhance boater access to the Atlantic Ocean. Sand from maintenance of this inlet has not been placed on Masonboro Island Reserve. Material is occasionally placed on select dredge material islands as a result of maintenance of the ICW or nearby private marinas and waterways. Due to the low elevation of the Reserve, particularly along its southern half, overwash of the beach is common during spring tides and storms.

As a result of the direct connection to the ocean at both inlets, the salinity of the waters within the site's boundary is consistent with ocean water and semidiurnal lunar tides influence the site, averaging 3.8 feet. Freshwater influx, with associated sediment and nutrient transport, comes from several small tidal creeks on the mainland across the ICW and from the Cape Fear River through Snow's Cut. Salinity ranges between 20-35 ppt. Waters at the site are designated as Outstanding Resource Waters by the N.C. Division of Water Resources and Primary Nursery Areas by the DMF.

The weather at the Masonboro Island Reserve is typical of a maritime climate, with the ocean having a strong moderating effect on air temperature compared to nearby mainland areas. Climatologically, the area is classified as subtropical with humid, warm summers and mild winters. Tropical cyclones, ranging from tropical depressions to large hurricanes, are a regular weather impact at the site, introducing freshwater into the estuarine system and sometimes causing storm surges that can lead to significant shoreline change. During winter, nor'easters periodically move through the areas, leading to erosion and sediment redistribution.

Key Habitats and Species

Habitats found within the core area consist of sound waters, intertidal and subtidal soft bottom mud and sand flats, oyster reefs, and intertidal and supratidal salt marshes. Within the buffer area, habitats include shrub thicket, maritime forest, dredge material areas, grasslands, sand dunes and the ocean beach (Figure 14).

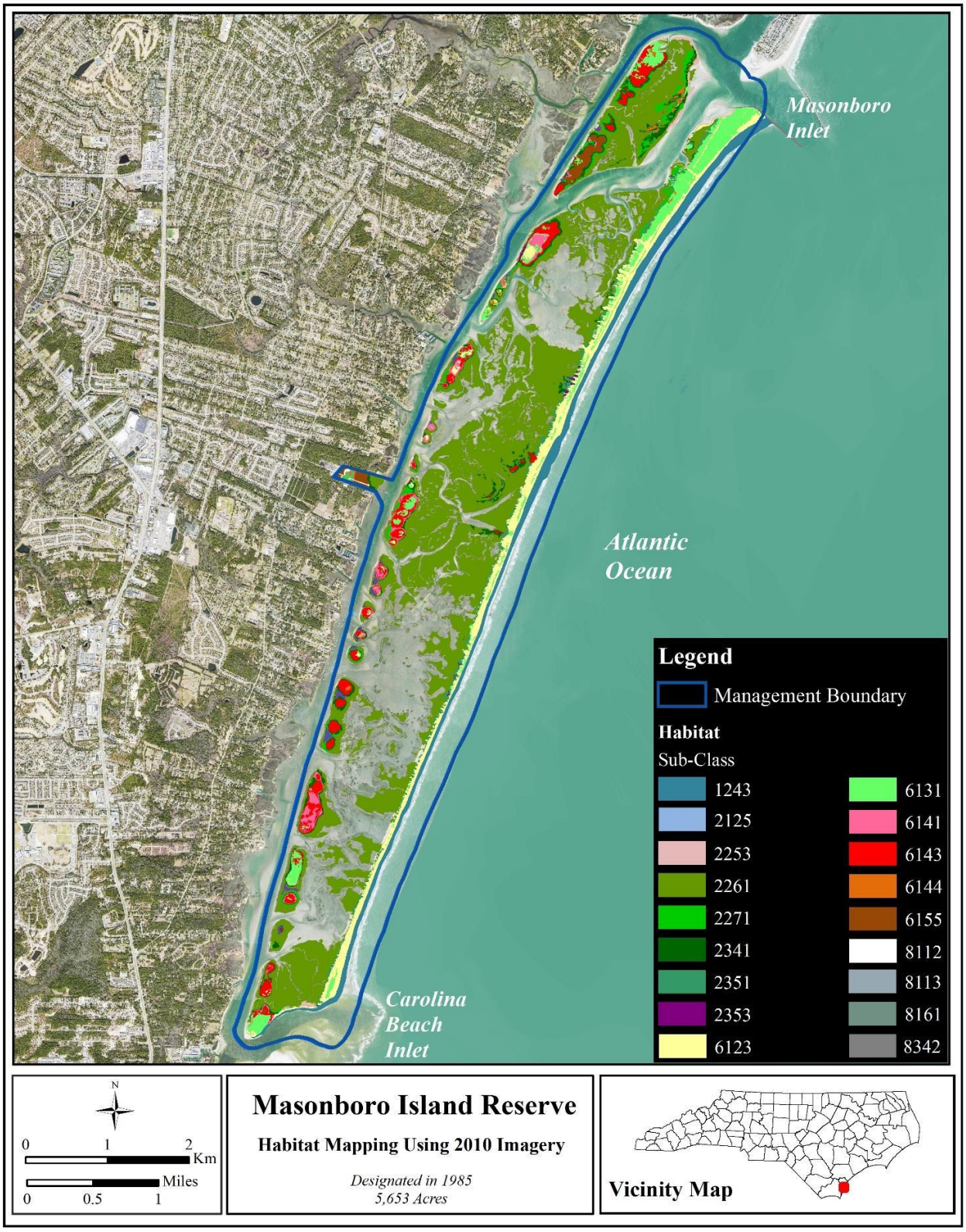

Figure 14. Masonboro Island Reserve Habitat Map

Habitat	Subsystem		Class		Sub-Class		COLOR
Marine	1200	Intertidal	1240	Unconsolidated Shore	1243	Sand	
Estuarine	2100	Subtidal Haline	2120	Unconsolidated Bottom	2125	Organic	
	2200	Intertidal Haline	2250	Unconsolidated Shore	2253	Sand	
			2260	Emergent Wetland	2261	Persistent	
			2270	Scrub Shrub Wetland	2271	Broad Leaf Deciduous	
	2300	Supratidal Haline	2340	Emergent Wetland	2341	Persistent	
			2350	Scrub Shrub Wetland	2351	Broad Leaf Deciduous	
					2353	Broad Leaf Evergreen	
Upland	6100	Supratidal Upland	6120	Unconsolidated Upland	6123	Sand	
			6130	Herbaceous Upland	6131	Grassland	
			6140	Scrub Shrub Upland	6141	Broad Leaf Deciduous	
					6143	Broad Leaf Evergreen	
					6144	Needle Leaf Evergreen	
			6150	Forested Upland	6155	Mixed	
Cultural Land Cover	8100	Developed Upland	8110	Impervious Cover	8112	Paved Roadway	
					8113	Large Building	
			8160	Herbaceous Cover	8161	Managed Turf	
	8300	Dev. & Managed Wetlands & Water	8340	Rocky Cover	8342	Rocky In-Water Structure	

Table 3. Masonboro Island Reserve Habitat Map Legend

Masonboro Island Reserve supports a myriad of coastal and estuarine species. Loggerhead (*Caretta caretta*) and green sea turtles (*Chelonia mydas*), both federally protected threatened species, nest on the ocean beach. Seabeach amaranth (*Amaranthus pumilus*), a federally listed threatened species, has historically been documented growing on the foredunes. Tough bumelia (*Sideroxylon tenax*), a federal species of concern, is found scattered throughout shrub thicket areas. Dune bluecurls (*Trichostema sp.*), a federally listed significantly rare plant, is found on dredge material islands within the boundary.

Other species of concern found at the site are the American oystercatcher (*Haematopus palliates*), Wilson's plover (*Charadrius wilsonia*), and least tern (*Sterna antillarum*), all of which routinely utilize Masonboro Island Reserve for nesting. The piping plover (*Charadrius melodus*), brown pelican (*Pelecanus occidentalis*), and black skimmer (*Rynchops niger*) use the site for foraging or during migration. Black skimmers historically nested on the island but have not been documented in recent years. The site is located within the Atlantic Flyway. In total, the site has been documented to provide habitat to over 250 species of birds and over 150 species of fish. Its waters and marshes provide important nursery area for numerous commercially important finfishes. The marshes and creeks of the site are home to the estuarine dependent diamondback terrapin (*Malaclemys terrapin*), which is a state species of special concern. The Atlantic bottlenose dolphin (*Tursiops truncates*) regularly utilizes the waters around the island. The waters and submerged areas of Masonboro Sound are an important source of oysters, clams, and blue crabs for local recreational and commercial fishermen.

Threats and Stressors

Property Ownership

The Masonboro Island Reserve is the only site within the NCNERR that includes privately owned inholdings.

Although these areas constitute a small total area within the management boundary, ownership of parcels by private individuals will eliminate the possibility of development on the island thereby keeping the ecosystem intact for Reserve purposes.

Visitor Use

Due to its proximity to the large, growing population center of Wilmington and the ease of access afforded by the ICW, portions of the Masonboro Island Reserve receive significant visitor use. Although most visitors leave little to no trace of their presence, inappropriate activities and excessive or irresponsible visitor use can result in damage to habitats and disturbance of wildlife as well as reduce the overall visitor experience. Sound side beaches along the northern stretches of the island are particularly heavily used during summer holidays, with visitor activity sometimes including very large gatherings, excessive alcohol use, and significant quantities of trash. The Reserve regularly promotes responsible visitor use of the site through signage, various communication initiatives, and social media to help maintain a balance between resource protection and public enjoyment and safety. Enforcement of Reserve rules and policies at the site, as well as State and local laws, is provided by partner agencies which often have limited time and resources to devote to this effort. The size of summer holiday gatherings has required the NCNERR to dedicate a portion of its funding to contract supplemental local law enforcement to maintain public safety. Enforcement of visitor use issues at the site is further complicated because the site is only accessible by boat.

Water Quality

The water quality in and around the Masonboro Island Reserve has been impacted periodically by sewage contamination associated with failures in or disturbances to the City of Wilmington wastewater treatment system and by non-point source pollution contained in stormwater runoff associated with land development and land cover change in the surrounding watershed (NCNERR, 2008). Wastewater contamination can result in shellfish bed closures and swimming advisories. Population growth projections, development and land cover change are likely to continue to affect water quality in the watershed in coming decades.

Sea Level Rise and Storms

Barrier islands ecosystems are subject to forces such as sea level rise and storms that move sediment, cause changes in topography and geomorphology, and require constant adaptation by vegetation communities. As sea level rises, barrier islands such as Masonboro Island Reserve retreat landward. Large storms such as nor'easters and hurricanes redistribute sediment across the barrier beach and sediment from the water column is deposited on the surface of the marsh, although accretion rates in the marsh are not well understood. The 2015 NC Sea Level Rise Report Update shows that the sea level in Wilmington, N.C., will increase an average of 2.4 inches in the next 30 years. Sea level rise and storms have the potential to result in significant change to the site's natural resources, particularly if water levels change at a greater rate than accretion is occurring.

Sediment Movement Disruption

At the Masonboro Island Reserve, a sand deficit resulting from the disruption of longshore sediment flow caused by the Masonboro Inlet jetties has been documented. To mitigate the deficit, sand has periodically been placed along the ocean beach as part of maintenance of Masonboro Inlet. However, the quantity of sand placed has not matched the projected deficit and the southern portions of the island are sand deprived (U.S. Army Engineer District, 2000). Changing conditions related to sand redistribution priorities and funding associated with these projects may decrease the likelihood of regular sand placement on Masonboro Island Reserve, presenting challenges to maintaining ocean beach habitat.

Invasive Species

Invasive plant species can alter habitats by outcompeting native vegetation. Species known to occur at the Masonboro Island site include the common reed (*Phragmites australis*), beach vitex (*Vitex rotundifolia*), and red algae (*Gracilaria vermiculophylla*). Over time, invasion by additional species may take place as range expansion occurs or new species are introduced to the region.

Predators

Masonboro Island Reserve represents some of the highest quality habitat available in southeastern North Carolina for nesting sea turtles and nesting, foraging, and roosting waterbirds, including several species listed as species of special concern in North Carolina. Reserve staff began monitoring sea turtle and shorebird nests in 2006 and these efforts show that predation has been a threat to sea turtle and shorebird nests. Predation has lowered reproductive success or resulted in complete nest failure. Red fox (*Vulpes vulpes*) are known to inhabit the island and were a major source of sea turtle nest predation between 2006 and 2013 (NCNERR, unpublished data). Red fox are sometimes considered subsidized predators due to their tendency to live near and benefit from association with humans; the red fox population has been managed to reduce the predation impact on sea turtle nesting. Raccoon are known to be present, gray fox are believed to be present, and coyote have been documented in the past.

Zeke's Island Reserve

Site Description and Location

The 1,635-acre Zeke's Island Reserve was designated in 1985 and is located in the Carolinian biogeographic province (Figure 2). The lagoon-like character of the northern open water portion of the site, known locally as "the basin," represents a unique estuary type with distinct water chemistry and water quality characteristics for the NCNERR. The site's location adjacent to the Cape Fear River makes it an excellent reference for river ecosystems and its position between additional undeveloped islands and marshes provides additional protection for its ecosystems.

The site is located in both Brunswick and New Hanover counties in southeastern North Carolina, just south of Kure Beach (Figure 15). The nearest population center is Wilmington, N.C., located 22 miles to the north.

Southport, N.C., is located across the Cape Fear River 10 miles to the south-southwest. The Zeke's Island site is bounded to the north by Federal Point (which includes Fort Fisher State Recreation Area and the North Carolina Aquarium at Fort Fisher), to the east by the Atlantic Ocean, the Cape Fear River to the west, and the Bald Head Island State Natural Area and greater Smith Island complex to the south.

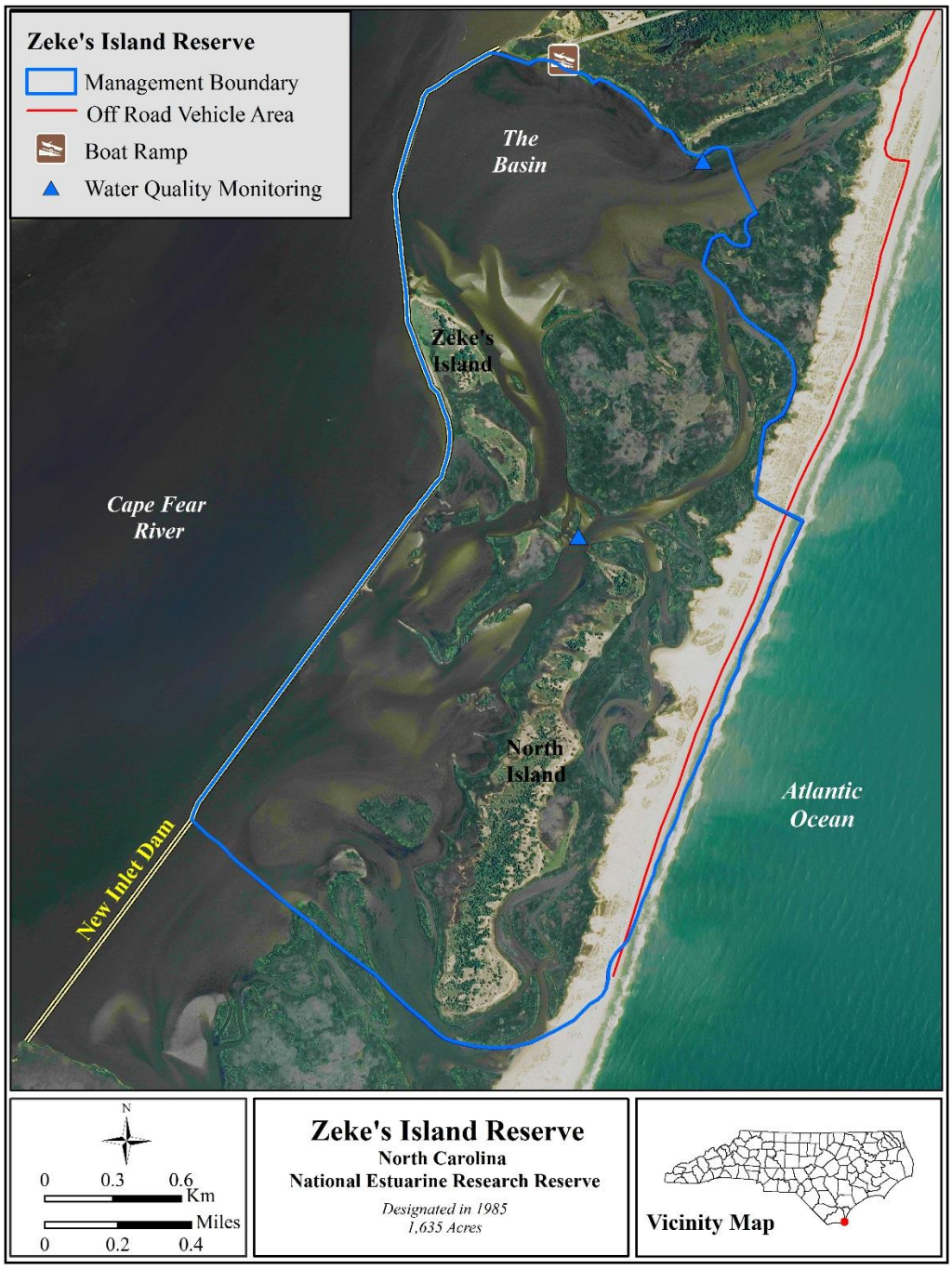

Figure 15. Zeke's Island Reserve Boundary Map

The western boundary for the Zeke's Island Reserve is a late 19th century rock jetty commonly called 'the rocks' which is comprised of the New Inlet Dam and Swash Defense Dam. The jetty was installed by the U.S. Army Corps of Engineers as a sediment control structure to minimize shoaling of the shipping channel in the Cape Fear River. The area to the east of the jetty has become lagoonal in nature (Figure16). The core area of the Zeke's Island Reserve includes 1,418 acres of estuarine habitats with tidally influenced basin waters, creeks, and intertidal and supratidal marsh communities. The buffer area for Zeke's Island Reserve comprises 217 acres: 177 acres of upland habitats distributed between Zeke's Island, North Island, and the barrier spit along the Atlantic Ocean, and 40 acres of intertidal ocean beach habitat along the Atlantic Ocean shoreline. Zeke's Island has elevations of only several feet. North Island has several scattered dune systems, some of which reach up to twenty feet above sea level.

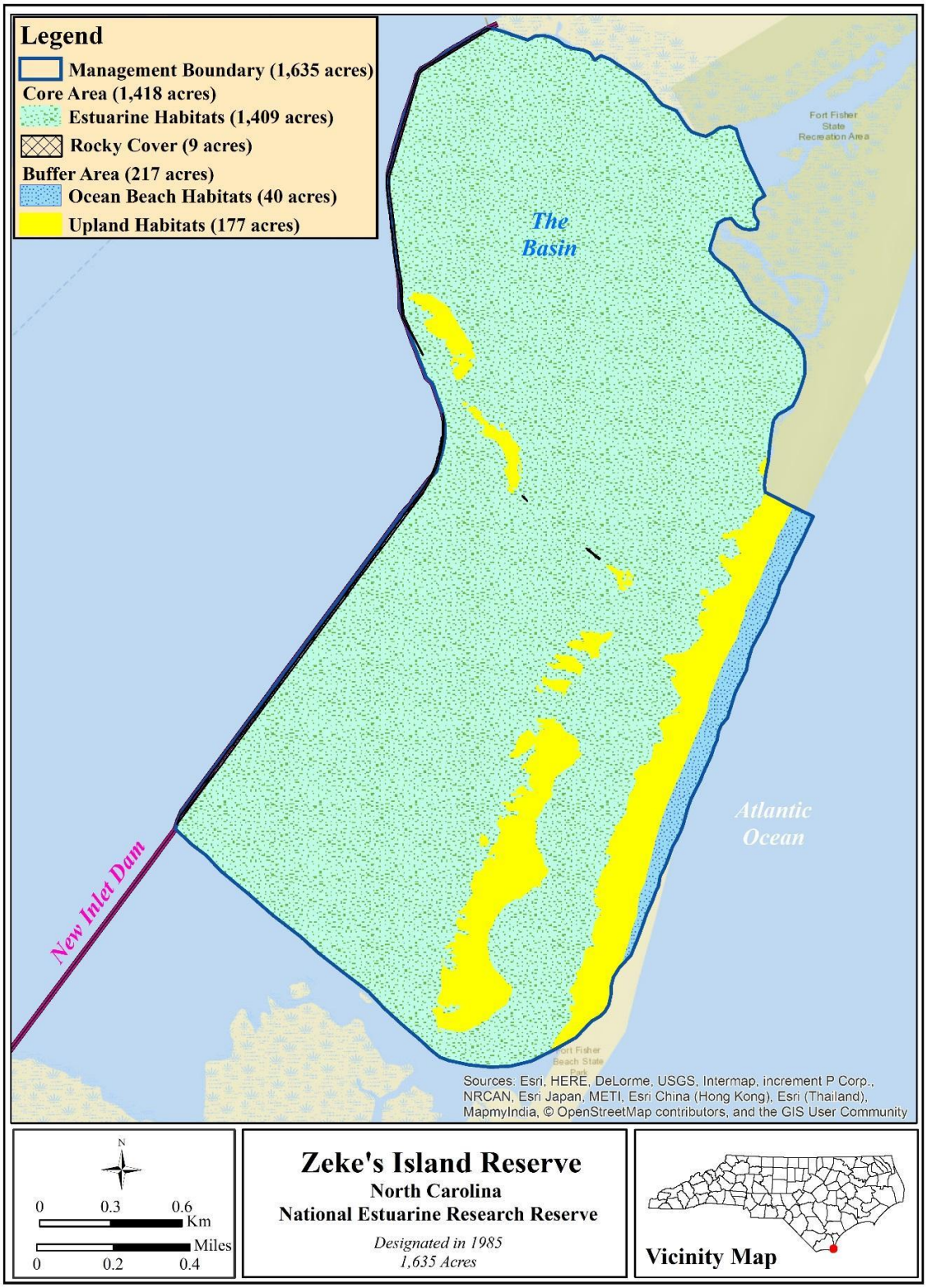

Figure 16. Zeke's Island Reserve Core and Buffer Map

Zeke's Island Reserve is owned by the State of North Carolina and management of the site is delegated by the State to DCM. The site is managed by staff located at the CMS and supported by the N.C. Division of Parks and Recreation, through its Fort Fisher State Recreation Area staff. Land management activities are conducted in cooperation with various State and Federal agencies, as well as local partner organizations. Enforcement activities are conducted by local and State law enforcement agencies on behalf of and in coordination with the Reserve. The Fort Fisher State Recreation Area staff provides the majority of the on-site management for daily operations along the beach strand and driving beach, as well as providing species of interest monitoring and protection.

The Zeke's Island Reserve serves as an outdoor classroom for teachers, students, and the general public. Fort Fisher State Recreation Area and N.C. Aquarium at Fort Fisher staff occasionally offer educational programs at the site. Long-term research and monitoring is conducted by Reserve staff at the site including SWMP water quality monitoring, biological monitoring of emergent marsh vegetation, habitat mapping, and monitoring long-term changes in marsh surface elevation. Partner organizations, university students and researchers investigate a wide array of coastal topics at the site.

The Zeke's Island Reserve is located in the Cape Fear River watershed and straddles the boundary between Brunswick County (to the south) and New Hanover County (to the east) (Figure 17, part of Lower Cape Fear Hydrologic Unit Code: 03030005). Land use in the Cape Fear River basin ranges from highly developed residential areas to agricultural uses to industrial development. These two counties boast the largest populations of the counties in which NCNERR sites are located. Both counties are rapidly developing with increasing populations and commercial development. The total population estimate of New Hanover County in 2014 was 216,298; 48% male, 52% female (Census.gov 2014). The population is comprised of 81.3% White, 14.6% Black, 5.4% Hispanic or Latino (Census.gov 2014). 16.5% of the population was living below the poverty level and the average household income was $69,443 (Census.gov 2013). The main occupations in 2013 were management, business, science, arts, and sales (Census.gov 2013). The top industries were educational services, health care and social assistance, arts, entertainment, recreation, accommodation, and food services (Census.gov 2013).

Zeke's Island Reserve: Lower Cape Fear River Basin, 2010 Land Cover
Data from NOAA CCAP

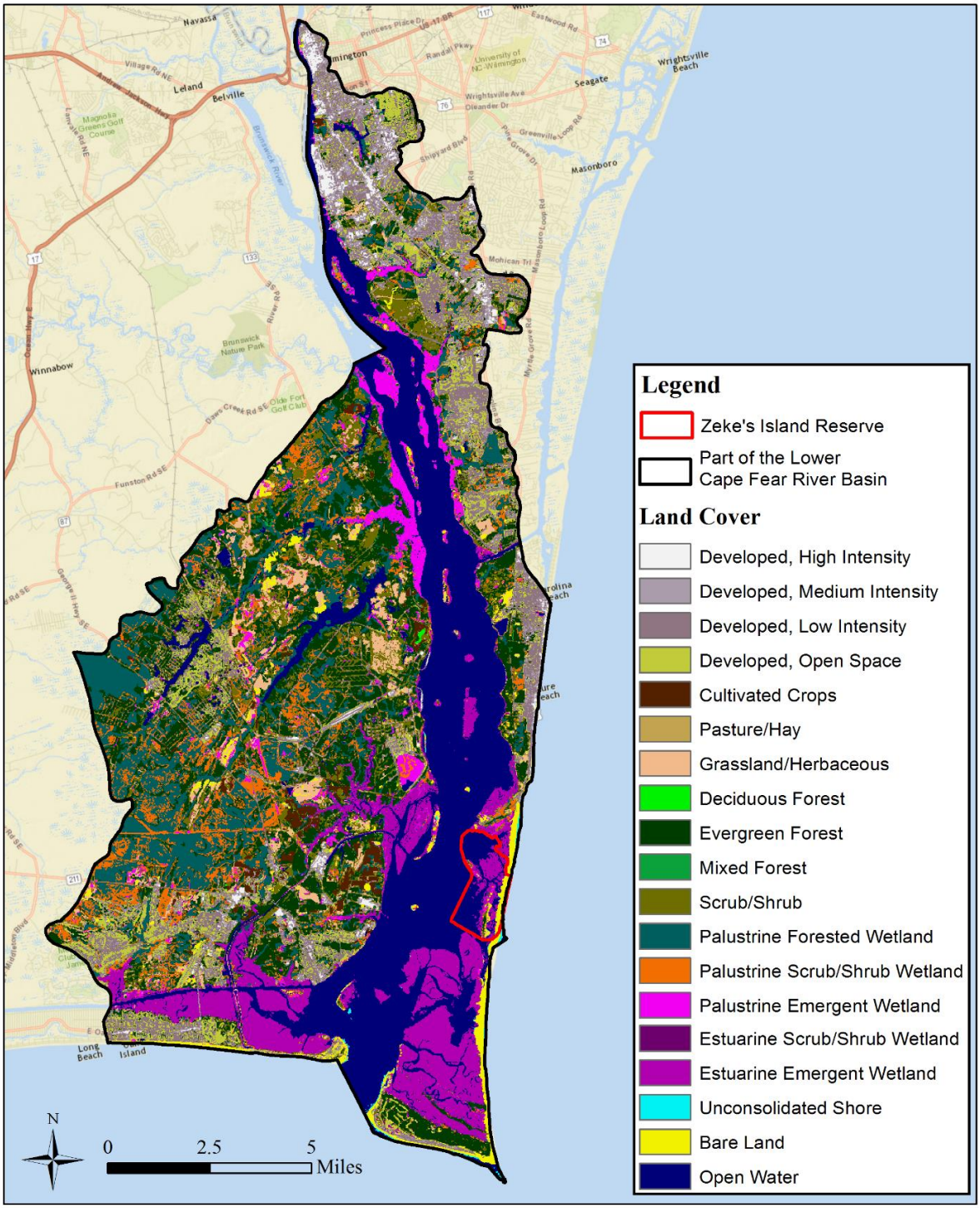

Figure 17. Zeke's Island Reserve Watershed Map

In 2014, the population estimate of Brunswick County was 118,836; 48.6% male and 51.4% female (Census.gov 2014). In 2014, the population was 85.4% White, 11.2% Black, 4.8% Hispanic or Latino (Census.gov 2014). 16.6% of people lived below the poverty level and $61,517 was the mean household income (Census.gov 2013). The main occupations in 2013 were business, science, arts, sales, and office. The top industries were educational services, health care and social assistance, manufacturing, retail trade, and real estate. (Census.gov 2013).

The waters of the Zeke's Island Reserve, as well as Zeke's Island and North Island proper, are accessible by boat. A boat ramp owned by the WRC is located at the northern end of the Reserve, providing motorized and non-motorized boat access to the Reserve. It is possible to access Zeke's Island by walking along the rock jetty, but this access method is not recommended because it is not safe and has resulted in injuries and emergency rescue of visitors. A walking trail at the Fort Fisher State Recreation Area overlooks the Reserve's marshes and waters.

Zeke's Island Reserve is used extensively by the public for traditional activities such as nature-based recreation, hunting and fishing. Visitors accessing the ocean beach via pedestrian trails or by the North Carolina Division of Parks and Recreation permitted 4 wheel drive off-road vehicle access engage in beach walking, sunbathing, surfing, birdwatching, and surf fishing. Visitors accessing the waters of the site via the public boat ramp are primarily using the site for motorized and non-motorized boating, hunting, and fishing, both recreational and commercial.

Geomorphology, Hydrology, Climate, and Weather

The Zeke's Island Reserve contains surface sediments representative of the coastal plain. These sediments are varying combinations of sand, silt, and clay, from terrestrial and marine sources. Some of these deposits are considered Recent (less than ~11,550 years old) and some are of Pleistocene (~1.8 million to ~11,550 years before present) origin (Atkinson et al. 1998, Moorefield 1978). The Pleistocene deposits are thin blankets of marine and estuarine sands and clays occurring in a series of terraces and scarps related to previous shoreline locations. These deposits overlay layers of Cretaceous (~140 to ~70 million years before present) and Tertiary (~70 to ~1.8 million years before present) terrigenous and carbonate deposits (Atkinson et al. 1998, Moorefield 1978).

The Cape Fear region is representative of coastal cape formations along North and South Carolina. Shoals often extend seaward from these cape areas. Frying Pan Shoals extends seaward from the Cape Fear estuary area outward to approximately 31 miles. Barrier island formations generally extend north and southwest off these cape regions. The accepted theory is that the capes have maintained their basic positions and morphologies throughout the Pleistocene and Holocene (~11,550 years ago to present) by migrating landward or seaward in response to sea level changes (Moorefield 1978).

Ocean inlets have historically formed, migrated, and closed within the barrier-spit area of the Zeke's Island Reserve. The last oceanic inlet in this area, New Inlet, closed in March 1999 (Cleary & Marden 2001), connecting Pleasure Island with Bald Head Island. Water exchange at the site is currently dependent on the adjacent Cape Fear River. Coastal processes continue to change and rework the beach environments that produce the site's barrier island and estuarine features.

Due to the tidal nature of the river in the area of the Reserve site, both upstream and downstream influences occur. Although the rock jetty reduces the rate and volume of water exchange with the river, it is porous and regularly overtopped during times of higher tides or higher river water levels, so the quality and characteristics of the river water directly influence the waters within the Reserve. The salinity range is typically 12-30 ppt, but can drop below 10 ppt during periods of heavy rain when significant input of freshwater from upstream can occur, carrying with it sediments and pollutants from across the Cape Fear River Basin, the largest in the state. Due to the site's proximity to the river mouth and the historical deepening of the river's shipping channel, high tides and tropical storm events can introduce large pulses of high salinity water into the area. Tidal range in Zeke's Basin averages 4 feet. Waters at the site are designated as High Quality Waters by the N.C. Division of Water Resources and a portion of the site is considered Primary Nursery Area by the DMF.

The weather at the Zeke's Island Reserve is typical of a maritime subtropical climate, with humid, warm summers and mild winters and with temperatures moderated by proximity to the ocean and river waters. Tropical cyclones, ranging from tropical depressions to large hurricanes, are a regular weather impact at the site. These storms can introduce freshwater into the estuary system and can cause storm surges that lead to significant shoreline change. Storms can also push ocean water up into the river system, exposing ecosystems to higher salinity waters. During winter, nor'easters periodically move through the areas, leading to erosion and sediment redistribution.

Key Habitats and Species

The unusual characteristics of the site have created a variety of habitats, including tidal flats, salt marshes, shrub thicket, maritime forest, sand dunes, ocean beach, and the hard surface of the rock jetty. Extensive salt marshes, open water, and submerged habitats dominate the site. High marsh habitats fringe the upland areas, particularly on Zeke's and North Islands. Small areas of maritime forest are found on both islands in the central portions with the greatest elevation (Figure 18). Habitats in these areas support a variety of faunal species, including white-tailed deer (*Odocoileus virginianus*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), marsh rabbits (*Sylvilagus palustris*), gray fox (*Urocyon cinereoargenteus*), and red fox (*Vulpes vulpes*).

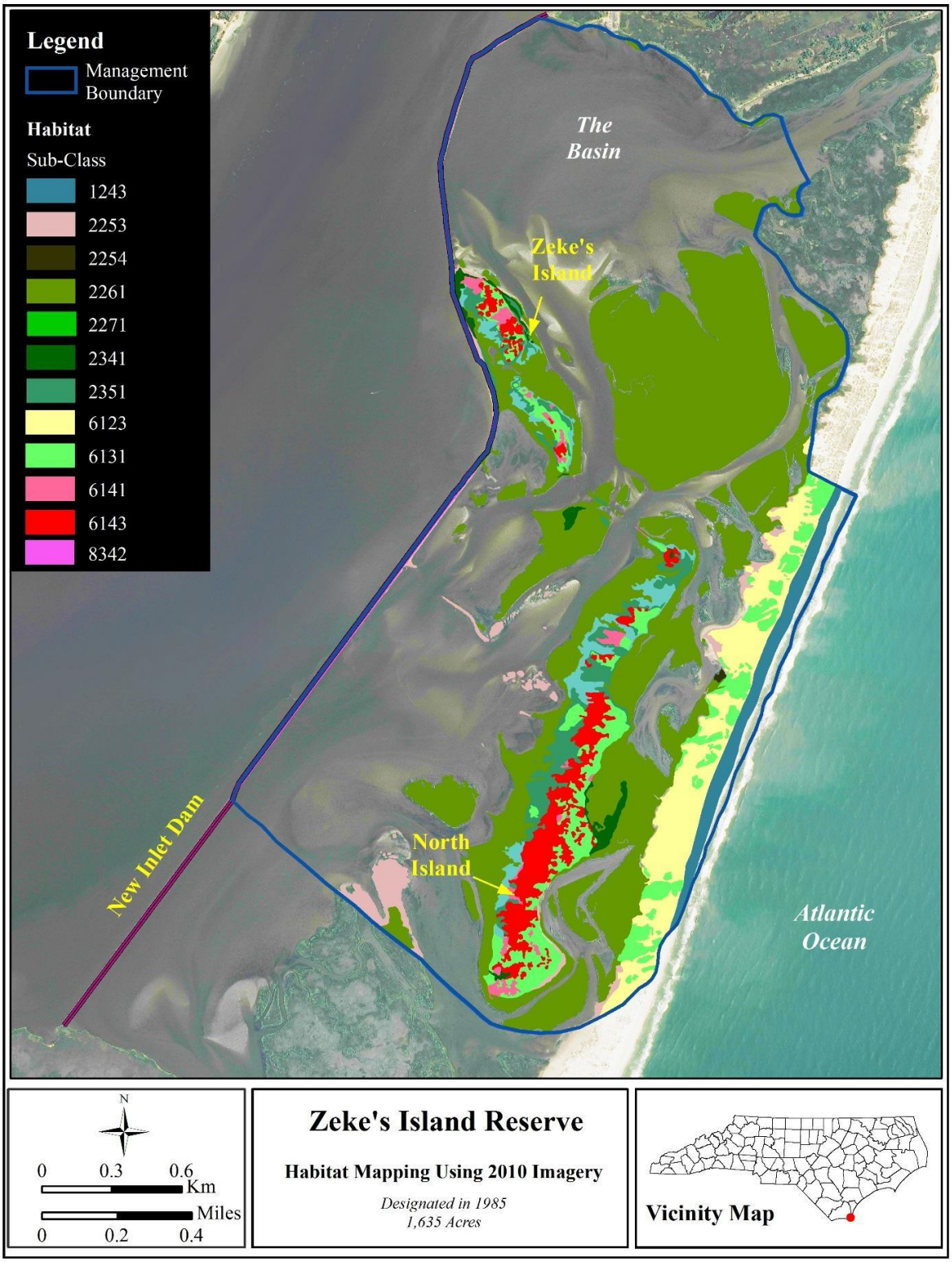

Figure 18. Zeke's Island Reserve Habitat Map

Habitat	Subsystem		Class		Sub-Class		COLOR
Marine	1200	Intertidal	1240	Unconsolidated Shore	1243	Sand	
Estuarine	2200	Intertidal Haline	2250	Unconsolidated Shore	2253	Sand	
					2254	Mud	
			2260	Emergent Wetland	2261	Persistent	
			2270	Scrub Shrub Wetland	2271	Broad Leaf Deciduous	
	2300	Supratidal Haline	2340	Emergent Wetland	2341	Persistent	
			2350	Scrub Shrub Wetland	2351	Broad Leaf Deciduous	
Upland	6100	Supratidal Upland	6120	Unconsolidated Upland	6123	Sand	
			6130	Herbaceous Upland	6131	Grassland	
			6140	Scrub Shrub Upland	6141	Broad Leaf Deciduous	
					6143	Broad Leaf Evergreen	
Cultural Land Cover	8300	Dev. & Managed Wetlands & Water	8340	Rocky Cover	8342	Rocky In-Water Structure	

Table 4. Zeke's Island Reserve Habitat Map Legend

The surrounding estuarine waters are highly productive and used regularly for recreational and commercial fishing purposes. Fish, shrimp, crabs, clams, and oysters also use the estuary as a nursery ground. Over 100 species of fish have been documented to utilize the site. The extensive mud flats support a vast array of invertebrate species that serve as food items for many species of fish.

Loggerhead (*Caretta caretta*) and green sea turtles (*Chelonia mydas*), both federally protected threatened species, occasionally nest on the site's open beaches. The marshes and creeks of the site are home to the estuarine dependent diamondback terrapin (*Malaclemys terrapin*), a state species of special concern. Seabeach amaranth (*Amaranthus pumilus)*, a federally threatened plant species, has also been found on the site's foredune areas. Dune bluecurls (*Trichostema sp.*), a federal listed significantly rare plant, is also found within the boundary.

The site is located within the Atlantic Flyway and shorebirds of interest nesting on the barrier island portion of the site include the American oystercatcher (*Haematopus palliates*) and Wilson's plover (*Charadrius wilsonia*). Various other birds utilize the site for foraging and resting during migration, including the black skimmer (*Rynchops niger*), dunlin (*Calidris alpina*), and red knot (*Calidris canutus*). Bird utilization surveys of site habitats have documented over 260 species.

Threats and Stressors

Sedimentation

Water depths in the basin area of the site are known to have decreased markedly in recent decades. Local fishermen report that many portions of the basin were up to 20 feet deep, as recently as the 1970s. Following closure of New Inlet, sedimentation has increased rapidly, resulting in shallow water depths throughout the basin area. Shallower water may contribute to the development of extensive algal mats and/or water quality changes, including episodes of hypoxia and occasionally unusual pH patterns.

Visitor Use

The ease of access afforded by the Fort Fisher State Recreation Area beach driving road and the WRC boat ramp expose portions of the site to significant visitor use. Although most visitors leave little to no trace of their presence, inappropriate activities and excessive or irresponsible visitor use can result in damage to habitats and disturbance of wildlife as well as reduce the overall visitor experience. Camping is not permitted at this site yet, illegal camping and campfires occur regularly. Driving on the barrier beach portion of the site is managed by marked corridors; however, occasional instances of driving in wet or vegetated areas occur. The rock jetty constitutes a safety hazard for visitors at the site; despite warning signage, many visitors attempt to utilize the dam to access Zeke's Island or for fishing. The Reserve regularly promotes responsible visitor use of the site through signage, various communication initiatives, and social media to help maintain a balance between resource protection and public enjoyment and safety. Enforcement of Reserve rules and policies at the site, as well as State and local laws, is provided by partner agencies which often have limited time and resources to devote to this effort. Enforcement of visitor use issues on Zeke's and North Islands is further complicated because these portions of the site are only accessible by boat.

Water Quality

The water quality in and around the Zeke's Island site has been impacted periodically by inputs from upstream activities such as non-point source pollution associated with land development and land cover change. Due to population growth projections, development and land cover change are likely to continue to affect water quality in the watershed in coming decades. Water quality can also be influenced by the Cape Fear River shipping channel which has introduced salt water further up into the river as it has been deepened to accommodate larger container ships. As previously stated, some hypoxia and unusual pH events have been documented, although the causes are not well understood at this time.

Sea Level Rise and Storms

Barrier island ecosystems are subject to forces such as sea level rise and storms that move sediment, cause changes in topography and geomorphology, and require constant adaptation by vegetation communities. As sea level rises, barrier islands tend to retreat landward which can be expected of the barrier beach at Zeke's Island Reserve. The 2015 NC Sea Level Rise Report Update shows that the sea level in Wilmington, N.C., will increase an average of 2.4 inches in the next 30 years. Sea level rise and storms have the potential to result in significant change to the site's natural resources, particularly if water levels change at a greater rate than accretion is occurring.

Invasive Species

Invasive plant species can alter habitats by outcompeting native vegetation. Species known to occur at the Zeke's Island site include the common reed (*Phragmites australis*), beach vitex (*Vitex rotundifolia*), red algae (*Gracilaria vermiculophylla*), and white poplar (*Populus alba*). Over time, invasion by additional species may take place as range expansion occurs or new species are introduced to the region.

II. Education Program Plan

Education Program Overview

The National Estuarine Research Reserve System's mission includes an emphasis on education, interpretation, and outreach. Education at each reserve is designed to fulfill the Reserve System goals as defined in the regulations (15 C.F.R Part 921(b)):

- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
- Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

To sustain these system goals, the 2011-2016 Reserve System Strategic Plan outlines education objectives that support the focus areas of climate change, habitat protection and water quality:

- Enhance the capacity and skills of teachers and students to understand and use Reserve System data and information for inquiry-based learning; and
- Increase estuary literacy and promote active stewardship among public audiences through the development and delivery of tools and programs addressing climate change, habitat protection, and water quality.

The Reserve System provides a vehicle to increase understanding and awareness of estuarine systems and improve decision-making among key audiences to promote stewardship of the nation's coastal resources. Education and interpretation incorporate science-based content into a range of programs and methodologies that are systematically tailored to key audiences around priority coastal resource issues.

Reserves conduct formal and informal education activities, as well as outreach activities that target culturally diverse audiences of educators and students, environmental professionals, resource users and the general public. Education and public programs, interpretive exhibits and community outreach programs integrate elements of Reserve System science, research and monitoring activities and ensure a systematic, multi-faceted, and locally focused approach to fostering stewardship.

The Reserve System is committed to preparing tomorrow's future leaders with the knowledge and understanding of our nation's oceans and coasts to be responsible stewards. To fulfill this commitment, the Reserve System has created the K-12 Estuarine Education Program (KEEP) to increase the estuary literacy of students, teachers and the general public. The KEEP Program helps students and teachers learn about essential coastal and estuarine concepts, develop data literacy skills and strengthen their critical thinking, team building, and problem-solving skills. K-12 and professional development programs for teachers include the use of established coastal and estuarine science curricula aligned with state and national science education standards and frequently involves both on-site and in-school follow-up activities.

Community education is another priority for the Reserve System. Community education programs foster behavioral change to promote resource conservation. These programs work with audiences whose choices directly impact the integrity of our estuaries and their associated watersheds.

North Carolina NERR Education Program

Education Program Context

The NCNERR education program builds on the NERRS System goals and Strategic Plan, delivering information to target audiences on N.C. coastal resources to foster environmental stewardship and informed decision-making. Reserve education programs are offered for a variety of audiences including K-12 and college students, formal and non-formal educators, and the general public. Field trips, activity books, and summer camps are offered to North Carolina's K-12 and college students to enhance lessons learned in the classroom. To serve formal and non-formal educators, professional development workshops are offered and classroom activities/curricula are developed and available for educator use. information about the Reserve and North Carolina's estuaries is shared with the general public during summer field trips to Reserve sites and at fairs and festivals. All education programs are open to the citizens and visitors of North Carolina but are most heavily advertised in North Carolina's 20 coastal counties including those that include Reserve sites. The Reserve's research and stewardship initiatives are incorporated into educational activities and scientific information is translated into language that can be understood and applied by target audiences. Where appropriate, education and training staff work to share relevant complementary messages to their intended groups. Efforts will be made to incorporate themes and projects that address the three NCNERR topical areas, as addressed in the Topical Areas Chapter.

Formal needs assessments are conducted every five years with the most recent one completed in 2014. From this evaluation, education staff gained information pertaining to what Reserve education offerings educators use, what topics they would like more information on, and the format they prefer for programs and curricular activities. Topics identified include changing coastal conditions, human impact on the environment, and how estuaries serve as nurseries for marine life. Education programs are also assessed through formal evaluations at the end of most offerings and conversations with program participants; this information is used to refine offerings and topics presented.

Education Program Capacity

Education programs are developed and administered by the education staff. Currently, the education staff includes the Education Coordinator located in the central office and a temporary Stewardship and Education Specialist located in the southern office. Summer education programs and activities are accomplished with the help of interns, part-time temporary assistance, and volunteers. Education programs are conducted in concert with Reserve training, research and stewardship staff who deliver program content and assist with logistics, including the Reserve Manager, CTP Coordinator, Research Coordinator, research staff in Wilmington, and stewardship staff in the northern, central, and southern offices. A teaching classroom for classes, camps, and workshops is located in the central office and a 27 ft. passenger boat is used to transport field trip participants to the Rachel Carson Reserve. For education programs in the southern region, staff use

meeting and classroom space at the CMS facility. Partner facilities are utilized in the northern and southern regions when other space is more conducive to programming or where Reserve facilities don't exist. Examples include the WRC Outer Banks Education Center and N.C. State Parks facilities.

Partnerships with other organizations are an integral part of the Reserve's ability to educate a broader population along the 300 miles of North Carolina's coast. Partners include N.C. Sea Grant, Albemarle-Pamlico National Estuary Partnership, the WRC, the N.C. Office of Environmental Education, the N.C. Maritime Museum and various divisions within the N.C. Department of Environmental Quality. These partners serve in a variety of roles such as co-hosting educator workshops, reviewing curricular activities, and leading student programs.

The education annual budget allows for purchasing of necessary supplies and materials to deliver programs. External funding opportunities are sought and funds are leveraged from partners to implement new programs and initiatives. All programs, except the summer camps, are delivered free of charge and in free partner facilities to maximize program funds.

Education Program Delivery

Education goals and target audiences are engaged through three programs: K-12 and College Student Education Program, Educator Professional Development Program, and Community Education and Outreach Program.

K-12 and College Student Education Program

The K-12 and college student program provides students with hands-on, inquiry-based learning opportunities with content that focuses on North Carolina's coastal and estuarine ecosystems. All K-12 programs are aligned to the North Carolina Standard Course of Study and National Science Standards. National Ocean Literacy Essential Principles and Estuarine Principles and Concepts are also incorporated into K-12 and college student programs. K-12 field trips, classroom visits and summer camps are part of NERRS KEEP.

Field trips are held primarily at the Rachel Carson Reserve each spring and fall and include a two-hour interpretive nature hike that highlights estuaries, and habitats and organisms found at the Reserve. Field studies are also available at the Rachel Carson Reserve for classes that are interested in exploring a topic more in-depth, such as vegetation monitoring, population studies, and water quality testing. Content is tailored to the appropriate grade level and standards. In partnership with Masonboro.org and Carolina Ocean Studies, the Masonboro Island Explorer Program allows New Hanover County fifth grade students the chance to visit the Masonboro Island Reserve. During these field trips, students visit different stations on the island and participate in activities that highlight salt marsh ecology, tidal creeks, and barrier islands. All three activities enforce the grade's curriculum standards. Field trips and studies are evaluated by the students, teachers, and chaperones to determine information learned, program effectiveness, and overall enjoyment. Programs are held at other NCNERR sites as staff and resources are available.

For classes that cannot travel to the Reserve, the education staff offers a variety of classroom-based programs on estuarine-related topics that can be led by teachers. Reserve education staff are available for classroom visits by request.

Through a partnership with the N.C. Maritime Museum, the Reserve offers four summer camp programs for children: Preschool Storytime and Crafts (ages 3-5), Seashore Life 1 (grades 1-2), Seashore Life 2 (grades 3-5), and Coastal Conservation Stewards (grades 6-10). NCNERR education staff schedule, design, and deliver these programs while the N.C. Maritime Museum advertises the camps and registers participants.

The K-12 and college student education program is supported by other Reserve staff members. Training and stewardship staff assist with program delivery and transportation for field trips and studies. Stewardship and research staff offer suggestions on how recent and relevant projects can be incorporated into K-12 and college educational opportunities and assist with translation.

Educator Professional Development Program

The purpose of the educator professional development program is to educate several different audiences--formal and non-formal educators and pre-service teachers. Formal educators are classroom teachers and non-formal educators are individuals who teach a specific subject, usually in the field. Pre-service teachers are individuals enrolled in college-level education courses. These programs inform educators about coastal and estuarine ecosystems to improve estuarine literacy in both educators and students. The Reserve accomplishes this through workshops and by providing supplementary curricular materials.

Education staff offer two different professional development programs; Coastal Explorations and Teachers on the Estuary (TOTE). The Reserve's Coastal Explorations Workshop is offered to all educators (formal, non-formal and pre-service) in North Carolina who would like to learn more about the Reserve program, estuaries and their importance. This 6-hour workshop highlights the Reserve's curriculum and includes a trip to a Reserve site. The workshop is offered twice a year, once in Beaufort and another rotating between the northern and southern regions. This workshop is currently approved to offer North Carolina teacher certification renewal credits and is an approved course for the North Carolina's Environmental Educators certification program. TOTE is a more in-depth workshop and is part of the NERRS KEEP Program. This program offers hands-on, field-based, professional teacher development opportunities by NERRS sites across the nation. The program goals are for teachers and students to increase their knowledge and appreciation of estuarine environments, as well as, acquire the necessary skills to act as stewards of estuarine resources. This 2-day (15 contact hours) workshop for formal educators highlights national curriculum, NCNERR curriculum, and includes a field trip to a Reserve site. TOTE differs from Coastal Explorations by incorporating research and stewardship staff-led presentations and hands-on activities showcasing current projects, and highlights NERRS Estuaries 101 Curriculum, which is not presented during Coastal Explorations Workshops.

Post-workshop evaluations are conducted for every workshop to ensure that content and delivery meet participant needs. Many educator professional development workshops are conducted in partnership with other organizations, such as offering meeting space and assisting with workshop content. For example, N.C. Sea Grant's educator has shared organization activities that relate to estuaries with NCNERR workshop participants.

The Reserve also provides K-12 educators with written, estuarine-based, curricular material for both classroom and field-based activities. In addition to the curricula, the Reserve produces educational posters, activity books, coloring books, and a variety of informational brochures to use in classrooms. Web resources are also available for teachers/educators to download and use, including basic estuarine information, videos,

and field guides. These resources are promoted during educator professional development programs and at relevant conferences.

Community Education and Outreach Program

The community education and outreach program strives to increase public awareness of the mission and goals of the NCNERR, enhance understanding of estuarine systems and processes by increasing estuarine literacy, and foster environmental stewardship in citizens of all ages. Target audiences are the general public including local citizens of and visitors to coastal North Carolina. Outreach activities include: public field trips; participation in environmental festivals and fairs; public presentations; and production of educational materials.

Every summer the Reserve offers naturalist-led public field trips twice a week to the Rachel Carson Reserve led by trained volunteers and/or Reserve staff. Public nature hikes and paddle trips have also been offered at the Currituck Banks and Masonboro Island Reserves as staff and resources allow.

Public presentations on the Reserve's programs and coastal and estuarine-related topics are delivered year-round by a variety of Reserve staff by request to organizations, including Boys and Girls Clubs, Boy Scout Troops, church groups, garden clubs, science clubs, preschools, colleges and universities, and other interested parties. Stewardship and research staff have held several seminar series in Wilmington on estuarine faunal species, their habitats, and related science and monitoring efforts.

Informational brochures, posters, interpretive signs, and display boards are used to inform local citizens and visitors about the Reserve and estuarine habitats. Web resources such as basic estuarine information and field guides are available for the public and are promoted through the Reserve's social media pages.

Delivery of community education and outreach programs involves the entire Reserve staff given the size of the Reserve staff and the location of expertise across the Reserve offices. Education staff develop educational materials, incorporating input from relevant staff as appropriate, and provide input and assistance to Reserve staff on appropriate content and materials when planning for presentations and outreach events. Stewardship staff deliver and/or play critical roles in site-based outreach programs. All staff deliver presentations to organizations.

Education Program Needs and Opportunities

The following needs, opportunities and partnerships will improve and expand upon current programming to meet the objectives and actions identified in this plan.

As part of the most recent education needs assessment, survey respondents identified that educator workshops are the most useful out of all of NCNERR's education programs. To expand TOTE and have the ability to attract more educators, more funding is needed for this program in order to staff additional workshops and purchase supplies and materials. Water quality demonstration equipment including ten water testing kits and a hand-held YSI are needed to supplement field activities and TOTE workshops that feature water quality testing as part of the Estuaries 101 curriculum. Tablets are also needed for workshop participants to interact with mobile applications such as the NOAA marine debris tracker application and access GIS data while in the field. To enhance classroom activities that include lessons about plant and animal

identification, a hand-held microscope and a projection microscope is needed. To support K-12, public education, and training programs conducted in the Beaufort office, an outdoor classroom is needed. More detail regarding outdoor classroom can be found in the administration plan.

Program offerings in the northern and southern regions are limited due to current staffing levels. Education staff fully rely on stewardship staff in the northern region to conduct programs independently or partner with local agencies and organizations. A full-time or temporary staff person is needed to expand education programs in this region. To fulfill education tasks in the southern region, it is critical to maintain the ability to fund staff at least partially dedicated to education programming. See the staffing plan for additional detail on staffing needs.

Seeds to Shoreline is a program where students and teachers grow *Spartina alterniflora* plants in their classrooms from seeds to plants and then plant the marsh grass at Reserve sites and other appropriate locations. This program represents an opportunity in which staff will continue to partner with the southeast NERRs and N.C. Sea Grant and seek additional funding and support for this program to incorporate additional schools into the program.

Videos are an effective and engaging method for sharing information with program participants and are an opportunity to connect with participants in a different way to complement more traditional methods. Education staff and interns and the Communications Specialist will produce videos to support education programs using existing field cameras.

Education Program Objectives and Actions

Education objectives are presented in bold text following Goal 1 below. Actions are listed under each objective, along with supporting text used to describe the implementation of each action.

Goal 1: Education and training inspire target audiences to protect coastal and estuarine ecosystems.

Objective 1.1 Two hundred fifty educators receive information on North Carolina's coastal and estuarine ecosystems and are able to apply curricula within their instruction.

Action 1: Conduct hands-on and field-based educator workshops, including Coastal Explorations and Teachers on the Estuary.

The Reserve's educator professional development program will seek to increase both the number of workshops offered and participants in Reserve workshops. As more educators become estuarine literate they can impart their knowledge to their students and thus increase estuarine literacy in North Carolina. Through partnerships with WRC, University of North Carolina Wilmington (UNCW), and North Carolina State Parks, the Reserve will conduct professional development educator workshops in northern and southern regions on the coast, increasing the Reserve's programmatic impact. These partners provide meeting space for the workshops in these areas. Education staff will develop workshop content, deliver programming, and increase

educational resources such as needed equipment and printed material through grant writing or partnership opportunities.

Coastal Explorations will be offered twice a year with one being conducted in the central region and the other one rotating between the northern and southern region and is open to all educators in the 20 coastal counties. This workshop serves as an overview of the Reserve program and North Carolina estuaries and highlights NCNERR curricula. Coastal Explorations workshops held in the southern region will target New Hanover County teachers to complement the Masonboro Island Explorers Program.

TOTE will be offered once a year and is open to all formal educators in North Carolina with educators working in the 20 coastal counties receiving first priority to attend. Each workshop will highlight both the national curriculum (Estuaries 101) and NCNERR curricula and will focus more in-depth on the current research being conducted at the sites and current stewardship projects.

All workshops will continue to be evaluated for their effectiveness and updated based on feedback. Evaluations are given at the end of each workshop. Participants are given the opportunity to comment on what they liked best about the workshop and changes that need to be made.

The number of educators reached (by grade level) and contact hours spent with staff through the educator professional development program are recorded as NERRS performance measures; data from action 1.1.4 is also incorporated into this measure.

Action 2: Update workshops and curricula based on current techniques and topics identified through the 2014 needs assessment as well as future surveys.

Curricular activities, originally developed in the early 1990s, are updated by education staff on a regular basis. The activities reflect up-to-date educational methods and information that better address different learning styles, such as inquiry-based activities.

The 2014 needs assessment indicated that educators would like to receive more information regarding changing coastal conditions, human impact on the environment, and how estuaries serve as nurseries for marine life. Educators also requested this information be delivered through hands-on activities, demonstrations, and field studies during 1 – 3 day workshops. This requested information will be incorporated into trainings by having a guest speaker and/or by adding a field study. Curricular activities will also be developed by education staff regarding these topics.

In response to a recent TOTE evaluation comment, a matrix outlining NCNERR curricula and how they correlate with North Carolina standards will be developed by education staff to provide an easy way for educators to explore the curriculum.

Action 3: Incorporate Reserve research and stewardship activities and monitoring data into workshops and curricula.

As more accessible online water quality SWMP data is developed and tablets are available for field programs, education staff will work with research staff to incorporate the mobile, user-friendly data interfaces into student and teacher activities. In addition to SWMP data, tablets will be used for presenting relevant GIS maps and data to program participants.

As research results become available, the education staff will work to translate, distill, and incorporate new information about estuaries and watersheds into educational curricula and products. The education staff will also work with stewardship staff to incorporate site-specific information into programming and encourage educators to participate in new and ongoing stewardship projects. For example, the 2015 TOTE workshop included a section on marine debris, an ongoing stewardship issue at local, state, and national levels, and participants met with stewardship staff to learn about marine debris, how to use NOAA's Marine Debris Tracker application, and ways to present the application to their students.

Action 4: Engage educators through partner-hosted education programs and events.

Often education staff are invited to present Reserve information and curricula as part of educator trainings being offered near a Reserve office by other agencies and organizations. These opportunities are a good way to work with the hosting organization to present about the education program. For example, education staff are invited to participate in the University of North Carolina's Scientific Research and Education Network (SciREN) event. This networking event brings researchers and teachers together for face-to-face interactions and to exchange ideas and materials relating to local/current research.

The Education Coordinator attends the North Carolina Science Teachers Convention every year and hosts an informational booth. Every other year (pending approval) a presentation is made at the convention informing participants about the Reserve's education program and offerings.

The number of educators reached (by grade level) and contact hours spent with staff through the educator professional development program are recorded as NERRS performance measures; data from action 1.1.1 is also incorporated into this measure.

Action 5: Maintain and enhance partnerships for program implementation and seek input from the NCNERR education advisory committee.

The audience, topical, and geographic diversity of the Reserve's education programs offers many opportunities for partnerships throughout coastal North Carolina. Many of the Reserve's partners help facilitate education programs such as partnering with North Carolina Sea Grant on TOTE workshops and the Seeds to Shoreline program. Seeds to Shoreline is a program where students and teachers grow *Spartina alterniflora* plants in their classrooms from seeds to plants and then plant the marsh grass at Reserve sites and other appropriate locations. Students also learn about the importance of this plant species to North Carolina estuaries.

The Education Coordinator seeks input from the NCNERR Education Advisory Committee on an annual basis regarding professional development and education programs. Staff will seek committee input on priorities for curricular development described in Action 2 of this objective as well as priorities and methods for incorporating new content into workshops. The NCNERR Education Advisory Committee is comprised of other educators employed by state agencies, formal educators, Reserve volunteers, and the Reserve Research Coordinator.

Objective 1.2 Five thousand students receive information on North Carolina's coastal and estuarine ecosystems and are able to describe an estuary and its benefits.

Action 1: Conduct educational field trips for K-college students, focusing each field trip on the grade's standards.

The Reserve will continue to provide field trip and/or field study experiences such as population studies and water quality monitoring for K-12 and college students. Field trips are ecology-based nature hikes that present basic estuarine information and are tailored to meet North Carolina's Standard Course of Study for the appropriate grade level. For example, during a field trip for third graders, education staff focus on plants and how they survive in an estuary and when leading a high school aged group, staff highlight water quality in North Carolina's tidal environments. Most field trips are conducted on the Rachel Carson Reserve as a result of staffing proximity and appropriate facilities. These field trips are evaluated by the students, teachers, and chaperones to determine information learned, program effectiveness, and overall enjoyment. As staff and resources allow, the education program will work to increase field trip opportunities for student groups at the Currituck Banks, Masonboro Island, and Zeke's Island Reserves.

The number of K-12 and college students reached through this program and the contact hours spent with the students per year are recorded as NERRS performance measures. The number of contact hours spent with students per year is recorded as a NCNERR 312 performance measure, with a target of 1080 student contact hours per year; data from actions 1.2.2, 1.2.3, and 1.2.4 are also incorporated into this measure. This target was established in 2012 and does not reflect planned growth during the scope of this management plan for this objective.

Action 2: Work with partners to offer the Masonboro Island Explorer Program.

Education staff will work with Masonboro.org, Carolina Ocean Studies, and the New Hanover County School System to offer this program for fifth grade students of New Hanover County. Reserve staff will continue to work with Carolina Ocean Studies to provide up-to-date activities for students based on fifth grade standards, and make changes to the activities based on staff observations and teacher comments as needed. Education staff will ensure that Carolina Ocean Studies instructors are current on the curriculum through a once a year training and will attend at least one trip per field trip season. Staff will participate in annual planning and debriefing meetings as appropriate.

The number of K-12 and college students reached through this program and the contact hours spent with the students per year are recorded as NERRS performance measures. The number of contact hours spent with

students per year is recorded as a NCNERR 312 performance measure, with a target of 1080 student contact hours per year; data from actions 1.2.1, 1.2.3, and 1.2.4 are also incorporated into this measure. This target was established in 2012 and does not reflect planned growth during the scope of this management plan for this objective.

Action 3: Present coastal and estuarine concepts and curricular activities to students through classroom visits.

The K-12 student education program will provide local outreach in schools in the vicinity of the Rachel Carson Reserve by request and staff availability. Classroom visits include conducting hands-on, inquiry-based activities, and providing information about the Reserve and its habitats. Information about classroom visits will be shared with educators through workshops, seminars, personal communications, and the web.

The number of K-12 and college students reached through this program and the contact hours spent with the students per year are recorded as NERRS performance measures. The number of contact hours spent with students per year is recorded as a NCNERR 312 performance measure, with a target of 1080 student contact hours per year; data from actions 1.2.1, 1.2.2, and 1.2.4 are also incorporated into this measure. This target was established in 2012 and does not reflect planned growth during the scope of this management plan for this objective.

Action 4: Conduct summer programs for students and incorporate new curricular activities.

The Reserve partners with the N.C. Maritime Museum to offer four summer programs for children: Preschool Storytime and Crafts (ages 3-5), Seashore Life 1 (grades 1-2), Seashore Life 2 (grades 3-5), and Coastal Conservation Stewards (grades 6-10). These programs are held in the Reserve's facility in Beaufort with daily field trips to the Rachel Carson Reserve where the students conduct field investigations and learn through hands-on activities. Core estuarine concepts and new and updated curricular content and activities developed by education staff are presented to summer program participants each year. For example, each summer camp conducted in the field starts off with a scavenger hunt using the NCNERR curricular activity titled "Exploring an Estuary" which introduces estuarine habitat, flora and fauna to participants. Education staff will also highlight new content developed under Objective 1.1 during summer programs. The N.C. Maritime Museum assists with advertising and registration.

The number of K-12 and college students reached through this program and the contact hours spent with the students per year are recorded as NERRS performance measures. The number of contact hours spent with students per year is recorded as a NCNERR 312 performance measure, with a target of 1080 student contact hours per year; data from actions 1.2.1, 1.2.2, and 1.2.3 are also incorporated into this measure. This target was established in 2012 and does not reflect planned growth during the scope of this management plan for this objective.

Objective 1.3: N.C. citizens and visitors understand the value of coastal and estuarine ecosystems and how the NCNERR protects these resources.

Action 1: Conduct public outreach programs at Reserve sites.

Summer public field trips are a core component of community education and outreach programs. These field trips are currently conducted bi-weekly on the Rachel Carson Reserve during the summer months. Three types of field trips are offered, depending on the tide: 1) 2-hour nature hike across the western part of the Rachel Carson Reserve, 2) a 2-hour boat trip to the Rachel Carson boardwalk at the eastern end of the Reserve and 3) a circumnavigation cruise around Rachel Carson Reserve including a visit to Middle Marsh. Kayak trips around Masonboro Island are led in the spring and fall by staff.

The number of public program participants is recorded as a NERRS performance measure; data from action 1.3.3 is also incorporated into this measure.

Action 2: Enhance partnerships with government agencies delivering public programming at Reserve sites.

Partner agencies such as the WRC, N.C. Maritime Museum, and N.C. Aquariums conduct general public education programs on Reserve sites. Education staff will work with these agencies to better understand how they use the sites and develop a mechanism for collecting data from partners on the number of participants and programs delivered on an annual basis. Education staff will collect and summarize these data annually and provide relevant site and program updates to partners.

Action 3: Participate in community events such as Earth Day festivals and National Estuaries Day.

Education staff reach the general public through outreach programs that involve display booths and activities during celebrations like Earth Day or National Estuaries Day. At these events, staff bring educational activities that focus on the importance of estuaries, current research being conducted on the sites and ways that the public can protect estuaries. Display boards were recently updated for these kinds of events, along with hands-on activities, such as a habitat matching game and touch tables, to inspire audiences to protect coastal and estuarine ecosystems. The target number for festivals and outreach events is 2 per region per year.

The number of public program participants is recorded as a NERRS performance measure; data from action 1.3.3 is also incorporated into this measure.

Action 4: Encourage program participants to make a commitment to protect estuaries.

Education program participants may choose to make an estuary pledge to protect coastal and estuarine ecosystems. The estuary pledge is an interface for engagement at public events and is used to accompany K-college educational activities on Reserve sites. Participants record a self-selected commitment that will aid in the protection of estuaries on an estuary pledge magnet or card that they take with them to remember their

commitment. Reserve staff offers guidance when necessary to aid in the selection and understanding of beneficial personal actions.

By engaging pledge signees to directly identify personal action(s) that can be taken at home or in the community that will positively impact the health, protection, or preservation of estuaries, NCNERR is able to promote understanding, stewardship and appreciation of coastal and estuarine resources. This activity also allows the opportunity to educate participants on how the selected action(s) helps to protect and preserve estuaries. As a result of making a personal decision to support estuarine protection, participants are more likely to have a place-based connection and greater appreciation for local estuaries.

Action 5: Recruit and train volunteers to support education activities.

Volunteers lead summer field trips to the Rachel Carson Reserve. Volunteers are recruited through public field trips, and through the Reserve website and social media outlets. Information about the Rachel Carson Reserve, NCNERR programs including current research and stewardship projects, and safety information is reviewed with volunteers during a pre-field trip season training led by education and stewardship staff.

The number of volunteers that support education activities and hours contributed are recorded as NERRS performance measures.

III. Coastal Training Program Plan

Coastal Training Program Overview

The National Estuarine Research Reserve System's mission includes an emphasis on education and interpretation. The Reserve System recognizes it has a responsibility to educate coastal decision makers and supports the Reserve System goals, as defined in the regulations (15 C.F.R Part 921(b)), through the Coastal Training Program:

- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
- Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

To sustain these system goals, the 2011-2016 Reserve System Strategic Plan outlines coastal training objectives that support the focus areas of climate change, habitat protection and water quality:

- Increase estuary literacy and promote active stewardship among public audiences through the development and delivery of tools and programs addressing climate change, habitat protection, and water quality.
- Improve the capacity and skills of coastal decision makers to use and apply science- based information in decisions that affect estuaries and coastal watersheds.

The CTP provides up-to-date scientific information and skill-building opportunities to coastal decision makers responsible for making decisions affecting coastal resources. Through this program, reserves ensure that coastal decision makers have the knowledge and tools they need to address local critical resource management issues.

Coastal decision makers are defined as individuals whose duties include making decisions that affect the coast and its resources. The target decision-maker groups vary according to reserve priorities, but generally include groups such as local elected or appointed officials, managers of both public and private lands, natural resource managers, coastal and community planners, and coastal business owners and operators. They may also include groups such as farmers, watershed councils, professional associations, recreation enthusiasts, researchers, and more.

Reserves are uniquely positioned to deliver pertinent information to local and regional decision makers given their place-based nature. CTP coordinators know the local people, places, and science and are able to skillfully convene training participants and experts to address coastal management issues. Training programs are built upon solid and strategic program documents, including an analysis of the training market and assessment of audience needs. Coordinators then work with the results to identify how their program can best address local and Reserve System priority issues.

Partnerships are integral to the success of the program. Reserves work closely with several other NOAA programs, as well as a host of local partners in determining key coastal resource issues, target audiences, and expertise to deliver relevant and accessible programs.

North Carolina NERR Coastal Training Program

Coastal Training Program Context

The North Carolina Coastal Training Program (CTP) focuses efforts within North Carolina's 20 coastal counties. Programs are generally in-person workshops conducted regionally, in the northern, central, and southern coasts, which align regionally with NCNERR sites. Within this geographical scope, the CTP target audiences include local elected and appointed officials, local government staff, state agency staff, land use planners, engineers, marine contractors, consultants, landscape architects, and real estate agents. Specific target audiences vary by program. For example, real estate agents are targeted for programs related to living shorelines, barrier island development, and low impact development. The goal is to increase real estate agents' knowledge, make them more informed professionals, and encourage them to share information with their clients.

Assessments of audience needs, which are formally conducted approximately every five years, are critical for the success of the CTP. Informal needs assessments – through post-workshop evaluations, communication with training attendees, and training partner requests – also assist the CTP in determining program focus. The most recent needs assessment of past workshop attendees and partners was conducted in 2014. This online survey revealed the need for information on the following topics: stormwater management, coastal wetlands, shoreline development rules, living shoreline implementation, community resilience/preparedness, sea level rise adaptation, and sustainable growth/development. These needs align with the NCNERR Strategic Plan Topical Areas – water quality, coastal and estuarine ecosystem protection, and coastal hazards; and with the NERRS Strategic Plan priorities – climate change, habitat protection, and water quality.

Coastal Training Program Capacity

Implementation of the CTP is conducted by a full-time staff person located at the Reserve office in Beaufort, N.C. in the central coastal region. This location allows for easy travel to the southern and northern coastal regions. The CTP Coordinator routinely seeks assistance from other staff to help with program logistics. The CTP annual budget allows for purchasing of necessary supplies and materials to deliver programs. Funds are also leveraged from partners to implement trainings on mutual program priorities. Almost all programs are delivered in partner facilities, most of which are free, to maximize program funds. For example, the New Hanover County Center (part of the N.C. Cooperative Extension) is used for programs held in Wilmington (southern region) and Jennette's Pier (part of the N.C. Aquarium) is used for programs held in the Nags Head area (northern region).

Every program delivered by the CTP is done so in coordination with partners. Partners vary by program type and include the DEQ, the DCM, N.C. Sea Grant, Albemarle-Pamlico National Estuary Partnership (APNEP), N.C.

Coastal Federation, OCM, and CCFHR. Routinely, academics and other professionals from local institutions help deliver programs based upon their area of expertise. Example institutions include N.C. Aquariums, UNCW, IMS, and N.C. Division of Energy, Mineral, and Land Resources' Stormwater Permitting Program. As programs continue to develop, new partnerships will be fostered to deliver the best available information to target audiences, meet mutual education goals, and increase program efficiencies.

Coastal Training Program Delivery

The CTP routinely coordinates with the research, education, and stewardship programs of the Reserve. This is done through program development that highlights the other sectors' work, sharing curricula foci, or developing trainings that fulfill a sector's information needs. Where appropriate, the CTP will incorporate data into trainings from NERRS system-wide programs such as the SWMP and Sentinel Site Application Module 1. The CTP Coordinator participates in NERRS workgroups to help with national initiatives. The CTP Coordinator also seeks external funding for projects relevant to priority areas and has been the Collaborative Lead on several NERRS Science Collaborative proposals, two of which were funded.

The CTP usually delivers training via in-person events and posts workshop materials online, such as workshop agendas, presentations, resources, and video recordings. The CTP strives to incorporate adult learning styles in all programming. This includes diversifying information delivery methods (i.e. presentations mixed with discussion, group problem solving, site visits, or other learning activities) as well as allowing participants to share their knowledge and experience. For example, workshops on living shorelines incorporate field visits to existing living shorelines (including those located on Pivers Island, where the NCNERR Beaufort office is located) with the opportunity for participants to plant marsh plants. Workshops on Low Impact Development (LID) incorporate key pad polling in presentations and participants play a large board game with the goal of reducing pollution entering a fictional watershed using LID techniques.

Training events give participants the opportunity to network with others who are dealing with the same issues. These opportunities may yield new partnerships to solve coastal problems and identify and address barriers to implementing effective coastal management techniques and policies.

In addition to offering training events, the CTP also provides technical assistance to partners and target audience members. Past technical assistance has included review of needs assessment surveys and planning and facilitating stakeholder engagement meetings. For example, the CTP partnered with N.C. Sea Grant to plan and facilitate a stakeholder meeting to help define responsibilities for removal of abandoned and derelict vessels among government agencies.

The CTP evaluates all events with post-workshop evaluations. The data collected helps to fine-tune future training events. Anecdotal data at training events (i.e. engagement of participants, questions asked, comments made to presenters or the CTP Coordinator) are also used to help evaluate workshop effectiveness and fine-tune training events. Data collected with the post-workshop evaluations are aligned with the NERRS reporting requirements to ensure consistency with other NERRS CTPs and ensure that NERRS performance measures are met. NERRS CTP performance measures include: maintain capacity to deliver at least five coastal decision-maker training events annually and 90% of the coastal decision-makers participating in CTP training

or services report they plan to apply what they learned in their work or decisions. Historically, the CTP has offered an average of ten training events annually and normally met the 90% of participants reporting an intent to apply information gained at CTP events in their work. The CTP also submits an annual success story that highlights training outcomes, synergies, or collaborations that result from CTP training and technical assistance activities.

Coastal Training Program Needs and Opportunities

Many of the information needs identified in the 2014 needs assessment have been long-term priorities addressed by CTP that will continue to be addressed. These remain priorities due to the enduring nature of these topics – they are challenges not solved in a few years and are influenced by increasing demand for resources, population growth, changes in regulations and policies, and new information. As new research or problem-solving approaches become available, the CTP incorporates these data, tools, and resources into programming to keep target audiences informed.

Community resilience/preparedness and sea level rise adaptation are newly identified needs. The CTP has the capacity, with the assistance of partners, to address these topics in the next five years. Additionally, the CTP seeks to establish collaborations with local communities and relevant partners to increase the impact of the CTP and the Reserve within its watersheds. Through stakeholder engagement processes, the CTP is poised to provide technical assistance on coastal hazard vulnerability, resilience, and adaptation. In some cases, external funding may be applied to accomplish tasks associated with these collaborations.

The main limitation of the training program is the ability to reach the entire N.C. coast with only one staff member located in the central coastal region. Thus, decisions are made on a case by case basis on where a workshop will be conducted and if the workshop will be replicated in the other coastal regions. This decision is usually determined by the topic being addressed, outside support provided by partners, and time constraints of the CTP Coordinator and of partners. Trainings based on high priority coastal management topics, determined by needs assessments and emerging coastal policy, are routinely offered in the three coastal regions. Training that meets Reserve staff needs or are a regular offering of the CTP are usually only conducted in one or two of the coastal regions, with the latter rotating regions as appropriate over time.

An opportunity for the CTP is to expand the strong network of partners that has been cultivated over the years to address newly identified audience needs. Partners serve as expert speakers, provide funding, provide meeting spaces, assist in marketing programs to target audiences, and serve as advisors to training content. Another opportunity of the CTP is increasing NCNERR and DCM staff involvement to address program needs. This can include the development and delivery of CTP activities. Lastly, the CTP is able to be nimble in its approach to training delivery. Emerging topics, audience needs, and audience and partner requests can easily be accommodated due to the flexibility of the CTP and the support received from NCNERR staff and partners.

Goal 1: Education and training inspire target audiences to protect coastal and estuarine ecosystems.

Objective 1.4: Annually, 90% of participants state that they intend to apply the science-based knowledge and skills relevant to coastal management gained through CTP activities.

Action 1: Coordinate core trainings for decision-makers in collaboration with program partners.

Core trainings include getting to know wetlands, barrier island development, LID basics for water quality protection, stormwater management, and living shorelines for estuarine shoreline stabilization. Additionally, training on stewardship related issues, such as citizen science and volunteer management, is an annual offering to support the stewardship program. Annual trainings targeting DCM staff are also coordinated based on the needs of the division that year.

The need for these core trainings was reaffirmed in the 2014 audience needs assessment. Core trainings are offered every one to two years and are often offered in response to a partner request. For example, the CTP has developed partnerships with county Associations of Realtors and real estate offices located throughout the N.C. coast. Historically, these partners request multiple trainings per year. Since these core trainings are routinely offered, accommodating these requests is a strength of the CTP.

Action 2: Coordinate new training events in response to the 2014 needs assessment and emerging policy issues in collaboration with program partners.

From this needs assessment, the biggest training need revolves around community resilience/preparedness to coastal hazards, which includes sea level rise adaptation and beach and estuarine erosion. Additionally, development and growth issues, such as balancing economic growth and development with resource protection, was a major theme that arose from the needs assessment. While the CTP has historically provided training on sustainable development, these needs present an opportunity to expand on this focus area.

To keep the CTP relevant between audience needs assessments, training programs are refined through post-workshop evaluations and training topics are oftentimes a result of emerging coastal policy. Assessment of emerging policy issues is accomplished through networking with partners, including the reserve's management partner, the DCM. For example, the division is working to promote living shorelines as an estuarine shoreline stabilization option where site conditions are appropriate. It became apparent that there was a lack of property owner and marine contractor knowledge on the effectiveness of living shorelines for erosion control. Thus, the CTP has worked collaboratively with permitting, policy, and research staff and other partners, such as the N.C. Coastal Federation, to craft trainings and outreach products to help promote the use of these more natural erosion control measures along the N.C. coast.

Action 3: Incorporate coastal and estuarine science into trainings.

A strength of the CTP is the incorporation of reserve and partner research results into programs. Every training begins with the scientific reasons why a resource is protected, including the ecosystem services it provides. This important context helps participants understand why environmental regulations exist as well as provides reasons to care about the resource.

The CTP is beginning to be viewed as a resource to local researchers who commonly have to incorporate outreach efforts into grant proposals. Through these partnerships, the CTP is able to increase its reach, incorporate the latest scientific findings in programs, and tap into external funding to support efforts. This also helps the CTP develop its yearly training schedule, as trainings are commonly scheduled as research project results are finalized.

Objective 1.5: Annually, at least two partners will receive technical assistance from the CTP to address mutual priorities relative to NCNERR topical areas.

Action 1: Establish collaborative relationships with local communities within Reserve watersheds and determine communities' technical assistance needs.

There are numerous ways in which these relationships could be established including connections made at reserve site LAC meetings, referrals from existing partners, funding proposals that include other reserve programs, and networking at CTP events.

Action 2: Connect with existing or new partners to address mutual priorities relative to NCNERR topical areas.

The CTP routinely assists partners such as the N.C. Sentinel Site Cooperative with training or meeting delivery. The CTP Coordinator also serves as a collaboration expert for researchers needing to engage stakeholders in research projects.

Action 3: Provide technical assistance to local communities and partners to address needs relative to NCNERR priorities, applying for external funding as needed and available.

Examples of technical assistance available to local communities and partners includes meeting planning and facilitation to engage stakeholders, needs assessments, and outreach. As technical assistance is provided, it may become clear that external funding is needed to make significant progress on the issue. Local improvements related to water quality, ecosystem protection, and coastal hazard resilience tend to be large scale endeavors not funded by a municipality's or partner's budget.

One source of funding is the NERRS Science Collaborative. The CTP Coordinator has served as the Collaborative Lead on proposals related to water quality improvements in the Towns of Wrightsville Beach and Beaufort. The role of the Collaborative Lead is to engage stakeholders in generation of the science to ensure that the science is meeting stakeholder needs and is applied by project end users.

Serving as Collaborative Lead can be a time consuming process. As an additional form of technical assistance, the CTP Coordinator could serve an advisor to a local professional working as a Collaborative Lead. This would increase the reach of the CTP while not overwhelming the CTP Coordinator as lead on multiple proposals during a funding cycle.

IV. Research and Monitoring Program Plan

Research and Monitoring Program Overview

The National Estuarine Research Reserve System's mission provides that reserves are protected and managed to afford opportunities for long-term research. Research at each reserve is designed to fulfill the Reserve System goals as defined in the regulations (15 C.F.R Part 921(b)):

- Address coastal management issues identified as significant through coordinated estuarine research within the system;
- Promote Federal, state, public and private use of one or more reserves within the system when such entities conduct estuarine research;
- Conduct and coordinate estuarine research within the system, gather and make available information necessary for improved understanding and management of estuarine areas.

To sustain these system goals, the 2011-2016 Reserve System Strategic Plan outlines research objectives that support the focus areas of climate change, habitat protection, and water quality:

- Expand capacity to monitor changes in water quality and quantity, habitat, and biological indicators in response to land use and climate change drivers.
- Improve understanding of the effects of climate change and coastal pollution on estuarine and coastal ecology, ecosystem processes, and habitat function.
- Characterize coastal watersheds and estuary ecosystems and quantify ecosystem services to support ecosystem-based management of natural and built communities.
- Increase social science research and use of social information to foster coastal stewards that value and protect estuaries.

The Reserve System's research and monitoring program provides the scientific basis for addressing coastal management challenges. Reserve research and monitoring activities provide valuable information about estuarine resources to increase understanding and awareness of their importance to a variety of audiences including scientists, resource managers, educators, and the general public.

Reserve System Research Program

Currently, there is one focused effort to fund estuarine research within the Reserve System.

The National Estuarine Research Reserve System Science Collaborative is a program that focuses on integrating science into the management of coastal natural resources. Currently administered through the University of Michigan, the program supports the co-development and application of relevant and usable knowledge and assessment information to address critical coastal management issues identified by the NERRS to improve the long-term stewardship of the nation's estuaries. The program is designed to enhance the Reserve System's ability to support decisions related to coastal resources through collaborative approaches

that engages the people who produce science and technology with those who need it. In so doing, the Science Collaborative seeks to make the process of linking science to coastal management decisions, practices, and policies more efficient, timely, and effective and share best practices and examples for how this can be done.

Reserve System Monitoring Program

The System-Wide Monitoring Program (SWMP) provides standardized data on national estuarine environmental trends while allowing the flexibility to assess coastal management issues of regional or local concern and is guided by the Reserve System-Wide Monitoring Program Plan. The principal mission of the monitoring program is to develop quantitative measurements of short-term variability and long-term changes in water quality, biological systems, and land use/ land cover characteristics of estuaries and estuarine ecosystems for the purposes of informing effective coastal zone management. The program is designed to enhance the value and vision of the reserves as a system of national reference sites and focuses on three ecosystem characteristics:

1. Abiotic Characteristics: Abiotic measurements are supported by standard protocols, parameters, and approaches that describe the physical environment including weather, water quality, hydrological, and sediment related parameters. The monitoring program currently provides data on water temperature, specific conductivity, percent saturation of dissolved oxygen, pressure, pH, turbidity, salinity, concentration of dissolved oxygen, and pressure corrected water depth. Meteorological data include air temperature, relative humidity, barometric pressure, wind speed, wind direction, rainfall, and photosynthetically active radiation (PAR). In addition, the program collects monthly nutrient and chlorophyll a samples and monthly diel samples at one SWMP data logger station. Data is Federal Geographical Data Committee compliant and available via the *Reserve System Centralized Data Management Office (http://cdmo.baruch.sc.edu/)*.
2. Biotic Characteristics: As resources are available, reserves are focusing on monitoring habitats and biodiversity.
3. Watershed and Land Use Classifications: The Reserve System is examining the link between watershed land use and coastal habitat quality by tracking and evaluating changes in coastal habitats and watershed land use/cover. This element is guided by the Reserve System Habitat Mapping and Change Plan.

Building on these foundational elements, the Reserve System is developing a network of sentinel sites and the capacity to assess the impact of sea level/lake level changes and inundation on the diverse set of coastal vegetative habitats represented in the system. Reserves are implementing a suite of activities, as described in the 2012 Reserve System Sentinel Site Guidance Document, to assess the relationship between vegetative communities (marsh, mangrove and submerged aquatic vegetation) and sea level. Reserves are adding surface elevation tables and monitoring pore water chemistry along vegetation monitoring transects and linking their SWMP to a network of specialized spatial infrastructure to allow precise measurement of local sea level and lake level changes and subsequent impacts to key habitats. The Reserve System is working in partnership with NOAA's National Geodetic Survey and the Center for Operational Oceanographic Products and Services to support the development of sentinel sites.

North Carolina NERR Research and Monitoring Program

Research and Monitoring Program Context

The NCNERR research and monitoring program strives to address scientific and technical aspects of coastal management through a comprehensive, interdisciplinary, and coordinated approach. In this pursuit, the program implements NERRS' research priorities, as well as state-level and Reserve priorities to foster a program that conducts both nationally significant and locally relevant research and monitoring. National guidance for the program is provided by the NERRS Strategic Plan which identifies the NERRS' areas of focus and investment, as well as science-based goals and objectives. State-level program guidance is provided by a number of sources including our state partner, the DCM, and the North Carolina Coastal Habitat Protection Plan (http://portal.ncdenr.org/web/mf/habitat/CHPP). These sources identified a number of research priorities (e.g., estuarine erosion and shoreline stabilization, habitat status and trends, comprehensive water quality monitoring) that are well-aligned with national priorities.

Priority research and monitoring topics are addressed within the NCNERR sites and in adjacent sounds and coastal watersheds located throughout North Carolina's coast. Within its boundaries, the NCNERR provides a network of diverse habitat types, watershed characteristics, and biogeographic settings needed to address complex coastal management issues. Research conducted within Reserve sites by research staff is highly focused on the research needs of NCNERR. Scientists unaffiliated with NCNERR also use the Reserves as living laboratories to address research topics that may be less focused on NCNERR priorities, but still germane to the understanding of coastal and estuarine ecosystems. Research conducted at Reserve sites requires a research permit (in addition to other necessary state and federal permits). The purposes of the research permit are to: 1) improve research coordination by reducing interference among research projects, 2) ensure research projects are compatible with other Reserve uses and do not compromise sensitive areas within Reserve sites, 3) provide an opportunity for research staff to interact with researchers to initiate new partnerships and advertise research program capabilities and available data, and 4) serve as a record for reporting on NCNERR's 312 research program performance measure—number of permits issued annually. Reserve research staff also use information collected during the permitting process to populate a research geodatabase and reference library for internal uses.

Research and Monitoring Program Capacity

The research program staff includes the Research Coordinator and two Research Specialists. The Research Coordinator is located at the NOAA Beaufort Laboratory. This location provides research staff with access to neighboring scientists and partners at marine laboratories affiliated with NOAA, Duke University, N.C. State University, University of North Carolina at Chapel Hill, as well as state agencies such as the DMF. The RC coordinates research and monitoring across the Reserve network; serves mentoring and supervisory roles for Research Specialists, temporary staff, and graduate students; and conducts collaborative and independent research to address NCNERR Strategic Plan Topical Areas, site-based needs, and coastal management needs. The Research Specialists are located in the Wilmington office at CMS, which provides research staff with access to research support and administrative services. The Research Specialists implement, operate, and maintain the Reserve's SWMP at Masonboro Island and Zeke's Island Reserves, assist with monitoring

activities at Currituck Banks and Rachel Carson as needed, conduct and assist with collaborative and independent research, and serve supervisory roles for volunteers and students at UNCW enrolled in independent study courses. The research program's activities are augmented by the work of temporary staff, interns, and volunteers.

Research and Monitoring Program Delivery

System-Wide Monitoring Program

The NCNERR implements each component of SWMP as identified previously in this chapter.

Abiotic indicators of water quality and weather

Research staff implement SWMP water quality, Chlorophyll *a,* and nutrient monitoring at four stations located at the Masonboro Island and Zeke's Island Reserves. Meteorological monitoring is conducted at Masonboro Island Reserve. Water quality monitoring began at two of the stations in 1994, providing one of the best long-term estuarine monitoring datasets in North Carolina for detecting trends and variation in water quality across broad spatial and temporal scales. Maintenance of the stations is a high priority to ensure high quality data continues to be collected and added to this valuable dataset. Station details (from north to south) are provided below.

1) Loosin Creek, Masonboro Island

In 2002, the Loosin Creek water quality station was established at 34° 10'20.0" latitude and 77° 49'58.1" longitude. The salinity range is typically 22-35, but can drop to 15 during periods of heavy rain. Tidal range averages 1.2 m. The creek substrate is characterized by sand and detritus based sediment with areas of soft mud. Depth ranges from 0.1 to 2.5 m. *Spartina alterniflora* dominated salt marsh and tidal creeks that are frequently used for commercial fishing and recreational activities surround the station.

2) Research Creek, Masonboro Island

In 1994, the Research Creek water quality station was established at 34° 09'21.7" latitude and 77° 50'59.9" longitude. The salinity range is typically 20-35, but can drop to 10 during periods of heavy rain. Tidal range averages 1.2 m. The creek substrate is characterized by sand and detritus based sediment with areas of soft mud. Depth ranges from 0.2 to 2.6 m. *Spartina alternifora* dominated salt marsh and tidal creeks that are frequently used for commercial fishing and recreational activities surround the station. In 2001, the meteorological station was established at Research Creek at a distance of 76 m from the water quality station. The meteorological station sits at an elevation of approximately 4.88 m above sea level.

3) Zeke's Basin, Zeke's Island

In 1994, the Zeke's Basin water quality station was established at 33° 57'17.0" latitude and 77° 56'6.0" longitude. The salinity range is typically 12-30, but can drop below 10 during periods of heavy rain and subsequent freshwater input from the Cape Fear River. Tidal range averages 1.2 m. The basin substrate is characterized by large rocks (the cribbings) with sand and detritus based sediment and a layer of soft

organic sediments. Depth ranges from 0.1 to 1.8 m. *Spartina alterniflora* dominated salt marsh and tidal creeks that are frequently used for commercial fishing and recreational activities surround the station.

4) East Cribbings, Zeke's Island

In 2002, the East Cribbings water quality station was established at 33° 56'23.5" latitude and 77° 56'28.1" longitude. The salinity range is typically 15-33, but can drop to 10 during periods of heavy rain and subsequent freshwater input from the Cape Fear River. Tidal range averages 1.2 m. The basin substrate is characterized by large rocks (the cribbings) with sand and organic sediment. Depth ranges from 0.5 to 2.7 m. *Spartina alterniflora* dominated salt marsh surrounds the station.

To better monitor the varied estuarine abiotic indicators of water quality within North Carolina, NCNERR has established additional partnerships to expand 'SWMP-like' monitoring of water quality. Through a partnership with CMS, a SWMP-like station was established at the CMS research pier within the Masonboro Island Reserve (data are available at http://loggernet.cms.uncw.edu:5600/OysterHatchery/index.html). SWMP-like stations were established at the Shackleford Banks portion of the Cape Lookout National Seashore and the Middle Marshes portion of the Rachel Carson Reserve through a partnership with the National Park Service's (NPS) Inventory and Monitoring Program (data are available as part of the Southeast Coast Network at https://irma.nps.gov/aqwebportal/https://irma.nps.gov/aqwebportal/). These water quality monitoring stations are implemented according to protocols established by the NERRS, but are not considered official SWMP stations. Through these partnerships, codified with Memoranda of Understanding (Appendix flag K and L), Reserve partners provide equipment and necessary consumables, and the Reserve provides staff to maintain the water quality monitoring stations. The abiotic component of SWMP was temporarily supported at the Currituck Banks Reserve from 2006-2007 through a partnership with Elizabeth City State University and the U.S. Geological Survey (data available at http://waterdata.usgs.gov/nc/nwis).

Biological monitoring

The biological monitoring component of SWMP addresses several biological systems including submerged aquatic vegetation and emergent marsh vegetation, nekton, phytoplankton, and benthic infauna. The NCNERR research program does not have the capacity to undertake all aspects of the biological monitoring component of SWMP. To date, the research program has focused efforts on monitoring emergent marsh vegetation at the Rachel Carson, Masonboro Island, and Zeke's Island Reserves. Monitoring of emergent vegetation is conducted proximal to water quality monitoring stations to better couple the water quality and biological monitoring components of SWMP.

A standardized monitoring approach following the protocols outlined in Moore et al. (2009) is applied to assess changes in the spatial and temporal distribution of emergent vegetation within the Reserves. Within each Reserve, seven fixed transects were located perpendicular to the vegetation line. Along each transect, quadrats (1 m^2) are used to sample emergent vegetation from the marsh-water interface to the marsh-upland transition. Emergent marsh vegetation has been monitored since 2008 and will continue to be monitored annually during peak biomass in N.C. (i.e., July-September).

In addition to the SWMP emergent vegetation monitoring described above, the scope of the emergent vegetation monitoring extends beyond Reserve boundaries. For example, the research program collaborates with scientists from the NOAA Beaufort Laboratory to examine how closely restored marshes mimic the function of natural marshes and how shoreline stabilization structures influence marsh vegetation. The marshes within the Reserve sites serve as 'reference' natural fringing marshes.

Monitoring of additional biological systems will be implemented based on priorities and as funding, staff resources, and partnerships allow. For instance, during the summer of 2015, the research program partnered with researchers from N.C. State University to conduct a pilot program to monitor plankton abundance and community composition at all four Reserve sites. In 2016, the research program partnered with researchers from IMS to monitor submerged aquatic vegetation abundance and community composition at the Rachel Carson Reserve.

Watershed, land use, and habitat mapping

The NERRS Habitat Mapping and Change component of SWMP focuses on tracking and evaluating changes in coastal and estuarine habitats over space and time. The goal is to understand the relationships between watersheds, land use, and habitat changes. In 2013, the research and stewardship programs conducted a joint effort with the Geographic Information System (GIS) Specialist to update habitat maps for each of the four Reserve sites. Habitat maps at each site were created using heads-up digitizing methods with *ArcGIS* and 2010 Statewide Orthophotography. Habitat classifications were based on the NERRS habitat classification scheme, which consists of four hierarchal levels and a set of non-hierarchal categories. The hierarchal levels are: system, subsystem, class, and subclass; with each level representing a significant break in land cover ranging from primary source of water (system) to leaf type, grain size, or cultural use (subclass). Following the creation of maps, Reserve staff conducted an accuracy assessment to determine habitat classification success of habitat maps. Reserve habitat maps are scheduled to be updated on a ten-year cycle, dependent on availability of appropriate aerial imagery and staff priorities. The updates will be used to evaluate changes in habitat distribution and condition for the Reserve sites.

Reserve watersheds were mapped at the estuarine basin scale and a smaller scale referred to as the targeted watershed boundary. The appropriate estuarine basin for each site was determined based on a flow analysis that most closely corresponds to a USGS 8-digit Hydrologic Unit Code (HUCs). Targeted watersheds represent those watersheds that directly flow into and potentially impact the habitats within the four Reserve sites (Figures 5, 9, 13, and 17). Targeted watersheds for the N.C. Reserves represent the USGS 14 digit HUCs encompassing the river systems directly flowing into the sites. NOAA's Coastal Change Analysis Program (C-CAP) provides online access to coastal land cover and land cover change information. The C-CAP data is available at 30-meter resolution for 1996, 2001, 2006, and 2010 (same year as imagery used for Reserve site habitat maps) and is appropriate for use at the watershed level. The C-CAP land cover data can be clipped to each Reserve's watershed and targeted watershed boundary to assess changes in land cover over time and potentially link changes in land cover to changes in Reserve habitats. Research staff will continue to assist the GIS Specialist with habitat mapping and C-CAP land cover analysis as new imagery becomes available. Opportunities also exist to include land cover information in education products and CTP workshops through topics such as low impact development, population change, and stormwater management.

NERRS Sentinel Site Program

The NERRS are ideally suited to assess the impacts of changing climate conditions on coastal areas across a diverse suite of ecosystem variables (e.g., changes in air, water, and soil temperatures; changes in sea level and vegetation). A number of responses relevant to climate forcing are already measured within elements of SWMP, such as marsh loss and changes in primary productivity. More importantly, Reserve sites have the operational capacity for intensive study and sustained observations to detect and understand changes in the ecosystems they represent, thereby serving as 'sentinel sites'. Recognizing this unique opportunity, the NERRS Sentinel Sites Program was initiated to understand climate change impacts on coastal ecosystems. As an active participant in the NERRS Sentinel Site Program, NCNERR is striving to establish sentinel sites for the initial purpose of understanding the impacts of sea level change and inundation on coastal habitats. Referred to as Sentinel Site Application Module 1 (SSAM 1): "Sentinel Site for Sea Level Rise and Inundation", NCNERR is measuring and comparing the responses of vegetative communities to changes in water levels and patterns of inundation at the Masonboro Island Reserve. The three other NCNERR sites are missing one or more required infrastructure components (e.g., a meteorological station) to become SSAM 1 compliant. The research program will explore expanding NCNERR sentinel site status to additional Reserve sites as resources and priorities align. Furthermore, the research program anticipates future Sentinel Site Application Modules where sentinel sites are established to address the effects of other climate-related stressors, such as ocean acidification, on coastal ecosystems. Each new Sentinel Site Application Module may require additional funding and infrastructure within Reserves.

Research

The Reserve conducts, promotes, and coordinates research at all sites. The sites provide undeveloped properties where natural processes occur with minimal anthropogenic impacts. Accordingly, the Reserves function as ideal sites for conducting coastal and estuarine research. In addition to serving as ideal sites for research, the Reserves provide ideal locations for demonstration projects. The public access to Reserve sites and public engagement through the education, training, and stewardship programs provide an excellent platform for demonstrating coastal management practices.

Nearly all research within Reserves is focused on understanding coastal processes with the goal of improved management of coastal resources locally, regionally, and nationally. In a typical year, the research program leads or collaborates on several projects within the Reserve sites and facilitates a dozen more by scientists from academic and research institutions, resource management agencies, and environmental and conservation groups. Research led by research staff addresses priority research needs identified by Reserve staff. External funding and partnership opportunities are often required to enhance the research program's ability to address priority research needs.

The Reserve facilitates research at NCNERR sites through a number of avenues. Research staff maintain an internal research permit database to minimize interference among projects and other site uses. Research and stewardship staff also provide assistance with field sampling, expertise in guiding site selection and project design, access to Reserve sites using Reserve vehicles and vessels, and provision of data (e.g., SWMP) relevant to particular projects. The Reserve's education, stewardship and coastal training programs also help facilitate

research by providing an extremely valuable outreach component that many external researchers and institutions do not possess.

The research program engages students in research within Reserve sites through the Coastal Research Fellowship. Funded through a partnership with N.C. Sea Grant, the fellowship provides 1-2 North Carolina-based graduate students with a one-year award of up to $10,000 to conduct research within the Reserve sites. Fellows must conduct research that addresses priority coastal management issues. The fellowship's research focus areas shift from year to year, but are generally aligned with the NCNERR Strategic Plan Topical Areas. The Reserve promotes and fosters this fellowship program through four main processes: providing funds in support of the fellowship through DCM, advertising the funding opportunity, conducting the application review process, and by assisting graduate students with any and all aspects of their fellowship project including site selection, field work, and manuscript preparation.

Partners

Partnerships and collaboration are paramount to the success of the research program. Research partnerships enhance the topical coverage of the research program, as well as promote the Reserve sites as a research platform to the broader scientific community. The topical and geographic diversity of the research program offers opportunities for new partnerships and expansion of existing partnerships.

Research Facilities
The facilities of the research program are largely met through existing infrastructure at the Reserve's offices and through informal partnerships with laboratories at nearby academic institutions that provide lab space and access to analytical equipment.

System-Wide Monitoring Program
Efforts to expand abiotic monitoring beyond current capacity requires partnerships, funding, and additional Reserve staff. The Reserve partners with the NPS and CMS to monitor water quality at the Rachel Carson Reserve and an additional station with Masonboro Island following SWMP abiotic monitoring protocols. Biological monitoring of emergent marsh vegetation at the Rachel Carson Reserve (and marshes in the surrounding county) is conducted through a partnership with scientists at the NOAA Beaufort Laboratory. In the past, water quality and emergent vegetation monitoring at the Currituck Banks component was accomplished through a partnership with researchers at Elizabeth City State University. The research program continues to explore partnerships with Audubon North Carolina, academics at Chowan University, and organizations involved in the Alliance for Currituck Sound for opportunities to resume water quality and emergent vegetation monitoring at Currituck Banks Reserve.

Research
The research program collaborates with a number of academic, state, federal, and non-governmental organizations to conduct research within the Reserves, their associated watersheds, and coastal counties. Examples of existing partnerships include those with (1) IMS and UNCW to assess the resiliency of living shorelines to large storm events, (2) NCCOS to assess the impact of shoreline stabilization on marsh vegetation, (3) CMST, the North Carolina Coastal Federation, and DMF to provide science-based strategies for

oyster restoration, (4) DUML to monitor the recovery of coastal habitats following removal of marine debris, and (5) UNCW to quantify the benefits and impacts of oyster aquaculture on estuarine ecosystems. The research program also looks to expand partnerships to broaden both the breadth and geographic coverage of its research. For instance, the research program is interested in expanding research related to living shorelines to Currituck Sound, which is a traditionally understudied region of the state. In concert with the education, stewardship and training programs, staff are exploring partnerships with U.S. Fish and Wildlife Service, Audubon North Carolina, marine contractors, and private citizens to accomplish this work. Lastly, the Reserve partners with N.C. Sea Grant to support the Coastal Research Fellowship discussed previously.

Research and Monitoring Needs and Opportunities

The research program has identified equipment-related needs that would improve and expand upon current research and monitoring efforts. Research staffing needs are discussed in detail in the Administration Plan. Program needs include the following:

1) To expand SWMP and Sentinel Site Application Module 1 to additional Reserve sites, the research program needs:
    a. Meteorological stations at the Currituck Banks, Rachel Carson, and Zeke's Island Reserves.
    b. Abiotic water quality monitoring at Currituck Banks Reserve.
    c. Platform upgrades for vertical control of deployed equipment to measure water level at Currituck Banks and Zeke's Island.
    d. Two additional surface elevation tables (SETs) each at Currituck Banks and Zeke's Island.
    e. A Real-time kinematic (RTK) rover unit for occupying vertical control network at sentinel sites. The rover unit would also be used for research projects related to quantifying shoreline change. The research program is exploring opportunities to partner with DCM to purchase a rover unit that could be jointly used by the research program and DCM regulatory program.
2) To improve efficiency in data entry associated with abiotic and biotic SWMP monitoring, the research program needs waterproof tablets with Wi-Fi for field applications.
3) To monitor shoreline change and coastal erosion (both horizontal and vertical) in response to major events (e.g., hurricanes) and over large spatial extents, map Reserve habitat, and survey flora and fauna (including invasive species), the research program needs a fixed-wing unmanned aerial system (UAS) with RTK capabilities. The research program is exploring opportunities to partner with DCM to purchase an UAS that could be jointly used by the research program and DCM regulatory program.
4) To obtain more accurate measurements of water level to evaluate storm surge and nuisance flooding, the research program needs more stable platforms for the continuous water quality monitoring stations. Current single piling platforms are not sufficiently stable to provide necessary accuracy for water level measurements.
5) To prevent possible damage to marshes at Currituck Banks, Rachel Carson, Masonboro Island, and Zeke's Island during monitoring of emergent vegetation and SETs, the research program needs boardwalks installed along vegetation transects and around SETs.

Research needs and priorities identified by partners, researchers, coastal managers and decision-makers are addressed below in the Research and Monitoring Objectives and Actions section.

Research and Monitoring Objectives and Actions

Research objectives are presented in bold text following Goal 2 below. Actions are listed underneath each objective, along with supporting text used to describe the implementation of each action.

Goal 2: Research and monitoring advance understanding of coastal and estuarine ecosystems and inform coastal management.

Objective 2.1: Research and monitoring is conducted within Reserve sites and associated watersheds.

Action 1: Prioritize research on coastal management topics annually through interactions with researchers, coastal decision-makers, and Reserve staff.

Research staff will identify high priority coastal management science needs by referring to several guiding documents including the NERRS Strategic Plan and the North Carolina Coastal Habitat Protection Plan. Additional guidance will be sought from DCM staff and academic scientists. Research staff will also work with stewardship and education staff to identify high priority Reserve site research needs. The research priorities will be circulated among the scientific and coastal management communities through informal communication in workgroup settings, the Reserve website, seminars, and NERRS Science Collaborative and Coastal Research Fellowship RFPs. The list of prioritized research topics will be revisited annually so that as the coastal management needs change, the focus of NCNERR's research efforts may follow. Research staff will generate the list during fall/early winter of each calendar year.

Action 2: Conduct research that addresses research priorities and NCNERR Strategic Plan Topical Areas.

The research program strives to conduct original, high-quality scientific research within Reserve sites and associated watersheds. Research staff will serve as PI or Co-PI on two or more proposals seeking external funding to support research on priorities identified in Action 1, as well as those relevant to addressing the NCNERR Strategic Plan Topical Areas.

Action 3: Continue implementation of the NERRS SWMP to assess change in abiotic and biotic indicators and habitat distribution.

The NERRS system-wide investment to purchase two YSI EXO sondes for each Reserve enabled the research program to fully transition to EXOs at all four abiotic SWMP stations at Masonboro Island and Zeke's Island abiotic SWMP as of fall 2016. The research program will continue partnering with CMS and the NPS to maintain SWMP-like monitoring at additional stations in Masonboro Island and Rachel Carson, respectively (see Partners section above). Biological monitoring of emergent marsh vegetation will continue at Rachel Carson, Masonboro Island, and Zeke's Island Reserves. Habitat mapping of Reserve sites was completed in 2013 as described above (see Watershed, land use, and habitat section

above) and will be revisited to assess habitat change over a 10-year period around 2020 as new imagery becomes available and Reserve resources allow.

Action 4: Explore opportunities to expand abiotic and biotic components of SWMP monitoring to additional Reserve sites.

Given the geographical, biophysical, and land-use differences associated with each Reserve site, it would be ideal to conduct SWMP-like monitoring at each site to draw conclusions relevant to each as it pertains to changes in water quality and emergent marsh vegetation associated with anthropogenic (e.g., increase in coastal populations) and environmental (e.g., sea level rise) drivers. Expanding abiotic and biotic monitoring to all four Reserves would also expand NCNERR's partnership base. To explore the potential for abiotic and biotic monitoring in Currituck Banks, research and stewardship staff engage with partners (see Partners section above). Funding for monitoring equipment and personnel required for routine, long-term monitoring would need to be established (see Research and Monitoring Needs and Opportunities section above).

Action 5: Continue implementing the Sentinel Site Application Modules as resources are available to detect and understand the effects of sea level change on estuaries.

Three of the four Reserve sites require additional infrastructure to address the effects of sea level change on emergent vegetation as part of Sentinel Sites Application Module 1. Masonboro Island is completely Sentinel Site compliant following installation of two SETs in fall 2015. Due to the nature of SETs, settlement of substrate, and desired precision in measurements, the new SETs at Masonboro will be of limited use for a few years. The remaining Reserve sites need one or more pieces of infrastructure before becoming fully compliant sentinel sites (see Program Needs section above). Research staff will explore funding opportunities and partnerships to continue the Sentinel Site build-out at Zeke's Island, Rachel Carson, and Currituck Banks Reserves.

Action 6: Analyze and synthesize Reserve research and monitoring data to evaluate trends and patterns of local, regional, and national significance.

The research program has generated an enormous amount of research and monitoring data. Abiotic SWMP data are analyzed yearly as part of the required NERRS QA/QC process, but the true value of this comprehensive data set will be better realized as more in-depth analyses and syntheses are conducted. Analyses and syntheses will be conducted with input from Reserve staff to create products that benefit all NCNERR programs, as well as the scientific and management communities. For instance, SWMP abiotic monitoring data can be synthesized to develop curricula for K-12 education programs and inform the scientific community of local, regional, and national trends. Analysis of long-term SWMP biological monitoring and monitoring of shoreline stabilization structures can provide the CTP with training material for workshops on living shorelines and green infrastructure. The research program is partnering with scientists at UNCW and colleagues within NERRS to acquire funding for analysis and synthesis of abiotic monitoring data. Additionally, research staff continues to partner with scientists from NCCOS to analyze long-term marsh monitoring and shoreline stabilization data for

publication in a peer-reviewed journal. Throughout the analysis, synthesis, and product development process, research staff will collaborate with Reserve staff and partners to identify how these products can best meet Reserve program needs while also addressing coastal management needs.

Objective 2.2: Research and monitoring datasets, results, and products are communicated to target audiences (e.g., coastal decision-makers, research community, Reserve program participants) to address relevant coastal and estuarine topics.

Action 1: Describe the Reserve's research and monitoring datasets, results, and products to coastal decision-makers and other end users through 10 or more forums annually.

Building on objective 2.1 and the associated actions, research staff will actively communicate available datasets, program capabilities, and products to relevant end users such as coastal-decision makers, coastal scientists, and educators. Dissemination of this information by research staff will occur through 10 or more forums annually (e.g., conferences, workgroups, proposals, publications). For example, research staff will deliver research- and monitoring-based presentations at university seminar series, serve on workgroups where staff expertise and program data can improve management of coastal resources, and provide a program overview and available data in support of education program objectives (e.g., TOTE; Objective 1.1, Action 1). Research staff will keep track of progress towards this goal with a spreadsheet that tracks relevant information such as the type of forum and information conveyed about the research program during the forum.

Action 2: Provide high-quality data that is accessible by all interested parties through the NERRS' Centralized Data Management Office's (CDMO) website.

The research program recognizes that quality data is paramount to good science. In each SWMP component NCNERR conducts—abiotic, biological, and habitat mapping—staff strive to collect robust, high-quality data. All data are QA/QC'd following NERRS protocols to ensure high-quality data. The research program also recognizes the importance of making SWMP data accessible to outside entities to maximize the benefit of these data for coastal management. Research staff will strive to submit SWMP data in a timely fashion to meet the CDMO submission deadlines for raw, quarterly, and annual data that can be easily accessed by outside entities. For instance, submission of raw abiotic monitoring data is due within two weeks of data collection. Staff will aim to submit all data to CDMO prior to submission deadlines. NCNERR is also currently submitting biological monitoring data to CDMO and will continue to do so. The research staff and GIS Specialist submitted habitat maps of the four NCNERR sites and required documents during 2016.

Action 3: Highlight research and monitoring projects on the Reserve's website.

Research staff will work with the Communications Specialist to ensure that NCNERR's website, and specifically the Research and Monitoring Projects webpage, contain projects relevant to coastal management priority issues. The webpage currently contains information on research projects relevant

to estuarine shoreline stabilization, SWMP, and oyster reef restoration. Webpage updates may include projects that expand on these topics or address new coastal management issues.

Action 4: Collaborate with education and training staff to package and integrate research and monitoring data into education and training programs.

The research program will work to ensure accurate and timely transfer of research results to the education and training programs. Research staff will continue to work with education and training staff to incorporate data, tools, techniques, and research results into education materials and programs. Opportunities for distribution of research through the education program include incorporation of products into K-12 curricula, community outreach display boards, newsletters, and presentations at education workshops such as TOTE.

Objective 2.3: Reserve sites are promoted as place-based research platforms and Reserve's long-term datasets are promoted as a research tool.

Action 1: Facilitate, promote, and participate in research conducted at Reserve sites, particularly research that supports the Reserve's mission and informs coastal management.

Research is critical to understanding and managing estuarine and coastal ecosystems at Reserve sites and surrounding watersheds. While the research conducted within Reserve sites is locally relevant, much of this work is also regionally and nationally significant. Understanding the importance of research within the Reserve sites to accomplishing NCNERR's mission, the research program is committed to ensuring Reserves serve as a research platform. Research staff will facilitate and participate in research on Reserve sites in a number of ways including project development, assisting researchers with site selection within Reserves, and providing supporting data, staff, transportation, and gear to researchers as available. The promotion of site-based research will occur in collaboration with Reserve staff through various forums including the Reserve website, social media, and Reserve newsletter.

Action 2: Review 12 or more research permit applications from external researchers annually, evaluate the percentage of applicants using the Reserve's long-term datasets for research, and maintain the NCNERR portion of the NERRS' research database.

The NCNERR requires all researchers that plan to conduct research in Reserve sites to submit a research permit application (Appendix L). The purpose of the research permit is to ensure research projects are compatible with other Reserve uses, do not interfere with other research projects, incorporate available data when applicable, and are catalogued for reporting on NCNERR's 312 research program performance measure. The target for the research program's 312 performance measure is 12 research permits issued annually. Over the past 5 years, the research program has issued an average of 11 research permits per year. The preceding actions should help to improve the visibility of the research program and increase the number of research permit applications that are submitted and reviewed each year. The research staff recently added an additional component to the research

permit application inquiring as to whether applicants are familiar with the Reserve's long-term monitoring datasets, if they plan to use any of the data in their respective research, and if they know how to access the data. Staff will evaluate trends in the percentage of applicants that plan to use these datasets to see if usage increases over time.

Permitted research is required to follow a set of conditions (Appendix L). One of the permit conditions requires that final reports and manuscripts that result from research conducted on the Reserve be submitted to the research program. Research staff use information on the permit application such as principal investigator(s), affiliation(s), project title, as well as reports and manuscripts to update the NCNERR portion of the NERRS' research database, which is the research program's NERRS performance measure. The NERRS' research database is updated annually during late fall/early winter.

Action 3: Support and promote the Coastal Research Fellowship in collaboration with N.C. Sea Grant to provide opportunities for graduate students to conduct research within Reserve boundaries.

The NCNERR supports and promotes the Coastal Research Fellowship program through four main avenues: providing funds in support of the fellowship, advertising the funding opportunity, conducting the application review process, and by facilitating the fellow's research during the fellowship year. Advertising the funding opportunity is done by the Reserve through email postings to student list-serves, directed phone calls to Principal Investigators, and advertisement at regional scientific conferences. Advertising to a broad audience should increase the number of applicants, level of competition and, ultimately the quality of the research. As part of the review process, the research program forms review panels, secures and compiles all reviews, and ranks candidates in collaboration with N.C. Sea Grant. Research and stewardship staff provide varying levels of support to facilitate the fellows' research. For instance, research and stewardship staff involvement has ranged from help with site selection to assisting with all aspects of the research including experimental design, field work, and data analysis. The research program will continue supporting and promoting the Coastal Research Fellowship.

Objective 2.4: Research partnerships are enhanced through collaboration with the Reserve Research Program.

Action 1: Provide advisory services to research community by serving on at least one graduate student committee and at least two science committees annually.

The research program is committed to serving the research community in several ways including serving on committees and workgroups. Research staff currently serve on graduate student committees, a number of local, regional, and national workgroups, including the NERRS bivalve workgroup, as well as advisory committees. Participation in these activities allows Reserve staff to provide subject matter expertise, thereby benefiting local, regional, and national coastal science and management. Additionally, these partnerships provide additional exposure to the NCNERR and its research priorities and capabilities among various groups, ultimately enhancing NCNERR partnerships and collaboration.

Action 2: Develop at least 2 collaborative research proposals annually seeking external funds to support Reserve research priorities.

Acquiring external funding through submission of proposals is often required to conduct research that addresses Reserve research priorities. Many of the Reserve research priorities are multi-disciplinary in nature and require development of collaborative research proposals to complement research staff expertise. During the collaborative process of proposal development, Reserve partnerships are strengthened and the research program's datasets and capabilities are shared among the scientific community.

V. Stewardship Program Plan

Stewardship Program Overview

Program Context

The Reserves within the NERRS, per its authorizing legislation the CZMA and Federal regulations (15 C.F.R. Part 921.1), are to be managed to ensure that Reserve ecosystems continue to be available for long-term estuarine research, education, and interpretation, while also enhancing public awareness and understanding of estuarine areas and accommodating compatible public use. The NCNERR is also directed by the CAMA to maintain, protect, and preserve its designated sites for NERRS purposes, utilizing the sites primarily for research and education, while providing public access and allowing compatible traditional uses such as hunting, fishing, navigation, and recreation that are consistent with the primary Reserve purposes.

The NCNERR stewardship program protects the natural integrity of each site for these purposes through its implementation of the stewardship plan. The stewardship plan provides a framework to address Reserve management responsibilities, activities, and strategies designed to balance protection and management of natural resources with access to and use of the sites by the public, to meet federal and state obligations associated with the sites, and to maintain the sites as a platform and information base for scientific and educational activities designed to foster more informed management of estuaries. The NCNERR stewardship approach uses the best available science to maintain and restore healthy, productive and resilient ecosystems and to share resource management information with local, regional, and national stakeholders. Stewardship strategies assess and respond to threats and concerns arising from coastal development, human use of the sites, environmental changes, and feral and invasive species.

Stewardship efforts can primarily be characterized into two broad categories: resource management and visitor access and use; therefore, the stewardship plan includes both the resource protection and public access and visitor use plans. Because stewardship staff are directly involved with NCNERR acquisition activities, this chapter also contains the land acquisition plan. NCNERR Strategic Plan objectives and actions related to each of these topics are discussed. Additionally, stewardship policies specific to recreation, off-road vehicle access, fishing and hunting, disposal of dredge material, habitat restoration, feral horses, and surveillance, enforcement and maintenance are located at the end of this chapter.

The stewardship program conducts activities at each of the sites and connects with the local communities surrounding each site through partnerships and community engagement. NCNERR stewardship staff interacts directly with local government officials, visitors to the sites, the general public, and specific user groups such as researchers, educators, non-governmental organizations and commercial operators. The stewardship staff also works to coordinate with partner organizations and agencies and/or with law enforcement agencies to address concerns at the sites. Across the sites of the NCNERR, stewardship efforts are aligned with the NERRS national strategic goals and strategies related to protection and management of coastal and estuarine ecosystems and watersheds.

Stewardship activities and strategies are implemented proactively using an adaptive management approach whenever possible. Management decision-making is conducted as a flexible, iterative process in which outcomes of management actions are used to inform future actions. When management challenges or concerns arise at the sites, site managers gather information for a baseline understanding of the situation. Subsequently, a range of management actions is considered, based on the best available science found in current literature. Because expertise or experience of partner agencies and organizations can contribute to improved understanding of a management concern, partners are also frequently consulted as part of the decision-making process. Following implementation of the chosen strategy, response is monitored and assessed. Results and new knowledge are applied as future efforts are planned and implemented. Throughout the adaptive management process, site managers share information and collaborate in choosing management actions.

Program Capacity

The stewardship program is primarily conducted by the Site Managers located in the northern, central, and southern regions of coastal North Carolina. The Northern Sites Manager, located in Kitty Hawk, is responsible for the Currituck Banks Reserve. The Central Sites Manager, located at the Reserve headquarters office in Beaufort, is responsible for the Rachel Carson Reserve. The Stewardship Coordinator & Southern Sites Manager, located in Wilmington, is responsible for the Masonboro Island Reserve and the Zeke's Island Reserve. Facilities, equipment, and infrastructure are shared among NCNERR staff, with stewardship staff coordinating with research, education, and administrative staff when stewardship activities will make use of shared resources. The capacity of the stewardship staff to engage in specific types of programs at each site varies and is based on the management needs at each site, as well as the total suite of activities within each site manager's responsibilities.

Partnerships

The NCNERR maintains ongoing partnerships with numerous local, state, and federal agencies, as well as a variety of private non-profit organizations. The work of some partners contributes to the accomplishment of Reserve goals, such as commercial operators who provide educational activities on the sites and deliver messages related to the Reserve mission. Other partnerships allow the Reserve to support local and regional efforts that are aligned with the Reserve mission, such as broader scale water quality restoration or invasive species management projects. The NCNERR stewardship staff works with partners on specific site-based projects, such as marine debris clean-ups, and with local communities to address issues of concern such as access to nature-based recreation like that which occurs at the sites. Site managers work to strengthen existing partnerships and seek out new partnerships on an ongoing basis in order to address topics of mutual interest.

Each Reserve site is managed in coordination with local agencies and organizations, based on local needs and site conditions. Primary partners for the Currituck Banks Reserve include the U.S. Fish and Wildlife Service Currituck National Wildlife Refuge, The Nature Conservancy, the WRC, and Currituck County. Primary partners for the Rachel Carson Reserve include the Town of Beaufort, the Maritime Museum, and the NPS Cape Lookout National Seashore. Primary partners for the Masonboro Island Reserve include New Hanover County, the N.C. Coastal Land Trust, the Town of Wrightsville Beach, and the N.C. Division of Parks and Recreation. Primary partners for the Zeke's Island Reserve include the N.C. Division of Parks and Recreation and the N.C.

Aquarium. Additional partners associated with each site support or provide guidance related to specific, discrete management activities. These partners, in addition to community members and other partners, serve on the NCNERR's LACs.

Volunteers

Volunteers play a critical role in the accomplishment of stewardship and resource management goals. Recruiting, training, and effectively utilizing volunteers from the local community serves the dual purpose of maximizing the effectiveness of stewardship staff efforts and instilling a stewardship ethic in individuals from the communities adjacent to the Reserve sites. Many of the Reserve volunteers are traditional users of the sites who visit and utilize the sites regularly; volunteering provides them with an opportunity to deepen their level of understanding and appreciation of the sites' natural resources. Community volunteers are directly engaged in a variety of stewardship activities at each site based on the resource management priorities per site, including marine debris removal, species of interest monitoring and protection, basic site monitoring and maintenance, and ecosystem restoration or enhancement projects.

Needs and Opportunities

The stewardship program seeks to utilize available human and material resources efficiently and effectively to implement the stewardship goals, objectives, and actions. The primary limitation to full implementation of the stewardship program across all sites is staff time. At the 2014 stakeholder meetings, local partners and site users recognized important stewardship activities that would benefit from additional stewardship staff resources, including species of interest surveys, marine debris removal, and community engagement programs. To address these limitations in the absence of additional stewardship staff, site managers utilize interns and volunteers to assist with implementation of stewardship activities that are appropriate for non-professional support. Stewardship staffing needs are discussed in detail in the Administration Plan. Supply and equipment needs are ongoing, as many stewardship tasks require specialized equipment and tools or utilize supplies that are consumed in the course of use. Larger needs, such as site infrastructure and interpretive signage, are discussed in the Administration Plan. Additionally, as new technologies related to resource management are developed, replacement of outdated equipment to increase efficiency is a priority. Examples of stewardship program needs range from basic field supplies such as field notebooks, binoculars, and appropriate personal protective equipment to specialized equipment such as GPS enabled cameras, ATVs, landscaping equipment, wildlife cameras, and boats. Operational funds and reprogrammed funds are regularly used to address these needs. When appropriate, stewardship staff pursue outside funding, independently or in collaboration with partners, to supplement these funds or to support specific project needs. Building partnerships with organizations and agencies with similar priorities increases the Reserve's opportunity to accomplish stewardship goals. Aside from these material needs, the key challenge to implementation of the stewardship program is a limited ability to respond to site use issues using existing Reserve rules in the N.C. Administrative Code, which are largely unchanged since their adoption in 1986. Reserve rules will be going through the State's mandated Periodic Rules Review Process beginning in 2017 (see Administration Plan Goal 4.1.1). Management of the Reserve sites would benefit from clear rules that address current issues and uses, support public safety, strengthen resource protection, and assist law enforcement partners in responding to site concerns.

Resource Protection Plan

The Resource Protection Plan is a required element of a NERRS management plan, per the Federal Code of Regulations, 15 CFR 921.13. The NCNERR management and statutory authorities are derived from federal and state sources including the CZMA Section 315, Federal Code of Regulations 15 CFR 921, CAMA, and N.C. Administrative Code 15A NCAC 07O. (See Appendix A, B, E & F) Each of these authorities mandates that the coastal and estuarine resources at the Reserve sites be protected and maintained in order to ensure a suitable and stable natural environment for long-term research and educational activities. This is the primary purpose of the resource protection function of the stewardship program. Each of these authorities also accommodates public access and use of the sites for activities that are consistent and compatible with resource protection, research, and education activities. Access and uses at each Reserve site vary depending on site conditions and are discussed in the public access section below.

Protecting the natural resources of the Reserve, including the key representative coastal habitats that led to designation of these sites as components of the NCNERR, and maintaining and enhancing these resources in the face of natural and human stressors, serves as the foundation for all stewardship activities and is central to the success of the Reserve and all of its programs. Use of the sites includes research, educational activities, and traditional activities such as hunting, fishing, navigation, and recreation. In order to protect natural resources and maintain ecosystem integrity at Reserve sites to ensure these primary uses continue, uses that may be detrimental or damaging to natural resources are managed or disallowed.

Table 5 summarizes allowable and prohibited uses per site and provides the sources for each. The sources are described in more detail below.

Table 5. Allowable and prohibited public uses at the four NCNERR sites. This list was compiled based on NCNERR policies, which are described later in the public access and visitor use plan, the North Carolina Coastal Area Management Act, 15A NCAC 07O (Appendix F), North Carolina General Statutes, county and town ordinances, and the State Nature Preserves Dedication letters (Appendix G).

Allowable and prohibited public uses at NCNERR sites				
Use	**Currituck Banks Reserve**	**Rachel Carson Reserve**	**Masonboro Island Reserve**	**Zeke's Island Reserve**
Pets	Allowed if pets are under control and as required by local ordinances[2,3,4]	Allowed if pets are under control and as required by local ordinances[2,3,4,5]	Allowed if pets are under control and as required by local ordinances[2,3,4]	Allowed if pets are under control and as required by local ordinances[2,3,4]
Off-road vehicles (other than boats, emergency vehicles, enforcement vehicles)	Allowed as defined by local ordinances; driving on dunes/vegetation is not allowed[1,2,3,4]	Prohibited[2,3,5]	Prohibited [2,3,4]	Allowed only in designated areas and with the required permit; driving on dunes/vegetation is not allowed[1,2,3]
Disturbing or removing live animals or vegetation; collection (sampling) of natural materials	Prohibited unless necessary permits or approval from management agency has been obtained[1,2,3]	Prohibited unless necessary permits or approval from management agency has been obtained[1,2,3]	Prohibited unless necessary permits or approval from management agency has been obtained[1,2,3]	Prohibited unless necessary permits or approval from management agency has been obtained[1,2,3]
Introducing exotic flora and fauna	Prohibited [1,2]	Prohibited [1,2]	Prohibited [1,2]	Prohibited [1,2]
Camping	Allowed only for research with written permission from DCM[1,2,3,4]	Allowed only for research with written permission from DCM[1,2,3]	Allowed with posted permission from DCM[1,2,3,7]	Allowed only for research with written permission from DCM[1,2,3]
Fires	Prohibited [2,3,4]	Prohibited [2,3,4,5]	Allowed only in areas designated by DCM[2,3,7]	Prohibited [2,3]
Recreation	Allowed as long as natural integrity and research and education activities	Allowed as long as natural integrity and research and education activities	Allowed as long as natural integrity and research and education activities	Allowed as long as natural integrity and research and education activities

	are not disrupted[1,2,3,6]	are not disrupted[1,2,3,6]	are not disrupted[1,2,3,6]	are not disrupted[1,2,3,6]
Use	**Currituck Banks Reserve**	**Rachel Carson Reserve**	**Masonboro Island Reserve**	**Zeke's Island Reserve**
Fishing and Hunting	Allowed within the limits of federal, state, and local laws[1,2,3,6,]; hunting also requires written permission from DCM[6]	Allowed within the limits of federal, state, and local laws[1,2,3,6]	Allowed within the limits of federal, state, and local laws[1,2,3,6]	Allowed within the limits of federal, state, and local laws[1,2,3,6]
Target shooting	Prohibited [1,3]	Prohibited [1,3,5]	Prohibited [1,3]	Prohibited [1,3]
Nudity	Prohibited [6]	Prohibited [5,6]	Prohibited [6]	Prohibited [6]
Pollution; deposition of solids or discharge of liquids	Prohibited [1,2]	Prohibited [1,2]	Prohibited [1,2]	Prohibited [1,2]
Disturbing research	Prohibited [1]	Prohibited [1]	Prohibited [1]	Prohibited [1]
Storage of personal property	Prohibited [1,4]	Prohibited [1]	Prohibited [1]	Prohibited [1]
Disposal of dredge material	Prohibited [2,3]	Allowed for U.S. Army Corps of Engineer projects and permitted and approved navigation projects within designated areas[2,3]	Allowed for U.S. Army Corps of Engineer projects and permitted and approved navigation and private projects within designated areas[2,3]	Prohibited [2,3]
Groundwater removal	Prohibited [1,2]	Prohibited [1,2]	Prohibited [1]	Prohibited [1,2,4]

Noise production	Prohibited if disruptive to local wildlife and the aesthetic enjoyment of the Reserve as a natural area[1]; Prohibited if disturbs other persons [4]	Prohibited if disruptive to local wildlife and the aesthetic enjoyment of the Reserve as a natural area[1]; Prohibited if causes public nuisance [4, 5]	Prohibited if disruptive to local wildlife and the aesthetic enjoyment of the Reserve as a natural area[1]; Prohibited if causes public nuisance [4]	Prohibited if disruptive to local wildlife and the aesthetic enjoyment of the Reserve as a natural area[1]; Prohibited if causes public nuisance [4]
Use	**Currituck Banks Reserve**	**Rachel Carson Reserve**	**Masonboro Island Reserve**	**Zeke's Island Reserve**
Disturbances of soil, excavation, mining, commercial or industrial uses, timber harvesting, ditching and draining, deposition of waste materials	Prohibited [1,2]	Prohibited [1,2]	Prohibited [1,2]	Prohibited [1,2]
Fireworks	Prohibited [1,6]	Prohibited [1,5,6]	Prohibited [1,4,6]	Prohibited [1,4,6]
Dumping and littering	Prohibited [1,2,3,4,6]	Prohibited [1,2,3,4,5,6]	Prohibited [1,2,3,4,6]	Prohibited [1,2,3,4,6]
Removal of artifacts	Prohibited [2,6]	Prohibited [2,6]	Prohibited [2,6]	Prohibited [2,6]
Disturbing feral horses	Prohibited including harming, approaching within 50 feet, feeding, petting, possessing, or riding feral horses[4]	Prohibited including harming, approaching within 50 feet, feeding, petting, possessing, or riding feral horses[5]	Not applicable	Not applicable

[1] 15A NCAC 07O – N.C. Administrative Code for N.C. Coastal Reserve
[2] State Nature Preserves Dedication letter
[3] NCNERR Stewardship Policy
[4] County Ordinance (Currituck County, Carteret County, New Hanover County, Brunswick County)
[5] Town Ordinance (Town of Beaufort)
[6] N.C. General Statues, including Coastal Area Management Act
[7] Guidance for camping and campfires can be found on the Reserve's website, www.nccoastalreserve.net

In addition to the resource protection guidance found in the aforementioned authorities, the sites of the NCNERR are designated as State Nature Preserves by the State and, as such, are subject to management guidance and principles administered by the N.C. Natural Heritage Program found in the N.C. Administrative Code (15A 12H) (Appendix M) that require each site's natural resources be protected and maintained in as nearly a natural condition as possible as public trust resources. The following management principles are applied for all dedicated preserves, unless exceptions are expressly provided in the dedication letters. The site-specific management principles identified in the site dedication letters provide guidance regarding potentially disruptive activities that are not allowed. The principles also include requirements for the NCNERR, as the managing agency, to implement management actions that protect natural resources from stressors. Topics discussed include controlling invasive species, managing visitor activity to prevent degradation, and installing the minimum amount of access and guidance structures to provide for safe and informed access. To ensure the NCNERR adheres to the requirements for State Nature Preserves, the stewardship staff coordinates with Natural Heritage Program staff when developing management approaches.

The Reserve is also subject to State laws and local ordinances that affect uses at the sites. These are primarily related to visitor activities and will be discussed in the public access section below. Finally, policies that further explain the stewardship program's approach to specific resource protection activities such as management of feral horses, dredge material placement, off-road vehicles, and traditional uses can be found at the end of the stewardship chapter.

Site managers monitor site conditions regularly and respond to resource protection issues by contacting the appropriate agencies and organizations for support or enforcement action. Enforcement of the rules that relate to protection of the sites is accomplished through regular communication and coordination with local, state, and federal law enforcement agencies, when law enforcement action is required. Memoranda of Understanding (MOUs) or similar agreements with enforcement agencies that support effective enforcement and resource protection can be found in Appendices O, P and Q. Coordination with local partner agencies and organizations is utilized to address resource protection concerns for which law enforcement response is not needed.

Resource protection can be complex due to the variety of stressors affecting each Reserve site. Challenges to the maintenance of sites in a natural condition can come from natural sources, uses of the sites, or anthropogenic activities in the watershed. Site managers operate at multiple scales to proactively address stressors that could compromise site integrity. Examples of activities that may be undertaken to protect natural resources from stressors include: installation of visitor guidance structures to protect sensitive habitats, collaboration with local communities and non-governmental organizations on regional conservation or restoration efforts, and engagement with the research staff and community to promote research to better understand impacts of stressors.

Species of interest management

Plant and animal species naturally occurring at the sites of the NCNERR vary from common and representative to rare and listed as threatened, endangered, or special concern. Some species are well

documented and considered to have stable populations; others are known to be at risk or have not been well studied. Some species are of particular interest to the research community or to a wider community of resource managers; others, including charismatic megafauna, can serve as "ambassadors" to the public, providing opportunities for volunteer participation and public engagement. Although basic inventory and monitoring activities would be beneficial at all NCNERR sites, at each site some species of special interest occur for which specific management actions are undertaken. Details regarding the current species of interest per site are included in the site descriptions.

Management activities related to species of interest, including protection and monitoring, are guided by the Reserve's foundational documents, including the Nature Preserve dedications and N.C. Administrative Code that mandate that the essential natural character of the sites be maintained.

A species may be of interest for a variety of reasons, including its conservation status and federal or state listing, its uniqueness or rarity, its ecological niche, its role as a representative species (umbrella, keystone, or indicator species), or due to a current known threat impacting the species. Site managers implement management actions related to species of interest to ensure that critical habitat is available and protected, contribute to broader species management initiatives at the state or federal levels, respond to site-specific threats, or as part of local or regional research efforts. In some cases, single-species management actions are designed; however, management actions that benefit multiple species are implemented when feasible.

Management activities related to species of interest, including survey and inventory efforts, short or long-term monitoring, and actions taken to protect habitat, are often resource intensive in terms of labor and supplies. Survey and inventory work to develop species lists or establish baselines can benefit from greater numbers of participants while monitoring activities often require labor to be expended over extended periods in order to accumulate data to support answering research questions, understand trends, or assess the results of previous management actions.

Given the number of species of interest associated with each site, these activities must be prioritized. Efforts are made to collaborate with partners to maximize efficiency or to utilize volunteers where these approaches can be employed effectively. Outside funding is pursued to support species management activities where appropriate. Projects in which the Reserve can contribute to an existing, broader effort are pursued when possible. Examples of species of interest activities that would ideally be possible include conducting intensive monitoring of multiple species of nesting shorebirds in order to contribute more fully to regional efforts, developing and engaging in ongoing mark-recapture work to support a stronger understanding of diamondback terrapin populations and management approaches, and establishing a shellfish monitoring program to track changes in native populations over time given the multiple pressures of extraction and environmental change affecting these organisms. More intensive efforts such as these are often delayed until the appropriate financial resources become available.

To prioritize management activities for species of interest, the following questions are considered:

- What species are rare, endemic, or of special legal status (endangered, threatened, special concern)?

- What species are the foci of larger monitoring or research efforts conducted by partners at the local, regional, or national level?
- What species can be monitored utilizing existing protocols tested and implemented by other NERRS or partners?
- For what species can the NCNERR support development of survey and monitoring protocols?
- What species are of importance to the public or can serve as ambassadors to link to the NCNERR mission and purposes?
- What species are being exposed to specific pressures or management challenges?
- What species are most sensitive to threats and stressors?
- What species play a crucial role in ecosystem function?
- What species can be monitored at reasonable cost and with low impact?
- What gaps in knowledge can be filled by survey and inventory efforts or what research questions can be answered through monitoring efforts?

Site managers make decisions regarding which species management activities to undertake based on consideration of the above. Also considered is the availability of funding to support activities; species management activities may occasionally be undertaken opportunistically if a funding source or funded partnership collaboration presents itself. Generally, prioritization of species management activities can be described as follows:

- High priority: species listed as threatened or endangered at state and/or federal levels; species under imminent threat; species that are the subject of a regional or national research project or initiative of limited duration
- Medium priority: species for which existing monitoring programs can be easily implemented; rare or endemic species; species for which a funded opportunity exists; species for which the NCNERR can support development of methodologies and protocols; species for which trained volunteers can be utilized effectively, and
- Low priority: species with no state or federal status; species with populations known to be stable; species for which no existing protocols are available; species for which no larger collaboration exists; species for which monitoring efforts would be costly and/or labor intensive.

Habitat management

Functional, intact habitats provide services to the natural and human communities in and around the Reserve sites. To protect and support the integrity of important habitats, site managers undertake management activities to document and understand habitat condition and to ensure that habitat integrity is not compromised. Management activities to understand conditions may include periodic monitoring of specific habitats and areas or application of remote sensing methods to analyze historic conditions. When conditions are determined to be suboptimal or opportunities exist to increase the quality of habitat, restoration or enhancement actions may be undertaken. Examples include: enhancing specific vegetation communities through selective plantings; altering geologic or hydrologic conditions to restore functions or mitigate for known impacts; and supplementing existing habitat through Reserve initiated or partner led restoration projects. Enhancement and restoration activities will be based the best available science,

planned in consultation with appropriate experts and partner organizations, and adhere to the Habitat Restoration policy included in the Reserve's stewardship policies.

Invasive, non-native, and feral species management

A variety of plant and animal species that are non-native to North Carolina's coastal ecosystems are found on NCNERR sites. Domesticated animal species that have become wild and are considered feral are found on Reserve sites. Non-native plants and animals can become invasive or act as nuisance species when they are able to out-compete native species, have no natural predators or population controls, or are promoted by human activity. These species have the potential to disturb and damage naturally occurring species, harm existing natural communities and disrupt ecological functions in the Reserve. Invasive plants currently occur at each NCNERR site and are discussed per site in the site descriptions. To address these possible changes and protect the sites' natural resources, invasive plant management strategies, including monitoring and treatment, are continuous. Site managers stay abreast of potential new threats, maintain partner relationships to support invasive and non-native management, and implement management activities using an adaptive management framework. Problems with non-native and feral animals vary per site and by scale. Accordingly, non-native and feral animals must be managed at the appropriate statewide, regional, or local level through coordinated, collaborative efforts. Actions at the site level, such as managing feral horses, focus on minimizing impacts to the sites by these animals.

Site managers prioritize invasive, non-native, and feral species to manage based on: the availability of staffing and funds; the likelihood that an organism will cause damage to a site's natural resources; and the potential for a removal effort to result in eradication or the likelihood of re-invasion by the organism. Management approaches are then developed and implemented that are species and site specific.

Specific objectives and actions related to resource protection are discussed below as part of Objective 3.1.

Public Access and Visitor Use Plan

The Public Access Plan is a required element of a NERRS management plan, per the Federal Code of Regulations 15 CFR 921.13. Public access to the NCNERR sites is defined as the ability of the public to pass physically and visually to, from, and along the ocean shore, other waterfronts, and over public lands. The ability to enjoy the oceans, bays and rivers is directly related to the ability to reach them. In providing for public access, the NCNERR must balance allowing for long-term public use and enjoyment of the sites while minimizing damage to and protecting the integrity of the sites' natural resources. A site-specific approach is used to provide public access due to the unique set of conditions and uses at each site. Support and management of public access may include structures that guide and facilitate access and signage to provide site and access information, support a positive visitor experience, and encourage visitors to follow rules for responsible use of the sites' natural resources.

The NCNERR sites are open access with no hours of operation or access fees. Details regarding modes of access to each site are included in the site descriptions in the Introduction chapter as well as visible on the boundary maps (Figures 3, 7, 11, and 15). Site managers work with the surrounding local communities to

improve access and address access-related concerns on an ongoing basis. Access to specific areas of sites may be restricted for limited periods of time to meet management goals or maintain public safety. Examples of these limited access restrictions include posting of bird nesting enclosures for species of interest and closure of specific areas for short durations following storms during which hazardous debris may have been deposited on site.

Access to the sites supports use of the sites' natural resources by visitors, researchers, and educators for a variety of purposes. The majority of visitors engage in activities that can be characterized as traditional uses, including hunting, fishing, navigation, and recreation for which direct involvement with natural elements of the environment is required. Access to near-pristine sites provides visitors with an opportunity for genuine interaction with the natural world. Visitor activities vary based on the natural resource characteristics of each site as discussed in the site descriptions. Examples of nature-based activities that occur at one or more sites include bird watching, beach walking or hiking, motorized and non-motorized boating, and other water-based recreational activities. Given the increasing human development in the coastal area of North Carolina, the NCNERR sites offer an opportunity for visitors to experience natural, undeveloped coastal and estuarine ecosystems in ways that can only be found in limited areas along the coast.

Researchers access the sites to utilize these outdoor laboratories and functional ecosystems available for research and monitoring, and as control sites. Educators access the sites to utilize these outdoor classrooms to educate people of all ages, encourage appreciation of the beauty and uniqueness of these sites, and foster a stewardship ethic in the citizens of and visitors to North Carolina. Other individuals accessing the sites include commercial operators providing transportation to the sites or programming at the sites, such as ecotours.

Although the stewardship staff are most closely engaged in managing public access and visitor use, other Reserve staff contribute to management of public access and visitor use. Research staff communicate with the research community about ways to minimize the impact research activities may have on natural resources and support research that helps site managers understand the impacts of visitor use. Education staff lead programs at the sites and develop programs and materials to encourage visitors to use the sites responsibly and develop the public's understanding and appreciation of coastal and estuarine ecosystems. Research and education staff also document and report any site concerns to the appropriate stewardship staff.

Challenges related to public access and visitor use are varied. Specific threats and stressors at each site are discussed in the site descriptions. In general, the primary public access concern for the NCNERR is the rapidly increasing coastal population in North Carolina, the associated increasing demand for natural and recreational areas and the potential increase in use impact pressure at the sites. Managing public access in the face of an increasing human population will require careful monitoring of impacts, development and testing of strategies to direct use to less sensitive resources, and an adaptive management approach that allows for flexibility and adaptation to respond to changing conditions in order to maintain the NCNERR sites in as near-pristine conditions as possible.

Due to the multi-component nature of the NCNERR and the isolation of the sites from Reserve offices, the majority of the visitors to the sites may never interact with a member of the Reserve staff. To communicate with visitors about the purpose of the sites and encourage responsible visitor behavior while supporting a positive visitor experience, signage at each site provides basic information to promote understanding of the

importance of the site and guide visitors in minimizing impacts. The NCNERR maintains minimal infrastructure on the sites to ensure that the near-pristine character of the sites is preserved. Trails, boardwalks, and overlooks exist at some sites, where installation of these structures is most supportive of both visitor access and resource protection. Development of site infrastructure is based on needs and opportunities as they arise. Information about existing on-site infrastructure at each Reserve site and needs is available in the facilities section of the Administration Plan.

Specific objectives and actions related to public access are discussed below as part of Objective 3.2.

Land Acquisition Plan

The Land Acquisition Plan is a required element of a NERRS management plan, per the Federal Code of regulations, 15 CFR 921.13. Because estuaries offer numerous and diverse benefits to society and natural systems, the U.S. Commission on Ocean Policy (2004) recommended that priority coastal habitats be identified and conserved. The NCNERR Land Acquisition Plan describes the values underlying acquisition activities and the processes used to evaluate and prioritize acquisitions.

An ongoing focus of the NCNERR Land Acquisition Plan is to complete acquisition of the remaining inholdings within the Masonboro Island Reserve boundary as owners express interest in selling. Acquisition of new lands outside of the site management boundaries has not been a priority for the NCNERR; however, in the future, selective acquisition and boundary expansion may be useful to enhance the program mission, further research, education, and stewardship goals, or address environmental change and allow for migration and connectivity of important habitats. New lands and waters may be parcels adjacent to current holdings or may comprise non-contiguous parcels within current site watersheds.

Priority habitats the NCNERR will consider for acquisition include areas that would add to the core of the sites, including sound waters, mud and sand flats, and intertidal and supratidal salt marshes. These areas are vital to the functioning of the estuarine system. Buffer habitats, areas adjacent to or surrounding the core habitats, that provide protection for core habitats and estuarine dependent species or that provide for habitat migration or support ecosystem resiliency will also be considered for acquisition.

Criteria that will be considered by the Reserve when determining whether to pursue acquisition include: the location of the parcel, the level of site management the parcel will require, the Reserve purposes served by the acquisition, and the community's support of the acquisition.

Specific objectives and actions related to public access are discussed below as part of Objective 3.4.

Stewardship Policies

In addition to the variety of authorities and management documents that guide stewardship of the sites, a number of site-specific policies are needed to address the diversity of site conditions and local uses. Stewardship policies were originally developed with input from OCM. Policies are reviewed periodically and updated by site managers in conjunction with the Reserve Manager, with input from LACs as appropriate, to respond to changing conditions at the sites.

Recreation

Recreation policies are intended to allow for rights of access for compatible and consistent uses of the sites while ensuring that Reserve natural resources are protected. Responsible use of the Reserve by traditional users and recreational visitors protects the Reserve ecosystems and enhances the user experience for subsequent visitors.

Policy 1: Traditional recreational uses of each site shall be allowed to continue as long as they do not disrupt the natural integrity of the site or any research or educational activities.

The four sites have long been used by area residents and visitors for swimming, fishing, hunting, nature study, hiking, and other nature-dependent recreational activities. These traditional uses have created a strong local pride in and attachment to the natural and aesthetic values of each site. Recreation can be compatible with research and education when visitors are informed and take steps to minimize the impact of their activities. Site managers implement actions such as signage guidance structures to guide visitors away from sensitive resources and to provide information to support responsible use. Where sensitive resources may be directly impacted by visitors or visitor safety may be compromised by site conditions, time-limited areas of restricted access may be implemented (i.e. posted shorebird nesting enclosure areas). Providing for public access and traditional and recreational use of the sites promotes appreciation of the Reserve's natural resources and meets the state and federal legislative requirements for the program. Protection of the sites and research and education programs take priority over recreational activities as per the Reserve program's legislative guidance; management actions will be implemented to minimize the impact of recreational activity on the natural integrity of the Reserve or if conflicts arise between these uses. Installation of interpretive trails and signage will be compatible with this policy with respect to protecting the natural integrity of the sites.

Policy 2: Users of the Reserve shall not disturb or remove any live animals (except for fish, shellfish, game animals, furbearers, or waterfowl per fishing and hunting policies) or vegetation at any site unless it is part of an approved research or educational project and all necessary permits have been obtained.

Removal and destruction of vegetation can lead to serious long-term damage to the ecosystems found in the Reserve by causing erosion or sedimentation, decreasing species richness, damaging habitat important to species of interest, or negatively impacting ecosystem function. Disturbing nesting birds and other animals can interfere with their natural habits, potentially causing nesting failure or departure of the animals from the Reserve. Visitors to Reserve sites are encouraged to observe live animals inhabiting or utilizing the Reserve and minimize the impact of their activities on the native wildlife.

Policy 3: Pets must be under control at all times.

Pets on Reserve sites can damage and destroy habitat or disturb wildlife if not properly controlled. Uncontrolled pets can also negatively affect other visitors' experience at the sites. In addition, pet wastes can carry potentially damaging bacteria or become a nuisance for visitors. Pet owners who choose to recreate on the sites of the NCNERR must keep their animals under control at all times and

collect and properly dispose of pet wastes. Owners and their pets are subject to the relevant county and municipal rules regarding leashing and appropriate disposal of wastes.

Policy 4: Camping or fires in designated areas are only allowed by written or posted permission from DCM.

Restriction of camping and fires protects the Reserve's habitats from disturbance and destruction. Camping at the Zeke's Island, Rachel Carson and Currituck Banks Reserves will be permitted only for research that requires overnight stays for observations or data gathering; written permission must be obtained from the Reserve. Primitive camping and campfires on Masonboro Island will be allowed in accordance to guidance posted on-site and via the Reserve's website which includes information on appropriate areas.

Policy 5: All visitors must pack out their own trash.

Debris and litter left behind by visitors can negatively impact the NCNERR habitats and organisms or can enter the ocean system and contribute to marine debris concerns at the global level; it can also negatively impact the experience of other visitors. Because the primary purposes of the Reserve are research and education, recreational facilities such as trashcans and restrooms are not available at the sites. Thus, it is the responsibility of visitors to plan to pack out all trash and refuse generated as a result of their visit. Many visitors demonstrate a stewardship ethic by also collecting and removing trash left behind by other visitors or true marine debris carried to the Reserve by weather, winds, and tides.

Off-Road Vehicles and ORV Access

Off-Road Vehicle and ORV Access policies provide guidance for the use of ORVs at sites where these vehicles are permitted while ensuring that Reserve natural resources remain protected. Responsible use of ORVs at NCNERR sites protects the Reserve ecosystems, supports visitor safety, and enhances the user experience for subsequent visitors.

Policy 1: No power-driven vehicles shall be used on the uplands and marsh sediments within the Rachel Carson or Masonboro Island sites except during emergency, enforcement, management, research, or dredging operations. Motorized boat use within these sites, consistent with WRC regulations, is not affected by this policy.

Unauthorized power vehicles (*e.g.*, motorcycles and ORVs) have created problems on the sites by damaging dunes and vegetation or by disturbing wildlife and visitors. The Town of Beaufort has an ordinance that prohibits motor vehicles on the Rachel Carson islands. New Hanover County has an ordinance that prohibits use of motor vehicles on Masonboro Island except for specific emergency and management purposes. ORVs permitted for emergency, enforcement, management, research, and dredging activities shall take actions to minimize impacts to the sites and avoid sensitive habitat areas. ORVs permitted on Masonboro Island will travel only in the intertidal beach zone during the shorebird and sea turtle nesting seasons (April-September).

Policy 2: Reserve operation at the Currituck Banks site shall not reduce current levels and rights of public access to properties located between the site and the Virginia line.

Currently, paved road access north of Corolla terminates at an ocean beach access ramp located within the Reserve site. Landowners, local residents and visitors depend upon this ramp to route them to the beach for access to lands located between the Reserve and the state line. Currituck County ORV regulations limit this access to the ocean beach seaward of the foredunes. Federal regulations restrict access through the Back Bay National Wildlife Refuge (VA) to certain permanent residents of Currituck Banks. Thus, the ramp and beach within the Reserve property are vital for public access to the northern banks.

When the beach is impassible due to high water levels, access across the site for property owners to the north will be extended to include back dune areas. The road in the adjacent Ocean Hills development to the south will also be part of this "high water" route. Dominion Power maintains a MOU with DCM for cooperative maintenance of a permanent easement granted to Dominion Power for an electric distribution right-of-way to service the northern banks (Appendix I). The easement is located in the back dune areas of the Currituck Banks site and its location must be considered when delineating “the high water” route.

If, at some point in the future, driving along the ocean beach conflicts with Reserve goals and objectives (*e.g.*, environmental issues, recreational beach uses, or research/education uses), it will be the responsibility of the state to make available replacement upland access and to do so prior to any restriction of current beach driving. Any such action will be taken only after full consultation and coordination with the LAC, Currituck County, NOAA, adjacent landowners, and current landowners between the site and the state line.

Access across the site shall be for the purpose of providing a vehicular route to and from properties located between Corolla and the Virginia state line. At no time shall the site be used to provide through access to Virginia (except for enforcement, emergencies, and the currently permitted beach driving access to the north allowed to permanent residents). Should improved access to properties located between the Reserve site and Virginia ever be provided from the north, access across the site may be terminated. Improvement of internal access within those subdivisions north of the site shall not alter provision of access across the Reserve site.

Policy 3: Off-road-vehicles at the Zeke's Island and Currituck Banks shall normally operate only on the flat, sandy beach area: driving over dunes and disturbing vegetation is prohibited. Vehicles using the Currituck Banks during flooded beach conditions shall follow interdune flats and avoid vegetated areas. Drivers shall avoid posted areas of nesting birds and turtles and shall observe the State or County mandated speed limit.

The destruction of plants and sand dunes accelerates erosion of barrier beaches and diminishes the Reserve's natural productivity and habitat diversity. The beach and dune areas are important nesting areas for various bird and turtle species that cannot find these natural habitats elsewhere along the rapidly developing coast. The Reserve staff will coordinate with the Fort Fisher Recreation Area superintendent in the delimitation of waterbird feeding and nesting sites within the Zeke's Island site.

Policy 4: At the Zeke's Island site, power-driven, off-road vehicles (other than boats, emergency vehicles, law enforcement vehicles, and vehicles permitted to engage in research and management activities) are only allowed in designated areas on the barrier spit. ORV use at the Zeke's Island site is managed by the N.C. Division of Parks and Recreation (DPR). A permit must be obtained and the required fee paid to the DPR prior to using ORVs at the site. Dates and hours of accessibility are determined by the DPR and vary seasonally.

The barrier spit is the only portion of the Zeke's Island site that is easily accessible to users of off-road vehicles (ORVs). This portion of the site overlaps with DPR's Fort Fisher State Recreation Area and DPR manages the ORV use per a long-standing MOU with DCM (Appendix N). Confining ORVs to this area does not diminish other uses within the site. The islands and marshes remain protected, while traditional users, such as fishermen, retain access to the inlet and sound waters. Special areas for bird nesting and wintering are posted to minimize impacts from vehicles and foot traffic. Sea turtle nests and hatchlings are marked and protected by DPR staff. Because the ocean beach of the Zeke's Island site serves as nesting area for sea turtles that come ashore to lay eggs during nesting season, ORV use during nesting season may be limited to daylight hours. Lights from vehicles can keep the turtles from coming ashore and nesting or interfere with turtle hatchlings' journey to the ocean. Tire tracks on the beach can also impede or misdirect the hatchlings.

Fishing and Hunting

Fishing and hunting policies clarify the traditional hunting and fishing activities supported by the Reserve while ensuring that Reserve natural resources remain protected and available for research and education activities. Hunting policies provide for public safety and resource protection while supporting this traditional use.

Policy 1: Fishing, shellfishing, and hunting may occur on the Reserve within the limits of federal, state, and local laws. Hydraulic dredging or "clam kicking" is prohibited within the Reserve.

Commercial fishing and recreational fishing and hunting will be allowed subject to existing county, WRC, and DMF regulations including but not limited to bag limits, seasons and gear. Collection of all migratory birds requires a U.S. Fish and Wildlife permit and a WRC license. In order to maintain ecosystem diversity and protect the natural integrity of the sites, hunting and trapping of certain species on upland portions of a given site may be necessary. If these rights do not exist currently, they may be extended on a case-by-case basis after consultation with Reserve staff and the WRC. Hydraulic dredging to harvest shellfish destroys underwater habitats by the severe disturbance of estuarine bottoms and vegetation and by extensive sedimentation of the water column. Such activity is expressly prohibited in the Reserve according to North Carolina Administrative Code Reserve Use Requirements.

Policy 2: Certain areas of the Reserve may be closed to commercial and recreational fishing and shellfishing to provide undisturbed sites for research and fisheries reproduction.

Portions of the sites may be closed to fishing and shellfishing based on research to better document the condition of the Reserve's submerged habitats and species that they support. Such closings would benefit commercial fishing by protecting nursery and spawning areas. Similarly, areas may be closed

for research projects if undisturbed waters and habitat areas are required. Authority to close certain areas of the Reserve rests with DMF. Reserve staff will seek input from LACs as appropriate to inform decision making on closures. When Reserve staff find that such a closing is warranted, the DCM will petition the DMF for such action in accordance with the existing regulations. Also, primary nursery areas within the Rachel Carson, Masonboro Island, and Zeke's Island site are protected from bottom-disturbing fishing gear by DMF regulations.

Policy 3: Hunting is permitted in the Reserve according to local, state or federal wildlife regulations. More stringent rules may be pursued if hunting conflicts with research and education uses or threatens the Reserve's wildlife populations. Target shooting is not allowed.

Existing WRC and U.S. Fish and Wildlife Service regulations set season, bag limits, and limits on methods of taking for game species found at Reserve sites (*e.g.*, migratory waterfowl, marsh hens, doves, deer, and other game). At this time, these regulations, when properly enforced, are adequate to maintain wildlife populations in the Reserve. Reserve staff will seek input from LACs as appropriate to inform decision making related to hunting rules. If the Reserve staff deem more stringent regulations to be necessary, the DCM will petition the WRC and the Secretary of DEQ to adopt appropriate restrictions in accordance with departmental procedures. The Currituck Banks site, and other sites if deemed appropriate, is registered with the State's Registered Lands program through the WRC to allow more effective enforcement of hunting regulations and protection of the Reserve.

Target shooting is prohibited within the Reserve sites because it is not formally regulated. Bullets may carry for great distances and cause severe injury or death, posing a hazard to staff and research, educational, and recreational users as well as creating a liability hazard for the state. Past problems with target shooting at the sites have resulted in damage to vegetation and signs and improper disposal of target materials. In addition, target shooting can present potential user conflicts and disturbance to adjacent property owners.

Dredge Material Placement

The Dredge Material Placement policies provide conditions and guidance to ensure that activities that alter site conditions are completed in ways that minimize damage to Reserve natural resources and encourage beneficial uses of dredging material.

Policy 1: Dredge material placement as part of U.S. Army Corps of Engineers projects shall be allowed to continue at the Rachel Carson and Masonboro Island sites, but only within existing disposal areas of designated easements. All operations must comply with the North Carolina Coastal Area Management Act (G.S. 113A-100 et seq.), Dredge and Fill Act (G.S. 113-229), Section 404 of the Federal Water Pollution Control Act (33 USC 1251 et seq.), and the Use Requirements of the N.C. Coastal Reserve (NCAC T15A: 07O). Deposition of dredge material within the Corps easement by private contractors will be allowed only if approved by the Corps, the DCM, and the State Property Office and the contractors have received appropriate permits from the DCM. Disposal sites must be located, designated, and managed to prevent sedimentation of marshes, intertidal flats and submerged lands, and to minimize impacts to ground nesting birds and sea turtle nesting areas. All dredge material shall be placed in a manner consistent with the best

technology available for prevention of mosquito and other disease vector breeding. Dredging projects that include a research component and/or produce an ecosystem enhancement benefit are preferred and will be given additional consideration. All dredging proposals shall be reviewed by the Reserve staff through the land owner permission portion of permit review process.

The U.S. Army Corps of Engineers (COE) retains perpetual easements along Taylor's Creek at the Rachel Carson site and along the ICW at the Masonboro Island site. Dredge material deposition at Rachel Carson site and along the waterway portion of the Masonboro Island site shall be in diked areas within the existing easements.

In areas that have received periodic deposition of dredge material, early stages of plant succession have been maintained, providing appropriate habitat for some species of birds. Ecosystem enhancement projects can be used to intentionally create benefits of this type. Research projects can be designed to help better understand the best methods and approaches for using dredge material beneficially.

Policy 2: Dredge material deposition on the ocean beach at the Masonboro Island site shall not occur during the critical nesting times of sea turtle and ground-nesting shorebirds (April - November). Populations of seabeach amaranth shall also be protected from direct deposition and from vehicular impacts of disposal operations. If dredging is unavoidable during that time period, it shall be contingent upon prior and concurrent monitoring for nesting activity and presence of seabeach amaranth.

Dredge material deposition occurs periodically on the ocean beach at the Masonboro Island site, typically in association with maintenance dredging of Masonboro Inlet. This deposition activity serves to partially mitigate the erosion and sediment loss caused by the jetty on the north end of the island. This deposition does not directly affect the estuary area within the Reserve as the dredge material will be washed back into the natural longshore transport of sediments. Impacts to surf zone fauna may occur, although these have not been extensively studied at Masonboro Island.

The courting and nesting of shorebirds at the Masonboro Island site extends from April through September. This roughly coincides with the sea turtle nesting season, which extends from May 1 - November 15. Thus, deposition of dredge material during these months plus the associated activities of bulldozers and other vehicles on the beaches can negatively impact these species. Seabeach amaranth, a federal and state threatened species, historically occurred on the upper beaches and foredunes of Masonboro Island and deposition of material and associated vehicular activity may disrupt species presence and habitat. Conducting seasonal monitoring of sea turtles and seabeach amaranth shall be a priority for the Reserve; if dredging and deposition activities occur outside the suggested timeframe, monitoring will be of increased importance in order to ensure that protected listed species are not affected.

Habitat Restoration

The Habitat Restoration policy is intended to ensure that any restoration or remediation project undertaken at a NCNERR site will provide benefit to the Reserve's natural resources and that restoration science will be furthered when research can be incorporated into a restoration project.

Policy 1: Projects to restore estuarine and upland habitats within the Reserve will be reviewed by state and federal Reserve staff. Input from other governmental agencies, LACs, and other interested parties will be sought as needed. Priority shall be given to areas impacted by visitor use, dredge material deposition, and invasive species. Restoration activities will be undertaken using the best available science. Whenever possible, restoration projects will include internal or independent research that advances restoration science and understanding of Reserve ecosystems and their function and response.

Given the diversity of habitats and uses within the various sites, occasional restoration projects may be beneficial or necessary. For example, some dredge material islands along the waterway side of Masonboro Island include former salt marshes that have been filled. Portions of these islands located outside of the Corps easement could be considered for mitigation projects where marsh could be restored and, thus, increase the Reserve estuarine area. Likewise, areas within sites that have experienced damage from visitor use or that have been altered by the presence of invasive or feral species may require remedial action. At both the Currituck Banks and Rachel Carson sites, damage to vegetation by feral hogs or horses, may be mitigated through restoration of groundcover species. Restoration projects present opportunities for long-term monitoring of structure and function within the restored habitat.

Feral Horses

The feral horse policies describe the ownership and management of horses that occur at the Currituck Banks and Rachel Carson sites. Effective management of feral horses reduces habitat impacts and protects horse health from the detriments of overpopulation.

Policy 1: The state of North Carolina is the lawful owner of the feral horses on the Rachel Carson site. However, the state does not own the horses that roam the Currituck Banks site.

The state Attorney General's Office has determined that the horses found on the islands composing the Rachel Carson site are owned solely by the state. The horses on Currituck Banks roam many properties and, thus, are not claimed by the state.

Policy 2: Scientific studies of population structure, feeding habits, and impacts on Reserve habitats plus information from analogous management programs of feral horses shall be used to manage the horses at the Rachel Carson site. Such information will also be used to consult with key parties concerning feral horse management on the Currituck Banks.

Information gathered from studies of feral horses on the sites plus additional data from other populations (*e.g.*, at Cape Lookout National Seashore and Assateague National Seashore) will be used to determine proper management of the horse herds. The primary goal of the NCNERR is to manage the sites for research and education. Though the horses are very popular with local residents, the animals represent a management conflict because they are an introduced species that consumes and tramples marsh vegetation vital to estuarine productivity, and their presence, activities, and wastes alter other natural processes. Decisions regarding horse management will be made in accordance with the Rachel Carson feral horse management plan with input from DEQ, OCM, and the LAC as appropriate. Decisions regarding horse management at

Currituck Banks will be developed in collaboration with the Currituck Outer Banks Wild Horse Advisory Board, which includes the Corolla Wild Horse Fund, Currituck County, representatives from each of the protected lands utilized by the herd (Reserve and U.S Fish and Wildlife Service), and community members.

Surveillance, Enforcement and Maintenance

Surveillance, enforcement and maintenance policies explain how the Reserve accomplishes these activities at the NCNERR sites. Appropriate surveillance and enforcement ensures that Reserve resources are protected and that traditional and recreational users can safely visit and utilize the sites.

Policy 1: The Reserve staff and enforcement personnel from other federal, state and local agencies shall periodically visit each site to identify and investigate possible violations of Reserve regulations. The Reserve also relies on researchers, educators, members of the LACs, and other users of the sites to report any problems.

Time and budget limitations keep Reserve and DCM staff from maintaining a continuous presence at each site in the Reserve. Enforcement agencies are able to visit the sites only periodically or in response to reports of possible rule violations or public safety concerns. Therefore, all users of the Reserve must exercise responsibility for obeying the management policies and rules of use stated in this plan, for reporting possible violations of the rules and policies, and for cooperating with Reserve staff and pertinent enforcement agencies.

Policy 2: The DCM, DMF, DPR, WRC, and local law enforcement agencies shall cooperate in the enforcement of Reserve use standards listed in the North Carolina Administrative Code (see Appendix M) as well as applicable state and local laws and ordinances.

Each site in the NCNERR falls into a number of different, sometimes overlapping jurisdictions involving state and local law enforcement agencies. Strong lines of communication and a strong sense of cooperation among the Reserve and the enforcement agencies ensures that rules and ordinances are effectively enforced. Site managers maintain regular communication with each of these groups to proactively address site concerns that may compromise public safety, to investigate any rule violations through the appropriate channels, and to take management action when necessary.

At Zeke's Island, the DEQ has assigned management responsibility for patrol and enforcement of the barrier spit to the DPR (Appendix N). In addition, the New Hanover County Sheriff has jurisdiction throughout the Zeke's Island and Masonboro Island sites. The Town of Beaufort Police and Carteret County Sheriff respond to law enforcement concerns at the Rachel Carson site. The Currituck Banks site is within the jurisdiction of the Currituck County Sheriff; response is coordinated with the deputy stationed in Corolla. Rangers of the Currituck and Mackay Island National Wildlife Refuge also patrol this site. The WRC has authority to patrol the lands and waters of the entire Reserve for enforcement of their regulations (i.e., hunting and boating) (Appendix O). Likewise, the DMF patrols the sites to enforce marine fisheries regulations (Appendix P).

Policy 3: When deemed necessary, the DCM shall enter into cooperative agreements with pertinent law enforcement agencies to clarify enforcement jurisdictions and responsibilities.

In the past, a lack of understanding on the part of the enforcement authorities regarding which agency should respond to a given problem has at times led to difficulty with response to law enforcement calls. The site managers work to improve effectiveness of law enforcement response by communicating regularly with law enforcement agencies and providing information regarding the Reserve, its sites, and its regulations to authorities. In addition, cooperative agreements that help to clarify each agency's role relative to Reserve management are used to support coordinated and effective enforcement of Reserve use standards.

Stewardship Program Objectives and Actions

Goal 3: Stewardship of protected sites contributes to the study and appreciation of coastal and estuarine ecosystems.

Objective 3.1 Coastal and estuarine ecosystems are managed and protected.
Actions that will be undertaken under Objective 3.1 support the resource protection plan and include activities that are specific to management, enhancement, and restoration of protected resources, including habitats and species of interest. Invasive, non-native and feral species are managed to support protection and restoration of protected resources. Actions related to development and enforcement of policies and rules to support site management are also discussed. Additional information regarding recreation and hunting and fishing can be found in the Stewardship Policies at the end of this chapter.

Action 1: Monitor general site condition at least monthly.

To adequately address protection of the NCNERR sites, the site managers will monitor each site on a regular basis as deemed appropriate based on season and use. Each site has a characteristic suite of communities and species, as well as a unique list of traditional uses and local threats and stressors associated with it, requiring that the monitoring schedule and protocols be site-specific. Monitoring may include assessment of any or all of the following: invasive and feral species presence and condition; threatened, endangered, and species of interest presence and condition; visitor use patterns or impacts; habitat change as a result of natural or anthropogenic influences; and condition of Reserve-owned equipment and structures. Monitoring activities will assist in maintaining the Reserves for use by researchers, educators, and the public. Monitoring also aids in designing management strategies to address stressors. The Reserve's surveillance and enforcement approach is described in the Stewardship Policies at the end of the chapter.

Action 2: Respond to issues on sites, coordinating with law enforcement, state and federal agencies, and partner organizations.

Enforcement of rules is conducted through partnerships with local, state, and federal enforcement agencies. Regular communication and coordination with these agencies will ensure that enforcement

response is effective and that enforcement gaps are identified and addressed. Responding to issues on the sites does not always require law enforcement action; where appropriate and based on site needs and conditions, strategies will be implemented to address potential disturbance or damage to site resources through cooperation with local communities using the lowest level of enforcement possible to get the desired compliance result. This can be accomplished through coordinated media campaigns or through outreach programs: a public relations campaign collaboratively implemented by the Reserve, New Hanover County Sheriff's Office, and the Town of Wrightsville Beach has been used to help address the impacts of large gatherings of visitors at the Masonboro Island Reserve, encourage responsible visitor behavior, and reduce the incidence of illegal activity; and a coordinated approach between the Reserve and the NPS has been used at the Rachel Carson Reserve to develop and deliver educational messages to reduce illegal and unsafe visitor interactions with feral horses. Through these partnerships and similar coordinated efforts, the NCNERR will effectively manage the Reserves against the effects of overuse or misuse associated with increased coastal population. Additional explanation of the Reserve's surveillance and enforcement approach is described in the Stewardship Policies at the end of the chapter.

Action 3: Manage species of interest by conducting survey and monitoring activities, protecting critical habitat areas, and implementing management actions to address concerns and support state, federal, and regional recommendations or initiatives.

Species of interest and associated management activities the Reserve will conduct under this management plan include:

- Regional and national monitoring efforts exist for the piping plover, listed as a federally endangered shorebird under the Endangered Species Act. The NCNERR supports efforts to survey for and document this species by participating in partner agency organized breeding and wintering surveys.
- The International Shorebird Survey (ISS) is a monitoring network with a focus on gathering data about shorebirds and the habitats they depend on. The surveys are conducted for all shorebirds, but with a focus on vulnerable species such as the threatened red knot. This data is used to set regional and national shorebird conservation priorities. At the Rachel Carson site, ISS surveys are conducted several times throughout the year by volunteers with staff support. Surveys at other sites are supported by staff as resources allow.
- Loggerhead and green sea turtles are listed as threatened under the Endangered Species Act. Nesting activity is managed either by partner agencies (DPR at the Zeke's Island site), partner organizations (Network for Endangered Sea Turtles at the Currituck Banks site) or by seasonal staff, interns, and community volunteers (at the Masonboro Island site) working to identify, protect, monitor, and excavate nests following hatching. Since 2010, the Reserve has also supported a regional loggerhead genetic fingerprinting project by providing egg samples from nests on Reserve sites.
- The diamondback terrapin is listed as a species of special concern in North Carolina and is identified as a priority species in the State Wildlife Action Plan. Management activities implemented by the NCNERR support priority activities suggested at the state level, including surveying of habitats for presence of terrapins and development of survey and

monitoring methods. At the Masonboro Island site, a pilot effort to create a citizen science based survey program was developed in collaboration with the N.C. WRC. This effort will be expanded to other Reserve sites or to other portions of the State's estuaries, as financial resources allow.

- The American oystercatcher is considered an umbrella species; management actions implemented to protect this species tend to indirectly protect other species utilizing the same habitat. In areas where nesting is determined to occur, posts and signs are used to demarcate nesting habitat and protect it from disturbance from visitor activity. At the Masonboro Island, Reserve staff and volunteers post nesting areas each season based on conditions and habitat utilization. At the Masonboro Island site, monitoring of nesting success has also been undertaken as funds allow and in collaboration with Audubon NC in order to support the broader range-wide effort of the American Oystercatcher Working Group (AOWG) to collect data to inform management of this species. The Reserve also supports banding of adults and chicks of this species at the Masonboro Island site, in coordination with Audubon. At the Zeke's Island site, the DPR monitors and protects nesting American oystercatchers. At the Rachel Carson site, staff and volunteers conduct occasional breeding surveys in cooperation with N.C. WRC. Sightings of banded oystercatchers at all sites are reported through the AOWG online database.
- Seabeach knotweed is a state endangered plant that grows in highly dynamic ocean and sound beach habitats. It can be used as an indicator species to assess the quality of these habitats, which are critical for listed nesting and foraging shorebird species including the piping plover and red knot. At the Rachel Carson site, volunteers conduct periodic surveys to document the presence and extent of this species.
- Remains of seabirds are regularly found along the shores of the Reserve sites. The Seabird Ecological Assessment Network (SEANET) program is an existing survey and research program coordinated through Tufts University. At the Rachel Carson site, staff provide transport and support for trained volunteers who conduct periodic surveys utilizing these existing protocols and contribute data to the existing database. This program will be expanded to include other Reserve sites, as financial resources allow.

Action 4: Manage, enhance, and restore habitats by implementing activities to support the natural integrity of sites, working with partners and contributing to state and regional initiatives.

Habitat management activities are undertaken based on specific site needs and are designed to utilize the best available science. Action may be taken to reduce or eliminate the impacts of a threat or stressor or promote resilience. Alternately, a project may be implemented to address an identified need for restoration or to strengthen or augment an existing habitat. Management actions may require characterization of conditions based on field data collection and supported through mapping and monitoring efforts. Methods and timing of habitat management actions are dependent on available staff and financial resources. Reserve staff work to connect with and build on state or regional initiatives in planning and implementing habitat management actions on the sites. An adaptive management framework in which monitoring, evaluation, and adaptation of strategies is used iteratively to adjust management when appropriate.

Habitat management activities the Reserve will conduct under this management plan include:

- Stewardship staff participate in regional efforts to address habitat protection at landscape scales. Staff will continue to participate in the Currituck Alliance for the Sounds, an initiative to study and advance resilience in and around the freshwater sounds, and the Onslow Bight Forum and Cape Fear Arch Conservation Collaborative, regional efforts to implement community conservation plans and promote stewardship of natural resources.
- Stewardship staff work to support Reserve habitat mapping efforts, but may also take on mapping of specific areas or habitats to understand and prepare for implementation of a management strategy. Efforts to collect accurate benthic habitat data at the Masonboro Island site began due to a need to develop a policy to manage shellfish aquaculture leases. This mapping effort was coordinated with the state's benthic habitat survey program through the DMF and collaborators at UNCW. The Reserve will continue to support ongoing efforts to improve benthic habitat maps to support a variety of purposes.
- Building off current research done by wetland scientists, vegetation monitoring and mapping will continue in the marshes at the Currituck Banks site. Mapping will provide information about vulnerability to erosion and inform decisions about potential shoreline stabilization projects. Vegetation monitoring will help prioritize sites for marsh restoration and aid in developing metrics to measure restoration success.
- Habitat enhancement and restoration at the Currituck Banks site will be undertaken through the construction of a wooden raised platform at the terminus of the primitive trail. The platform will prevent further erosion of the shoreline and damage to the existing marsh habitat by trampling. It will also enhance the visitor experience through an improved view of the Currituck Sound and a more stable walking surface. Interpretive signage will be included in the project, depending on funding.
- Grassland enhancement projects involve protecting early successional upland plant species from the damaging effects of invasive species and/or undertaking planting projects to support habitat function. A previous grassland enhancement project at the Rachel Carson site will be monitored and opportunities may be pursued to implement similar projects at this and other sites.
- Large pieces of marine debris can disturb and cause damage to habitats by smothering vegetation, excluding plants and animals from utilizing habitats and opening areas to colonization by invasive species. At the Rachel Carson Site, debris research and removal efforts, coupled with data collection, will continue to be undertaken by staff and volunteers to protect and restore habitats.
- A documented sediment deficit exists at the Masonboro Island site resulting from the influence of the jetty stabilizing Masonboro Inlet. Sand is placed on the ocean beach during periodic maintenance events. The Reserve will continue to coordinate these efforts with the Army Corps of Engineers and local government partners in order to protect existing habitat and restore ocean beach habitat.
- The NCNERR is working with the North Inlet-Winyah Bay National Estuarine Research Reserve, SC on a recently awarded NERRS Science Collaborative grant to use the Climate Change Vulnerability Assessment Tool for Coastal Habitats (CCVATCH), a habitat vulnerability assessment tool that will help the Reserves better understand coastal habitat vulnerability to changing climate conditions. The assessment will be applied to marshes at all four sites of the

NCNERR. Stewardship and training staff will prepare for and implement the community engagement and expert elicitation aspects of the CCVATCH.

Action 5: Manage invasive, non-native and feral species by conducting survey, monitoring and treatment activities on sites and in coordination with partners as appropriate.

Management activities undertaken under this action are based on specific site needs and are designed utilizing the best available science. Activities may require characterization of conditions based on field data collection and supported through mapping and monitoring efforts. Management strategies may include eradication, treatment to prevent the spread of an existing invasion or maintain populations at a defined level, or monitoring to determine trends prior to further action. Methods and timing of invasive, non-native and feral species management actions are dependent on available staff and financial resources. Reserve staff work to connect with and build on state or regional initiatives in planning and implementing management actions on the sites. An adaptive management framework in which monitoring, evaluation, and adaption of strategies is used iteratively to adjust management when appropriate.

Invasive, non-native and feral species management activities the Reserve will conduct under this Management Plan include:

- Alligatorweed (*Alternanthera philoxeroidesroides)*, an invasive exotic aquatic plant, is currently found in pockets along the sound shorelines and creeks at the Currituck Banks site. Alligatorweed forms dense mats that crowd out native species and impede recreational activities such as boating, swimming, and fishing. Reserve staff will work with the USDA and other partners in the region to identify areas of concern at the site and potential treatment options for eradication.
- Feral hogs are an actively managed invasive species at the Currituck Banks site. Staff will continue to work with the U.S. Department of Agriculture Wildlife Services program (USDA-WS) to eradicate hogs from the site. Feral hogs are managed through trapping, exclusion from specific areas of habitat, and monitoring with trail cameras. Depending on funding availability, additional management may be undertaken utilizing radio telemetry and GPS collars to study movement patterns and habitat use and to support aerial-based removal.
- Feral horses are actively managed as non-native species at both the Rachel Carson and Currituck Banks sites. The State owns and manages the Rachel Carson horses, but does not own or manage the Currituck Banks herd. At the time the Rachel Carson site was designated as part of the NCNERR, the state-owned feral horse population was experiencing a population explosion that led to significant impacts on marsh habitat and horse welfare. To avoid repeating this situation, best protect site habitats, and meet its obligation as the state's management agency, the Reserve established a population management target of 30 animals. Current management includes use of a remote dart delivery system to administer an immunocontraception vaccine (birth control) to select mares annually. Forage availability, which is linked to vegetation health, is monitored through body condition and activity budget studies of the horses. Feral horses utilize the Currituck Banks site as a small portion of their total available habitat; these horses are not owned by the State and are monitored by partner

organizations under a multi-agency approved management plan on which the Reserve is a signatory.

- Salt cedar (*Tamarix*) is an invasive plant found at the Rachel Carson site. Initial treatment efforts attempted in 1999 were not cost and time effective. Since 2001, management efforts have been focused on monitoring the spread and die-off of individual *Tamarix* plants.
- Beach vitex (*Vitex rotundifolia*) is under treatment at the Masonboro Island site. Working with the Beach Vitex Task Force, a regional management group, Reserve staff survey and treat occurrences with herbicides annually. Although early management recommendations suggested that the plants would not be capable of producing viable seeds outside their native habitats, plants at the Masonboro Island site have successfully seeded, requiring ongoing maintenance management effort.
- The presence of non-native red foxes at the Masonboro Island site has resulted in damage to sea turtle and shorebird nests. Management of this species has been undertaken as funding allows to achieve predation rates at or below those recommended in sea turtle recovery plans, shorebird management plans, and best practices documents.
- Gracilaria *(Gracilaria vermiculophylla*) is a non-native red algae that has invaded the waters of the Zeke's Island and Masonboro Island sites, creating erosion of marsh edges and potentially causing changes to water biochemistry in discrete areas. Management of this species includes working with researchers to determine and characterize the invasion and exploring possible treatment methods.
- White poplar (*Populus alba*) occurs on the upland extent of Zeke's Island, within the Zeke's Island site. Eradication of this woody invasive capable of outcompeting native maritime forest species will be accomplished through periodic herbicide treatment.

Action 6: Support efforts to assess and update rules and policies to respond to site conditions and ensure the Reserve's mission is fulfilled and local, state and federal laws are upheld.

By rule, the sites in the NCNERR are protected primarily for research and education; traditional uses that are compatible and consistent with these priorities are allowed. Occasionally, conditions or uses are determined to be incompatible or inconsistent but current policies, rules or enforcement do not provide clear direction for addressing these situations. Site managers review applicable state rules and county and local ordinances to identify opportunities to better support site protection and enforcement. To address identified rule and policy gaps, clear policies or rule update recommendations are developed based on site manager, program, and Division experience. Stewardship policies are reviewed and updated by site managers, the Reserve Manager and LACs, as needed. New or updated rules are developed and recommended by site managers and the Reserve Manager and adopted based on departmental authority and approval. If deemed necessary for protection of NCNERR resources and to ensure safe public use of the sites, changes or additions to existing policies and rules will be pursued.

Action 7: Document and maintain natural history records by developing a centralized online database, populating it with existing geographic and photographic species records, and continuing to document observances on sites.

Maintaining past and current natural heritage records is essential for understanding the ecological significance and condition of NCNERR sites. Natural heritage records are useful for understanding how ecosystems and habitats may be changing over time and evaluating the potential environmental impacts of proposed research and stewardship projects and development projects on adjacent lands. Additionally, a natural resource database to house natural history records and photographs is critical to the preservation of stewardship staff knowledge, documentation of site occurrences, and as a resource for current and future research and education efforts. Site managers will collect records, including geospatial data and images, as available, and maintain records in a standardized format. Depending on availability of funding, a database designer will be contracted to develop an internet-accessible database to house the records.

Action 8: Enhance partnerships with natural resource management agencies and organizations by providing advisory services and developing collaborative projects that support protection of ecosystems.

Stewardship staff coordinate and collaborate with a wide variety of partner agencies and organizations. Site managers provide information and advice as requested to share their individual areas of expertise and strengthen these partnerships. Site managers also work collaboratively with partners to design, seek funding for, implement, and review ecosystem protection, management, enhancement, and restoration activities undertaken at site, local, and regional scales.

Objective 3.2 Access is accommodated for site uses that maintain protection of natural resources and are compatible with research and education activities.

Actions that will be undertaken under Objective 3.2 support the public access and visitor use plan and include activities that are specific to public access, encourage users of the sites to be responsible stewards, and ensure a positive experience for all user groups. Additional information regarding recreation and hunting and fishing can be found in the Stewardship Policies at the end of this chapter.

Action 1: Provide for public access to sites by installing and maintaining structures, signage, and trails to guide and inform visitors.

In order to provide a positive visitor experience, encourage responsible use, and instill an environmental ethic in visitors to the NCNERR sites, the stewardship staff plan for, install, and maintain minimal infrastructure on the sites. Site managers maintain and replace identification and rules signs on an ongoing basis. Structures and trails are developed based on site needs and funding opportunities. Informational signs containing site descriptions, program information, and visitor use guidance are installed at regularly used access points. Additional interpretive signs, frequently highlighting specific site use topics or more detailed descriptions of site features, are designed and installed when conditions suggest that this will be an effective means of communicating with visitors. Site managers coordinate with other Reserve staff and partners to seek funding for and to develop access and guidance infrastructure. Existing on-site facilities and needs are detailed in the Facilities Plan.

Action 2: Work with local partner agencies and governments to support efforts to provide access facilities for local communities to engage in nature-based recreational use of the sites.

As near-pristine natural areas, the sites of the NCNERR are important to members of the surrounding communities interested in recreational activities that are dependent on access to nature. Members of local communities visit the sites of the NCNERR to engage in activities such as bird watching, hiking, beach combing, boating, surfing, and paddling. The stewardship staff support these uses of the sites by communicating with local partners about the ways in which the sites are accessed by the community, including boat ramps, ORV accesses, and parking areas to facilitate continued access. In cooperation with local partners, site managers may pursue opportunities to provide additional access points or to make improvements to existing access facilities consistent with the Reserve purposes.

Action 3: Provide information to specific user groups to promote safe and appropriate use of the sites while preserving natural integrity and minimizing impacts by providing information about site resources and guidance for minimizing impacts during use of sites.

Stewardship staff directly engage several specific user groups: educators, researchers, and commercial operators. Educators and researchers are provided with information and guidance tailored to their needs and based on the character, location, frequency, and duration of their activities on a site. Site managers may recommend adjustments to a planned research or education activity in order to reduce its impacts on sensitive resources or minimize potential conflicts with other uses and/or users. Commercial operators, businesses that utilize the sites as part of their ongoing operations or business activities, are engaged by stewardship staff on an ongoing basis. Because preservation of the natural integrity of the sites is in the best interest of the commercial operators and because commercial operators interact directly with significant numbers of site visitors, the site managers engage the commercial operators as partners in stewardship of the sites. Site managers provide information to commercial operators about the sites' resources, NCNERR program activities, and responsible use of the sites. To directly and indirectly reach recreational users of the sites, stewardship staff provide information to the general public via the website, social media, on-site signage, scheduled outreach programs, and personal communications. Recreation policies 1-5 address management of recreational activities and provide greater detail regarding responsible use of the sites.

Action 4: Inspire current and potential site users to appreciate and engage in the stewardship of estuarine and coastal ecosystems by providing opportunities for active participation in Reserve activities on the sites.

Site users who are directly engaged in hands-on activities can experience learning that leads to a feeling of attachment and appreciation of the sites. To encourage visitors to develop a stewardship ethic, the site managers provide opportunities for community members to participate in a variety of stewardship activities. These activities are typically coordinated by site managers and may include site cleanup and maintenance, monitoring and protection of species of interest, invasive species management, and biological surveys. Opportunities to engage in hands-on stewardship activities are

promoted through a number of media outlets and locations to reach out to both current visitors and potential future visitors to the sites.

Action 5: Engage researchers, educators, and commercial operators as active participants in stewardship of the sites by encouraging them to provide information about site observances and their use of the sites.

In order to better understand the interests and potential impacts of these specific user groups, it is important for site managers to have information about these users' activities, including the location, frequency, duration, and character of use. Researchers and educators are engaged on an ongoing basis, depending on the details of their activities; these users are also engaged by the Reserve's research and education staff as detailed in the research and education plans. Site managers reach out to commercial users on an annual basis to encourage submission of information about their activities on the sites. Because they are physically present on the sites in the course of their activities, these user groups are recognized as potential partners in observing and reporting site management concerns. To best utilize this opportunity, commercial operators, educators, and researchers are encouraged to communicate with site managers about conditions on the sites and observances of an interesting or concerning nature.

Action 6: Assess and characterize use of the sites to inform balanced management between access and resource protection and to reduce potential conflicts between user groups by monitoring uses, engaging user groups, and implementing management actions.

Each site has a unique set of uses and user groups and may include recreational use, commercial use, research and education use, and other traditional uses such as hunting, fishing and navigation. To increase understanding of use trends per site, stewardship staff may conduct studies on specific or general use patterns and impacts of uses. As coastal populations continue to increase, the likelihood of conflict between uses and the potential for damage to protected resources also increases. Where a use may be conflicting with other uses or resulting in damage to protected resources, management strategies may be implemented using an adaptive management framework. Approaches site managers utilize to understand and address management concerns related to site uses may include: periodic monitoring and data collection; surveys of site visitors or specific user groups; and meetings and input from user groups. Site managers also seek advice from partners and consult scientific literature to inform decision making related to management of site uses.

Management activities the Reserve will conduct to better understand and balance uses at Reserve sites under this Management Plan include:

- Hunting is recognized and protected as a traditional use at Reserve sites. Increased residential development adjacent to the sites has resulted in an increase in the number of concerns expressed by community members regarding the relationship between safe recreational use and hunting. The Reserve will explore options to balance these uses and promote safe use of the sites for all users; management actions may include implementing policy or outreach strategies and working with partner agencies to develop more effective tracking and management of hunting activity.

- Community engagement and development of management strategies in conjunction with local governments can be used to resolve use conflicts. At the Currituck Banks site, the Reserve will work to consider options to ensure proper use of the parking lot for access to the boardwalk and trails.
- Understanding visitor use patterns supports management decision making. Protocols to develop annual visitation numbers were developed and implemented for the Masonboro Island and Rachel Carson sites. Stewardship staff will evaluate these efforts, determine appropriate next steps, and continue to use similar approaches to collect data that will support effective management actions when addressing site concerns.
- Previous research conducted at Reserve sites indicated that many visitors were unaware of the purpose and management framework under which the Reserve sites are managed. Outreach and community engagement strategies were implemented to address these findings. Similar efforts will continue to build on these strategies and the Reserve will consider conducting follow-up research to assess the effectiveness of these efforts.
- With increasing coastal populations, Reserve staff have noted an increase in the levels of commercial and recreational fishing at some Reserve sites. Opportunities will be pursued to increase interaction with the DMF, collaborate on fisheries related research and management projects, and consider interactions between fisheries activities, natural resource protection, and recreational use of the sites.

Objective 3.3 Trained volunteers contribute to and benefit from supporting stewardship activities.

Action 1: Recruit volunteers to support stewardship activities by engaging students, community members, and civic groups and utilize volunteers to accomplish and enhance stewardship activities.

Site managers recruit volunteers from local communities and educational institutions to assist with site management activities. Due to the resource limitations at the Reserve, volunteer participation plays an important role in accomplishing the goals of the stewardship program. Engaging members of the public directly in active participation in stewardship activities encourages the development of a stewardship ethic and understanding of the importance of coastal and estuarine resources. The NCNERR 312 performance measure for the stewardship program sets a target of 1350 hours of volunteer effort to be contributed toward completion of stewardship program goals and under the direction of stewardship staff.

Action 2: Advance volunteers' skills and knowledge of stewardship of coastal and estuarine natural resources by providing mentoring, training, and hands-on field experiences.

Site managers seek to offer volunteers the opportunity to grow in skills and knowledge. Volunteers receive training and information to enrich their experience and volunteer activities are designed to be meaningful and to contribute significantly to site management and resource protection. Handbooks and training sessions are used to promote learning. Some volunteer opportunities include longer term activities in which volunteers can develop skills such as species identification or use of natural resource management equipment and practices. Volunteers have been trained to support activities such as shorebird surveys, sea turtle nest monitoring, and monitoring of vegetation change.

Action 3: Provide a safety briefing at each field-based volunteer training or activity.

Safety is critically important for activities conducted in an outdoor setting or on and around water. To support a safe volunteer working environment, a safety briefing is conducted at the start of each field-based volunteer activity. Volunteers receive information about the possible hazards and risks associated with the activity, the location of safety supplies, and the safety and communication systems in place, such as a weather lookout or on-shore contact.

Action 4: Facilitate management of volunteers to support Reserve programs by maintaining effective tracking and communication tools and providing current volunteer resources and materials.

Stewardship staff maintain spreadsheets that are used to track volunteer contributions to the Reserve and report on volunteer performance measures biannually. Stewardship staff also communicate regularly with volunteers to promote recruitment and maintain relationships in order to build a core of regular volunteers. Stewardship staff coordinate the periodic update of volunteer materials, including web-based information and print materials. In order to ensure that volunteers can participate in all appropriate aspects of Reserve operations, stewardship staff coordinate with other sector staff in these efforts.

Objective 3.4 Boundary expansion and acquisition opportunities are explored to protect Reserve sites. Actions that will be undertaken under Objective 3.4 support the land acquisition plan and include activities that are specific to acquisition efforts and expansion of the Reserve boundaries and its holdings.

Action 1: Evaluate acquisition of inholding and adjacent properties from willing sellers to expand boundaries to parcels that meet NERRS definitions for core and buffer areas as appropriate.

The four sites comprising the NCNERR represent the most tangible and enduring aspects of the program. Permanently preserved, undisturbed examples of various estuarine types are fundamental to the underlying concept of NERRS. Thoughtful acquisition and boundary expansion planning is essential to ensure proper environmental protection and to anticipate user demands and potential impacts from activities in the surrounding communities and watersheds. Opportunities to expand current site boundaries to incorporate additional acreage and important representative natural resources may occur and will be pursued as possible.

The Masonboro Island Reserve is the only NCNERR site that has privately held inholdings within its management boundary. Twelve properties totaling approximately 17 acres on Masonboro Island proper plus some areas of the adjacent spoil areas remain in private ownership. Acquisition of these parcels by the State for inclusion in the NCNERR will eliminate the possibility of development on the island, thereby keeping the ecosystem intact for Reserve purposes. The North Carolina Coastal Land Trust, which absorbed the former Society for Masonboro Island and worked to protect Masonboro Island, continues to assist in acquisition efforts through annual landowner contacts to pursue potential donation or sale of property or property rights to the State of North Carolina for inclusion in the NCNERR.

Action 2: Maintain and enhance relationships with adjacent and inholding property owners.

The NCNERR works to maintain positive relationships with adjacent property owners, recognizing that this group has a unique opportunity to observe activities and disturbance on the sites and that this group may be most directly affected by activities on the sites. Open communication with these neighbors can benefit both the Reserve and the adjacent owners, as information is shared and site concerns are addressed. Cultivating informed neighbors, valuing their input, and responding efficiently strengthens the community of support around the Reserve sites.

Adjacent property owners include private individuals and public partners. Private landowners on adjacent properties have been invited to participate in Reserve-led field activities such as diamondback terrapin surveys. They have also been recruited to serve on the sites' LACs. As many adjacent property owners also frequently visit the sites, opportunities arise to directly engage them by offering them information and encouraging them to contact staff with concerns. Engaged neighbors have reported illegal activity such as target shooting, allowing staff to take action to resolve the issue quickly. Reserve staff will continue to encourage adjacent property owners to be engaged in management of the sites and will explore additional opportunities to reach out to this group.

Reserve staff will also continue to maintain regular communications and strong relationships with partner agencies and organizations with adjacent holdings. Good communication facilitates implementation of management actions such as treatment of invasive species, monitoring of species of concern, and response to law enforcement or safety concerns.

At the Masonboro Island Reserve, many of the remaining inholding property owners visit the site less frequently than the Reserve staff. Because of this, it is likely that Reserve staff will be aware of potential harmful impacts, such as wildfire, vandalism or invasive species presence, prior to the inholding owners. Serving as a resource for these owners, maintaining open communication, and continuing to be respectful neighbors facilitates productive relationships and increased understanding of the Reserve and its purposes.

Action 3: Explore opportunities for assessing future acquisitions based on prioritization of habitat protection and ecosystem resilience needs.

Existing Reserve sites were chosen in part because of the representational value their natural communities possess. Moving forward, additional acquisition to support ecosystem resilience will need to be considered. Sea level rise, land subsidence, and changes to climate systems may affect Reserve sites, though to varying degrees. Effects may include loss of habitat, conversion of areas from one habitat type to another, introduction of non-native species, and changes in patterns of wildlife utilization. As the effects on representative natural community types become more fully understood, non-contiguous acquisitions may be needed to ensure that representative habitats continue to be protected and ecosystems continue to function. For example, the Currituck Banks Reserve will likely experience sea level rise impacts prior to other NCNERR sites (NC Sea Level Rise Report Update 2015). If

it becomes apparent that sea level rise will impact the natural communities at this site to the point they are no longer representative, sites containing examples of ecologically intact communities may be considered for acquisition or boundary expansion to ensure that the site continues to include core and buffer areas representing the habitats and ecosystem.

Ecological value will be the primary criteria for all future acquisitions. Parcels will be analyzed based on characteristics such as types of habitat available, quality of habitats, presence of priority species, connectivity with other protected areas, and potential for habitat migration. Additional criteria that will be considered in evaluating any potential acquisition or boundary expansion include: the location of the property and ease of access for management; how the property will help to fulfill Reserve purposes; the level of effort and resources required for management of the property; and the level of community support for acquisition of the property. Reserve stewardship and administrative staff will evaluate each potential acquisition and boundary expansion to ensure that the acquisition will result in a net gain for the Reserve. Results of planned and future vulnerability assessments will be incorporated as appropriate into acquisition planning and prioritization.

Existing tools developed by the State and conservation partners may be used to assess and prioritize properties under consideration for acquisition. For example, the N.C. Conservation Planning Tool scores parcels in a variety of categories, four of which are applicable to the NCNERR mission: Biodiversity and Wildlife Habitat, Open Space and Conservation Lands, Water Services, and Marine and Estuarine Resources. This and similar tools will be incorporated where effective to provide an objective measure of the conservation value of potential acquisitions and inform acquisition decision making.

VI. Administration Plan

Administrative Plan Overview

Administration of the NCNERR advances the operations, infrastructure, and stature of the NCNERR to support and enable the implementation of the education, training, research, and stewardship programs to fulfill its mission. The administration team includes the Reserve Manager, and the Education, Training, Research, and Stewardship Coordinators. Administration encompasses a wide range of activities including providing long-term direction and vision for the program; working with NOAA, DCM, and strategic partners to fulfill program requirements and address needs; ensuring that rules and policies result in program compliance with authorities and relevant laws; overseeing day-to-day operations; assessing and addressing infrastructure needs; appropriately staffing the Reserve, and providing staff with the skills and resources necessary to perform their jobs and do it safely; and communicating the work and value of the NCNERR and relevant coastal and estuarine ecosystem and management information to target audiences. This work is described herein as the administration plan, and includes the staffing plan.

Organizational Framework

NERRS operates as a federal-state partnership. OCM provides direction, funding, and review for the System and individual Reserves and state partners manage the individual Reserves.

Office for Coastal Management (OCM)
Direction is provided by the OCM through the NERRS Strategic Plan and regular interaction with Reserve managers and sector coordinators. Coordination between the federal and state partners is provided by OCM program specialists. The program specialist communicates directly and regularly with Reserve staff, building a level of trust between the partners and familiarizing the federal and state personnel with NERRS and Reserve management procedures and policies.

Section 315 of the CZMA provides non-competitive operations funding and competitive construction and acquisition funding for the System. The OCM administers these funding programs and program specialists review operations work plans through annual cooperative agreements and performance reports to ensure compliance with program policies and special award conditions. The OCM provides technical assistance and oversight of system-wide programs such as the SWMP, CTP, and the KEEP.

The OCM also conducts performance evaluations on the operation and management of individual Reserves pursuant to sections 312 and 315 of the CZMA. The purpose of NOAA review is to ensure that a state partner is complying with NERRS goals, approved funding agreements and work plans, and Reserve management plans. Deficiency findings must be addressed in operation awards and management plan updates in an appropriate and timely manner to avoid withdrawal of National Estuarine Research Reserve designation.

North Carolina Division of Coastal Management (DCM)

The state partner in the NCNERR federal-state partnership is the North Carolina Department of Environmental Quality's (formerly the Department of Environment and Natural Resources) Division of Coastal Management (DCM) (Figure 19). The DCM carries out the state's CAMA, the Dredge and Fill Law and the federal CZMA of 1972 in the 20 coastal North Carolina counties, using the rules and policies of the N.C. Coastal Resources Commission. Per CAMA, the NCNERR is administered by DEQ. CAMA also states that DEQ "shall consult with and seek the ongoing advice of the Coastal Resources Commission" (G.S 113A-129.2 (b)).

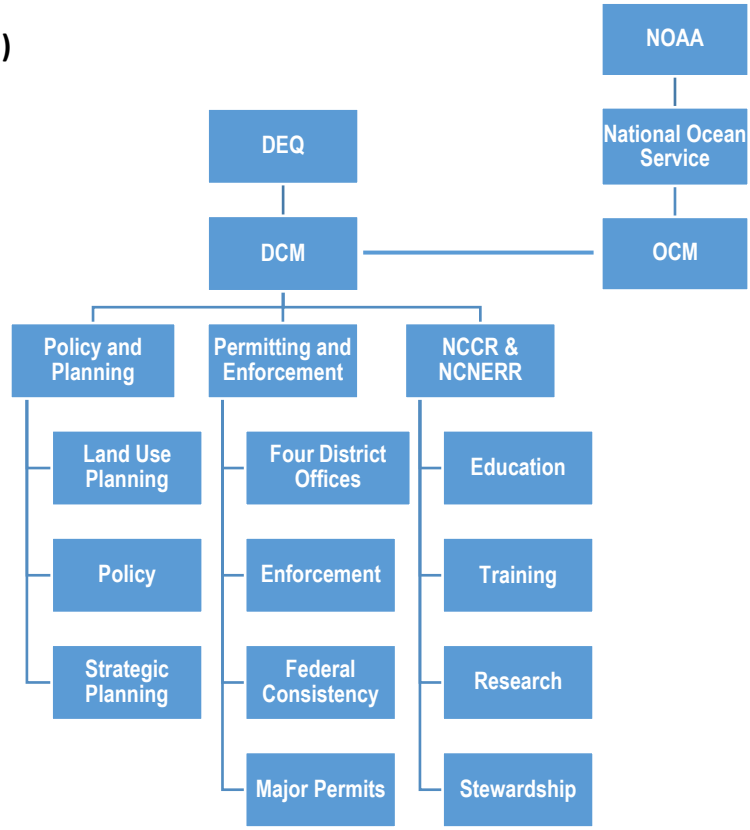

Figure 19. NCNERR Organizational Framework Chart

The organizational chart for DCM is presented in Figure 19. The Division is organized into three sections: Policy and Planning, Permitting and Enforcement, and the North Carolina Coastal Reserve (NCCR), which includes the NCNERR.

The DCM is an appropriate state partner for the NCNERR because:

- The organizations have complementary missions as both are authorized by the CZMA to protect coastal resources. This partnership embodies the original vision of the CZMA for holistic and more effective coastal management;
- Both organizations address relevant coastal management issues, and a broad range of expertise, programming, and results is available to inform section-specific issues and broader coastal management topics and initiatives where collaboration is appropriate; and
- There is a cost-savings to both programs as 315, 306, 306A, and 309 funds are managed by one agency and are leveraged to achieve collective efforts.

The Reserve Manager participates in DCM Director-led bi-weekly section coordination meetings that bring together Reserve, Planning and Policy, Regulatory and budget staff. Monthly DCM budget meetings are also

held. Examples of collaboration include: development and review of policy and rules; discussion and alignment of program planning documents such as the NCNERR management plan and DCM's 309 Program Enhancement Strategy; cross-section workgroup on living shorelines to collaboratively promote this technology where appropriate through policy, permitting, research, training, and outreach; and delivery of external and internal trainings through the CTP that address barrier island, wetlands, and estuarine shoreline regulations that the Division implements.

Strategic Partnerships

The administration of the NCNERR is achieved through a collaborative process involving the following strategic partners. These partners perform core functions of the NCNERR such as providing facilities and staff, collaborating on and implementing programs, and enforcing relevant rules and laws.

Center for Coastal Fisheries and Habitat Research (CCFHR)
The CCFHR, part of NOAA's National Ocean Service's National Centers for Coastal Ocean Science (NCCOS), manages the NOAA Beaufort Laboratory on Pivers Island where the NCNERR's central office is located. Location of this NCNERR office at CCFHR provides quick access to the Rachel Carson Reserve which is across the waterway from Pivers Island and a variety of opportunities for collaboration. CCFHR and NCNERR share the administration building which was constructed in 2007 and provides office space for Reserve staff, a teaching classroom, and an auditorium. Outside facilities support field operations and programming. The NCNERR and CCFHR are currently developing an agreement and it will be made available when complete.

Co-locating the Reserve with CCFHR provides mutual benefit to the parties in fulfilling NOAA's Next Generation Strategic Plan objectives of *improved understanding of ecosystems to inform resource management decisions*, and *healthy habitats that sustain resilient and thriving marine resources and communities*, and addressing NCCOS's science priorities: environmental stressors, resilience and coastal climate vulnerability, coastal and marine ecology, monitoring and detecting change, and social science. This partnership also supports the DCM's mission to *protect, conserve, and manage North Carolina's coastal resources through an integrated program of planning, permitting, education, and research* and the Reserve's mission to *practice and promote informed management and appreciation of North Carolina's coastal and estuarine ecosystems and provide protected sites for research, education, and stewardship.*

The NCNERR provides a science to management relationship between CCFHR and the coastal decision-maker community and a science to education connection between CCFHR and K-12 and community audiences. The Reserve and CCFHR enhance their respective research capabilities through collaborative partnerships addressing relevant coastal habitat and management-related questions consistent with their respective planning documents. Examples of collaborative work include ongoing research and monitoring on a range of estuarine shoreline stabilization techniques including comparisons to natural reference marshes; connecting CCFHR scientists to professional audiences at CTP workshops and K-12 student and teacher programs through

presentations on coastal and estuarine ecology and research; joint participation in the NCSSC, a collaborative effort to address sea level rise impacts by leveraging NOAA trust resources, ecosystem monitoring tools, and expertise; and living shoreline and stormwater best management practices demonstration and monitoring.

University of North Carolina Wilmington (UNCW)

The NCNERR has a long-standing relationship with the UNCW, which has provided office space and staffing support for the NCNERR since 1989. A significant percentage of the NCNERR's annual cooperative agreement is contracted to UNCW to fund three full-time contract positions and house the Reserve's southern office at the CMS where the contract employees and several temporary positions and seasonal interns are located. Waived indirect from this contract is used to meet the cooperative agreement's match requirement. This partnership allowed the NCNERR to expand its staff when the state was not able to create more staff positions and it provides a staff presence near and quick access to the Masonboro Island and Zeke's Island Reserves. A MOU between NCNERR and UNCW is available in Appendix J.

Co-locating the Reserve's southern office with CMS provides mutual benefit to the parties by supporting the mission of the University and CMS to *promote basic and applied research.* This partnership also supports the Reserve's mission to *practice and promote informed management and appreciation of North Carolina's coastal and estuarine ecosystems and provide protected sites for research, education, and stewardship.*

The Reserve provides a science to management relationship between the University and the coastal decision-maker community and a science to education connection between the University and K-12 and community audiences. The Reserve and the University enhance their respective research capabilities through collaborative partnerships addressing relevant coastal habitat and management related questions consistent with their respective missions.

This partnership with UNCW also allows for collaboration with UNCW's Biology and Marine Biology department, Environmental Studies department and the Shellfish Research Hatchery. Faculty and graduate and undergraduate students conduct research, education, and stewardship projects at the southern sites and NCNERR staff consult with faculty on site management and coastal resource issues. Examples of collaborative projects include water quality monitoring of CMS' seawater system intake using NERRS System-wide Monitoring Program protocols; general public programming on oysters and the Shellfish Research Hatchery; research and monitoring of diamondback terrapins at the Masonboro Island Reserve; and a 2016 NERRS Science Collaborative project in which UNCW faculty are examining the ecosystem services of shellfish aquaculture at the Masonboro Island Reserve and other similar sites.

Local Advisory Committees

The N.C. Administrative Code (15A NCAC 07O.0104) directs DCM to establish a LAC for each Reserve site. These committees serve as advisory groups, whereby members work with NCNERR staff to provide input and recommendations on stewardship, research and education activities at the sites, and review policies and implementation strategies for staff consideration. The committees operate per the Local Advisory Committee Operating Procedures document, updated October 2013. Available on the Reserve's website (www.nccoastalreserve.net), the Operating Procedures provide an overview of the NCNERR; outline the purpose and roles of the committees; describe membership including member selection, member responsibilities, and terms of service; and define committee meeting operation and administration.

LAC membership is comprised of community members and organizations, and relevant governmental agencies and non-governmental partner organizations that represent the NCNERR program areas, partners and user groups to provide diverse perspectives on management and program implementation at the NCNERR sites. Representation from these groups varies by committee based on the characteristics and needs of each Reserve site. Members are appointed by the Secretary of DEQ.

The committees are chaired and managed by NCNERR staff and meet at least annually. The meetings follow a standard agenda that includes Reserve-wide and site-specific updates, a member roundtable, and public input period.

Friends of the Reserve

Friends of the Reserve (FOR) is a non-profit 501(c)(3) organization that works exclusively to support the preservation, development and cooperation of the North Carolina Coastal Reserve and NCNERR for charitable, educational, and scientific purposes. FOR is a voice to speak on behalf of the Reserve and works to sustain and increase funding for the Reserve programs.

The FOR board of directors is comprised of representatives from across the coastal region to reflect the distribution of Reserve sites. The Reserve Manager serves on the board in an ex-officio capacity, ensuring that FOR is aware of and addressing NCNERR needs, and coordinating with existing NCNERR programs. A MOU between NCNERR and FOR is located in Appendix Q.

Additional Partners

The NCNERR also partners with a wide variety of agencies and organizations at various levels of engagement. A memorandum of understanding (MOU) between the NCNERR and a strategic partner is developed and periodically updated to set forth mutual expectations regarding partner roles that support operation of the Reserve. All MOUs are included in the Appendices of the management plan and are referenced throughout the plan as the partnerships are addressed.

Current Staff and Needs

An adequate staff is necessary to implement the management plan and to achieve the NCNERR's education, training, research, and stewardship goals and objectives. The NCNERR is currently staffed by nine full-time permanent positions employed by the DCM or UNCW, three long-term temporary staff, and a variety of seasonal interns and staff. Figure 20, the NCNERR organizational chart, indicates the employer and location of each full-time permanent position. Current staff responsibilities and duties are outlined below as is the list of future staffing needs and the rationale for each.

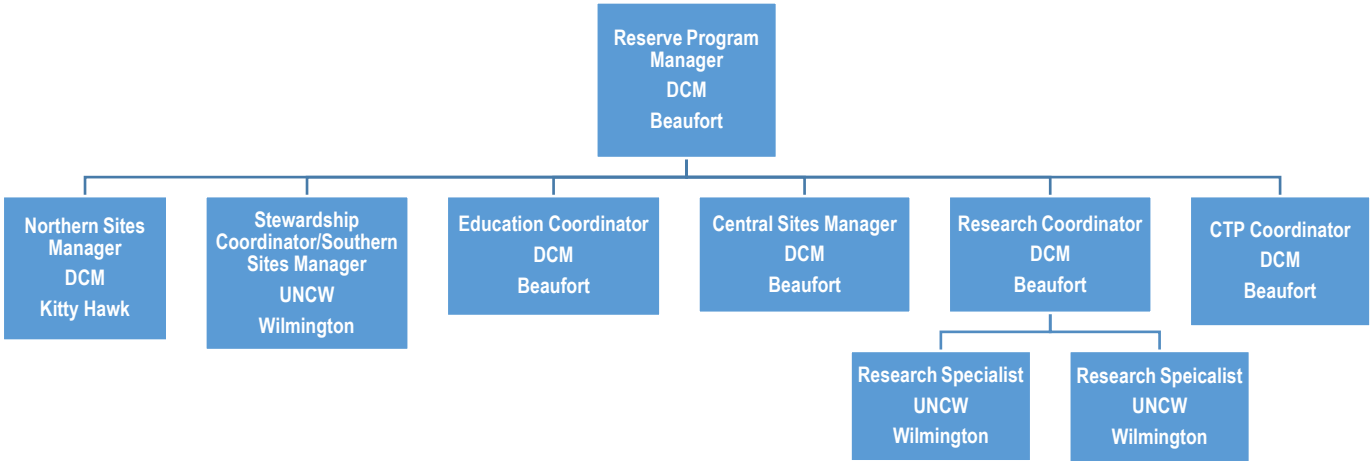

Figure 20. NCNERR Organizational Chart with Full-time Employees and Location

Full-time Staff Responsibilities and Duties

1. Reserve Program Manager:

- Fulfill Reserve mission, goals, and objectives
- Ensure the NCNERR's rules and policies are current and met, and that Reserve programs successfully meet the mandates of the NERRS and the DCM
- Seek and administer federal and other grants, contracts, and state budget appropriations
- Provide oversight and coordination of education, training, research and monitoring, and stewardship programs
- Supervise the following positions: Education Coordinator, CTP Coordinator, Research Coordinator, Stewardship Coordinator, Central Sites Manager, and Northern Sites Manager
- Develop and maintain partnerships with local, state, and federal agencies, groups and individuals to enhance NCNERR exposure and capacity at the local, state, regional, and national levels
- Maintain responsibility for all activities, lands, and facilities within the Reserve site boundaries and for office and laboratory facilities leased from partners
- Receive and evaluate input from LACs in coordination with stewardship staff

2. Education Coordinator:

- Manage and deliver the K-12 and college student education program, educator professional development program, and community education and outreach program in accordance with the NCNERR management plan and NERRS and DCM mandates
- Supervise temporary staff and summer interns
- Provide regular guidance and direction to the temporary Stewardship and Education Specialist in Wilmington on education activities
- Produce educational materials including curricula to meet educator needs
- Develop and maintain partnerships to enhance education programs
- Administer education grants and budgets
- Work with the CTP to ensure complementary and consistent education and training programs where appropriate and assist with CTP workshop logistics
- Coordinate with research staff on current research developments at the local and national level for translation into education activities
- Meet with K-12 education advisory committee annually to discuss current educational programming and seek input on programs
- Represent the NCNERR at local, state, and national levels by serving on boards, committees, and workgroups
- Represent NCNERR at festivals and meetings and develop content for such events for NCNERR staff
- Assist with Rachel Carson Reserve site management and research and stewardship programs as needed

3. Coastal Training Program Coordinator:

- Deliver workshops for coastal decision-makers based on formal and informal needs assessments in accordance with the North Carolina CTP Strategy document on key coastal issues, the NCNERR management plan, and NERRS and DCM mandates
- Provide technical assistance to partners and customers including meeting design and facilitation
- Meet minimum CTP performance requirements and submit appropriate reporting
- Develop and maintain partnerships to enhance the CTP
- Administer CTP grants and budget
- Produce materials to support workshop issue areas
- Represent the NCNERR at local, state, and national levels by serving on boards, committees, and workgroups
- Supervise temporary Communication Specialist
- Coordinate with research staff on current research developments at the local and national level for translation into training activities
- Work in close collaboration with the education program to ensure complementary and consistent education and training programs where appropriate and assist with education program field trips
- Assist with Rachel Carson Reserve site management and research and stewardship programs as needed

4. Research Coordinator:

- Coordinate all research and monitoring activities performed within the NCNERR in accordance with the NCNERR management plan and NERRS and DCM mandates
- Administer the Reserve research permits, which are utilized as a 312 performance measure, and maintain the NCNERR portion of the NERRS research database
- Foster partnerships to link the Reserve research and monitoring program to other relevant state, federal and university activities in the state and region to enhance program implementation
- Conduct research and long-term monitoring projects on the NCNERR sites that address Reserve topical areas and site-based research needs as well as local, state, and national coastal management needs
- Administer research and monitoring grants and budgets
- Supervise Research and GIS Specialists and summer interns, including providing guidance to graduate research fellows
- Translate research and monitoring results for incorporation into various formats to reach target audiences, including scientific and management communities
- Represent the NCNERR at local, state, and national levels by serving on national, state, and local boards, committees, and workgroups
- Coordinate with education and training staff on research developments at the local and national level for potential incorporation into education and training activities
- Work with stewardship staff to prioritize research projects to address site management needs and identify potential funding opportunities relevant to priority research projects
- Assist with Rachel Carson Reserve site management and education, training, and stewardship programs as needed

5. Research Specialists (2):

- Implement the System-wide Monitoring Program in accordance with NERRS and the CDMO requirements
- Procure and maintain SWMP equipment and supplies
- Deploy equipment as scheduled
- Conduct Quality Assurance /Quality Control procedures on data and prepare annual reports for submittal to CDMO
- Conduct Reserve research projects and perform data analyses in collaboration with the Research Coordinator
- Represent the NCNERR by serving on boards, committees, and workgroups
- Assist the Research Coordinator with grant proposals, preparation of manuscripts for publication, presentations and other outreach activities
- Assist the Research Coordinator with developing and maintaining partnerships to further research programs
- Assist the Research Coordinator with managing the research budget
- Assist with Masonboro Island and Zeke's Island Reserves site management and stewardship, education and training programs as needed

6. Stewardship Coordinator and Southern Sites Manager:

- Manage the stewardship program in accordance with the NCNERR management plan and NERRS and DCM mandates, coordinating with the Reserve Program Manager, Northern Sites Manager, and Central Sites Manager on activities performed at and across the sites and site management policies and issues
- Develop and implement stewardship policies and rules in coordination with Reserve Program Manager
- Manage the Masonboro Island and Zeke's Island Reserves
- Conduct Masonboro Island and Zeke's Island LAC meetings
- Supervise the temporary Stewardship and Education Specialist, seasonal staff, and interns*
- Administer stewardship grants and budgets
- Develop and maintain partnerships to enhance stewardship programs
- Represent the NCNERR at local, state, and national levels by serving on boards, committees, and workgroups
- Link the Reserve stewardship program to other relevant state, federal, and university activities in the state and region
- Manage a volunteer force to support site activities
- Deliver community outreach and education programs as requested and resources allow
- Facilitate and assist with research at the sites in conjunction with research staff as needed

*Stewardship is accomplished in conjunction with the Reserve Program Manager as the Stewardship Coordinator does not supervise the site managers.

7. Central Sites Manager:

- Manage the Rachel Carson Reserve
- Coordinate with the Stewardship Coordinator and Northern Sites Manager on site activities, policies, and issues
- Conduct Rachel Carson Reserve LAC meetings
- Develop and maintain partnerships to enhance stewardship programs
- Supervise seasonal staff and interns
- Assist the Stewardship Coordinator in administering stewardship grants and budgets
- Captain Reserve vessels to deliver education programming
- Manage a volunteer force to support site activities
- Represent the NCNERR by serving on boards, committees, and workgroups
- Deliver community outreach and education programs as requested and resources allow
- Facilitate and assist with research at the Rachel Carson Reserve in conjunction with research staff as needed

8. Northern Sites Manager:

- Manage the Currituck Banks Reserve
- Coordinate with the Stewardship Coordinator and Central Sites Manager on site activities, policies, and issues

- Conduct Currituck Banks Reserve LAC meetings
- Develop and maintain partnerships to enhance stewardship programs
- Supervise temporary staff and interns
- Assist the Stewardship Coordinator in administering stewardship grants and budgets
- Manage a volunteer force to support site activities
- Represent the NCNERR by serving on boards, committees, and workgroups
- Deliver community outreach and education programs as requested and resources allow
- Facilitate and assist with research at the Currituck Banks Reserve in conjunction with research staff as needed

Temporary Staff Responsibilities and Duties

Long-term temporary staff positions are those that are critical for the operation of the program but permanent positions have not been created and who are employed for a longer period than summer seasonal staff. These positions are also listed in the staffing needs section below for this purpose. These positions are staffed when funding is available.

1. Geographic Information Systems (GIS) Specialist (Central Office):

- Provide GIS services on a wide variety of geospatial needs including dataset, tool, and map development
- Manage the GIS databases and files
- Maintain and update GIS/GPS software and equipment as needed
- Conduct SWMP-like monitoring at the Rachel Carson Reserve
- Assist with education, research, and stewardship programs as appropriate
- Support Division-wide GIS needs

2. Communications Specialist (Central Office):

- Implement outreach campaigns that support education, training, research, and stewardship activities
- Disseminate Reserve research products and results to increase understanding of their importance to public policy
- Develop and maintain website content
- Develop and disseminate triannual Reserve newsletter
- Implement social media strategy for Reserve communications
- Disseminate communication pieces to local media

3. Stewardship and Education Specialist (Southern Office):

- Support stewardship program implementation and site management at Masonboro Island and Zeke's Island Reserves including monitoring and documenting site conditions and uses; maintaining trails and implementing access improvement projects; and assisting with site management projects
- Coordinate daily operation of species of concern monitoring activities

- Conduct outreach and community engagement activities including managing volunteers; delivering outreach programs and representing the NCNERR at festivals; and supporting communications activities for the southern office
- Support stewardship program administration and logistics

Seasonal Temporary Staff Responsibilities and Duties

The NCNERR employs a variety of seasonal temporary staff and interns to accomplish spring, summer, and fall field activities and to deliver and assist with summer programming. These positions also provide valuable training and program experiences for the students and entry level professionals that fill them. Typical seasonal temporary staff and intern positions include a stewardship intern at the northern office; two to three positions to support education, stewardship and research activities at the central office; and at least three stewardship positions at the southern office. The number of positions varies year to year based on need and funding availability. The positions are funded through 315 funds and the North Carolina State Internship Program. The North Carolina Internship Program provides students with professional work experience that connect their classroom experiences and potential career choices.

Staffing Needs

The geographic distribution of the NCNERR sites resulted in a regional parsing out of programs due to program priorities and location of staff early in the program's implementation. Evaluation of programs, facilities, current staffing levels, and projected staffing needs revealed that there are needs and opportunities for programs at all offices as well as administrative assistance to facilitate operation of the NCNERR. Staffing needs identified in this plan are long-term needs that the program has identified to enhance capacity to meet current workload demands and more fully implement system-wide programs across the sites. The Reserve Program Manager will work to develop position descriptions, seek funding and establish the positions through DCM or UNCW as funding resources allow, without detriment to current programs and based on priority needs. These staffing needs are not necessarily listed in the order of priority and because the order in which positions may be created is unknown, allocation of actual job duties may be adjusted to reflect priority needs at the time of position creation.

1. Create full-time permanent positions for the GIS Specialist, Communications Specialist, and Stewardship and Education Specialist temporary positions that are described in the temporary staffing section above.
    a. The NCNERR previously had a full-time permanent GIS Specialist position through UNCW; however, the position was eliminated as a result of budget reductions. The NERRS recognizes that GIS support is critical to the operation of a reserve and ongoing GIS needs at the NCNERR justify creation of a permanent position.
    b. The Communications Specialist position provides critical work to enhance the NCNERR's visibility, and communicate responsible use of the sites and research projects and results

with target audiences. These focus areas represent three of the four themes identified as priorities at the 2014 public input sessions.

c. The Stewardship and Education Specialist increases the capacity of the Stewardship Coordinator and Southern Sites Manager by assisting with site management at the Masonboro Island and Zeke's Island Reserves. The 2009 NCNERR 312 Evaluation recommended creating a full-time permanent Southern Sites Manager to address similar activities (see below), alleviating excessive workload from the Stewardship Coordinator and Reserve Manager. The Stewardship and Education Specialist position delivers outreach to New Hanover and Brunswick Counties that the Masonboro Island LAC and 2014 public input sessions identified as needed and vital to enhance community understanding of the NCNERR and engagement. These duties are combined into one position to maximize available funds and address two priority needs.

2. Administrative Assistant (Central Office)

The NCNERR does not currently have any dedicated administrative assistance although the DCM Morehead City Office Manager does provide contractual and purchasing support. The program staff in each office has taken on many of the administrative duties themselves to ensure operation of the program and offices. As the program has grown, however, the time spent handling administrative duties such as ordering supplies, making copies, managing grants and contracts, and maintaining office equipment and vehicles, has increased. An administrative assistant located in the central office will assist the three Reserve offices in accomplishing administrative tasks, thereby resulting in more efficient operations and relieving program staff of these duties and providing them with more time for program development and implementation. The 2009 NCNERR 312 Evaluation recommended providing administrative assistance on at least a part-time capacity.

3. Assistant Manager (Central or Southern Office)

The implementation of the Reserve Strategic Plan and programs at the four NCNERR sites given the differences and distances between the sites will benefit from the addition of an Assistant Manager. The purpose of this position will be to support the Reserve Manager with daily operation of the Reserve as well as maintain responsibility for discrete tasks based on need and skill. This will provide the Reserve Manager with more time for broader partnership development, coordination at the state, regional, and national levels, and fundraising for the NCNERR given its unique characteristics described above and the Manager's additional responsibilities of managing the NCCR.

4. Reserve Specialist (Northern Office)

The Currituck Banks site offers many exciting research, stewardship, and education opportunities. Creation of a Reserve Specialist position in the northern office will allow staff to better take advantage of these opportunities. While priorities will be assessed at the time of establishment, this position may allow for the reintroduction of SWMP-like water quality monitoring at the site

and additional SWMP, research, stewardship, training, education and outreach activities. The remoteness of the site also presents a safety concern when the Northern Sites Manager is in the field alone and the two positions will support each other while in the field. Workload challenges and the lack of assistance and colleagues in the northern office are cited as reasons for previous employees leaving the Northern Sites Manager position. The establishment of this position will address these concerns, thereby enhancing longevity in the Northern Sites Manager position. The Reserve Specialist's duties will be informed by the Research Specialist and temporary Stewardship and Education Specialist duties, and be supervised by the Northern Sites Manager, and work closely with research and education staff.

5. Southern Sites Manager (Southern Office)
   The Stewardship Coordinator is currently responsible for implementing the stewardship program and initiatives at all four sites in conjunction with other stewardship staff while also implementing a variety of site management and public access activities at the two southern sites, Masonboro Island and Zeke's Island. Given the complexity of the issues at the two southern sites and the distance between all four sites, it is necessary to create a Southern Sites Manager position. This will allow the Southern Sites Manager to focus on management of the Masonboro Island and Zeke's Island Reserves and the Stewardship Coordinator to focus on implementation of the stewardship program for the NCNERR. The 2009 NCNERR 312 Evaluation recommended creating a full-time permanent Southern Sites Manager for these reasons. This position will emulate the Northern Sites Manager duties and will be supervised by the Reserve Program Manager or Stewardship Coordinator.

6. Volunteer Coordinator (Northern, Central, or Southern Office)
   A Volunteer Coordinator will assist the Reserve in managing its volunteer program. Duties of a Volunteer Coordinator may include supporting volunteer activities at all four NCNERR sites; produce a volunteer needs assessment; write duty statements for each volunteer position or function; streamline the policies and procedures for recruiting, screening, and placing volunteers; determine volunteer recognition procedures and award scales; develop volunteer orientation and training programs, including a comprehensive docent training program; track and report volunteer hours; and recruit new volunteers through outreach to schools, non-profits, civic organizations, and businesses near the Reserve sites. Volunteers play an important role in enhancing program visibility of and community engagement in the NCNERR, both of which were themes identified at the 2014 public input sessions.

7. Education Specialist (Southern Office)
   Many education and outreach opportunities exist at the Masonboro Island and Zeke's Island Reserves. Creation of an Education Specialist position in the southern office will allow staff to better take advantage of these opportunities as education and southern office staff already have full workloads. Duties of the Education Specialist will include the following: deliver outreach

programs; represent the NCNERR at festivals; assist with the Masonboro Island Explorer program; assist the Education Coordinator in delivering teacher workshops in the area; assist the CTP Coordinator in delivering trainings in the area; and support communications activities for the southern office. Expanding education and outreach programming in New Hanover and Brunswick Counties is important because this area is the most densely-populated area of the coast and two of the four NCNERR sites are located in this area. Additionally, the Masonboro Island LAC and 2014 public input sessions identified local education staff as needed and vital to enhance community understanding of the NCNERR and engagement.

Administrative Objectives and Actions

The NCNERR administrative goal, objectives, and actions ensure the administrative, operational, and financial capacities of the Reserve are adequate to effectively support the programmatic and topical area goals, objectives, and actions.

Goal 4: The NCNERR is recognized as a leader in coastal and estuarine ecosystem research, training, education, and stewardship through effective administration and communication strategies.

Objective 4.1 Rules and policies assist in fulfilling the Reserve's mission and local, state, and federal laws.

Action 1: Evaluate and update rules through the Rules Review Process.

The Reserve's rules in the N.C. Administrative Code, 15A NCAC 07O, are scheduled to be reviewed by the Rules Review Commission in June 2017 as part of the mandated Legislative Periodic Review and Expiration of Existing Rules process (G.S. 150B-21.3A). This process requires review of existing rules every ten years, which is summarized in a report submitted to the Rules Review Commission. Work to implement this process began in 2016 with the classification of each rule in 07O as necessary with substantive public interest, necessary without substantive public interest, or unnecessary per G.S. 150B-21.3A (c)(1). Input was sought on the classification from the LACs, N.C. Coastal Resources Commission, DEQ, and public through a noticed public comment period to inform the report to the Rules Review Commission. After the Rules Review Commission and Joint Legislative Administrative Procedures Oversight Committee review the report, rules that need to be readopted based on the rule citation classifications will go through the rule readoption process scheduled to begin in fall 2017. The rules will be evaluated and updated, and any proposed amendments to the rules will be considered during this process. Rule changes may be considered to update and clarify existing language and address gaps and changing site conditions and uses to ensure staff and law enforcement partners are able to protect the Reserve's natural resources, ensure safe public use of the sites, and achieve an appropriate balance between uses at the sites. Proposed rule changes will be developed by Reserve, Division, and Departmental staff with input from the LACs and the N.C. Coastal Resources Commission. See also Objective 3.1 Action 6.

Action 2: Update policies as needed based on program and site conditions.

Policies provide additional guidance and clarification to rules on uses and management of the sites. Site conditions and uses change over time and these changes may warrant review of existing policies or development of new policies. Policy changes provide the opportunity to adjust guidance as needed based on the best science and information available at the time to address specific situations as they arise. Potential policy changes will be developed by Reserve and Division staff with input from the LACs. See also Objective 3.1 Action 6.

Action 3: Inform rule and policy updates with program and site assessment information.

Program and site assessment information will be used to provide the best available information on program implementation, site natural resources, and site uses to inform rule and policy updates. Formal data collection efforts such as those described in Objective 4.3 Action 3 will be used as well as less formal but equally important methods including staff observation and documentation, third party reporting, and staff and partner investigation.

Objective 4.2 Reserve core partnerships are enhanced.

Action 1: Strengthen relationship with OCM through annual cooperative agreements and performance reports, and by addressing federal evaluation recommendations, participating in national meetings, and contributing to system-wide initiatives.

OCM is the federal agency in the Reserve's federal-state partnership and it is critical to maintain and strengthen the program's relationship with OCM to ensure that the Reserve is meeting NERRS standards and implementing national system initiatives. Annual cooperative agreements set forth the work plan for the Reserve each year based on the approved management plan, utilizing the federal and state funds that contribute to the Reserve's annual budget. The agreements are developed by the Reserve and approved by OCM, and align with the state fiscal year. Bi-annual performance reports document progress on the cooperative agreements. Progress on federal 312 evaluation recommendations and NCNERR 312 performance measures are reported on annually. Engagement at the system-wide level is important to inform national guidance documents such as the strategic plan and national priorities and to share the NCNERR perspective. This is accomplished through attendance at national and sector meetings and participation in NERRS workgroups. Current examples of NCNERR contributions to system-wide initiatives include staff participation on the SWMP data management and oversight committees, the TOTE workgroup, and the CTP Oversight Committee.

Action 2: Strengthen relationship with DCM by providing technical expertise on education, training, research, and stewardship, and collaborating on mutually beneficial activities and topics.

DCM is the state agency in the Reserve's federal-state partnership and it is important to ensure that the Reserve provides technical expertise and assistance on appropriate and mutually beneficial activities and topics. Current examples of this include CTP assistance on DCM grant planning

workshops and delivery of workshops on barrier island and estuarine shoreline science and regulations. Reserve staff leads and participates in the Division's living shoreline workgroup providing coordination across the Division's programs and training, outreach and research on living shoreline-related priorities. DCM planning and policy and regulatory staff contribute expertise and assistance to Reserve staff on Reserve topics and issues as needed such as shellfish aquaculture policy development. Collaborative opportunities are developed as needs arise through ongoing communications, development and implementation of both Reserve and coastal program cooperative agreements, and implementation of the coastal program's 309 Strategy.

Action 3: Strengthen relationship with UNCW and CCFHR through regular communication with partner administrations, finalization and implementation of memoranda of understanding, participation in facility committees, and collaboration on mutually beneficial activities.

The NCNERR shares facility space with UNCW and CCFHR, employs contract staff through UNCW, and collaborates with both organizations on a variety of mutually beneficial activities. Regular communication between facility leadership and staff is critical to ensure smooth operations and that Reserve, UNCW, and CCFHR needs are communicated and met. This is accomplished through CCFHR lab management meetings and meetings as needed with the CMS Director and CCFHR Director. Staff participate in facility committees such as the Beaufort People Committee, the UNCW Outdoor Spaces Committee as well as participate in several CMS Research Collaborative Meetings. The Reserve and CCFHR continue to work to develop an agreement between the organizations. The Reserve and UNCW will update its MOU in 2017. Collaboration on mutually beneficial activities is developed based on partner needs and expertise. Currently, the Reserve and CCFHR partner on marsh monitoring and living shoreline projects, and stormwater best management practices evaluation. The Reserve and UNCW partner on a wide variety of research projects and water quality monitoring, and Reserve staff employ and mentor student interns and volunteers working on specific stewardship and research projects.

Action 4: Maintain and strengthen education, training, research, and stewardship activities through formal and informal partnerships.

Partnerships are key to the success of the NCNERR and its education, training, research, and stewardship programs. The capacity section of each program chapter in this plan describes the diversity of partners that the program works with to achieve program and partner goals. NCNERR partnerships include long-term formal arrangements codified via memoranda of understanding (See appendicies); externally funded project-specific work; joint collaboration on projects that meet mutually beneficial needs; and utilization of space in partner facilities to conduct programs. Partnership development and enhancement is conducted by program staff with support from the Reserve Manager.

Objective 4.3 Reserve operations support the implementation of the mission.

Action 1: Utilize a collaborative decision-making process and effective internal communication mechanisms to provide direction for the Reserve, foster understanding regarding decision-making, and ensure that programs are appropriately supported.

The staff of the NCNERR is distributed across three offices that are considerable distances from one another. As such, it is important to provide regular and open mechanisms for communication and decision-making. Staff meet as follows: monthly coordinator meetings with the Reserve Manager and program coordinators; all staff meetings that occur approximately three times per year; stewardship meetings scheduled as needed; and monthly meetings with supervisors. Agendas for the coordinator and stewardship meetings are shared with all staff, who are also invited to attend, to promote awareness of business that will be conducted.

The coordinator meetings are used to provide administrative and program updates; discuss Reserve-wide input and/or approaches on projects and documents; plan and implement the annual cooperative agreements, including cross-sectoral activities; and discuss budget and Reserve priorities. Staff shares input at these meetings on temporary staffing, program, and office needs and priorities are discussed. The Reserve Manager utilizes this input to allocate funding to address priorities as available.

All staff meetings provide opportunities for information sharing through broader administrative and program updates and project presentations; gathering Reserve-wide input on priorities, projects, and documents relevant to all staff; conducting cross-sectoral work; enhancing safety through presentations and discussions; and strengthening relationships.

Stewardship meetings provide a venue for staff to discuss topics relevant to the stewardship program, plan stewardship initiatives, collaborate on site management strategies, and work together to develop policies and rules. This opportunity for information sharing and problem solving supports staff in their daily, individual work as site managers. Education, training, research, and communications staff attend stewardship meetings as needed to accomplish cross-sector goals and to promote an integrated approach to the Reserve's stewardship efforts.

The Reserve Manager and Research Coordinator meet monthly with their direct reports to provide regular opportunities to receive and share updates, follow-up on action items, and discuss successes, issues, and concerns. This has proven to be very helpful for staff across the program, whether they are located in the same office as their supervisor or not.

Additionally, a number of Reserve documents that are critical to the operation of the Reserve are accessible by all staff on a shared drive to promote efficient and transparent communication. Examples include budget tracking sheets, program and office needs list, purchasing list, active cooperative agreement and grant list, LAC membership, and volunteer tracking.

Action 2: Ensure the Reserve's organizational structure supports staff and programs, including addressing staffing needs as resources are available.

The Reserve's organizational structure is described in the current staff and needs section of this chapter and reviews current full-time, temporary, and seasonal position responsibilities and duties as well as staffing needs. Temporary and seasonal positions are filled based on need and available funding. Staffing needs identified in this chapter are long-term needs that the program has identified to enhance capacity to meet current workload demands and more fully implement system-wide programs across the sites. The Reserve Manager will assess the Reserve's organizational structure on a regular basis to achieve efficiencies and better manage workloads, support existing staff, and create and fund new positions as opportunities to do so arise.

Action 3: Utilize appropriate databases and performance measures to track and evaluate program achievement, natural resources, and site use.

Federal and state authorities require that a variety of data are collected in the form of performance measures and research permits to ensure that the Reserve is meeting national standards and adhering to its rules. NERRS performance measures are reported bi-annually through performance reports and national databases. NCNERR 312 performance measures are reported annually through performance reports using national and NCNERR databases. The NCNERR maintains several internal databases and record keeping systems for gathering information to support these efforts and help staff better understand volunteer contributions and use of the sites. Information collected includes research permit applications and approvals, volunteer hours and numbers, LAC member attendance, and commercial use submitted voluntarily by known users. Additional processes will be developed under this management plan to document natural resources through a natural resource inventory database (See Objective 3.1 Action 7) and third party education program delivery (Insert education action reference). These data will be utilized to assess performance of the NCNERR at the national level and to document trends in volunteers, use, and natural resource condition.

Action 4: Maintain and enhance file and data storage and sharing methods and infrastructure to meet current and future needs.

A variety of efforts will be undertaken during the scope of this management plan to modernize file and data storage, sharing methods, and infrastructure, working towards a long-term, sustainable, and efficient approach to enhance access to files and data across the Reserve offices and ensure information preservation. Examples of specific projects that will be undertaken include: develop a site-based geodatabase, one for internal use and one for external use, to support program activities and management decisions that includes data such as easements, research permits, habitats, access points, trails and infrastructure; create and maintain an internal central repository for administrative documents, using Laserfiche where appropriate (e.g., memoranda of understanding, acquisition files); and transition LAC minutes to Laserfiche to enhance external accessibility.

Action 5: Practice excellent workplace safety for staff, volunteers, and visitors through effective procedures and appropriate equipment, supplies, and signage.

Excellent workplace safety is essential for staff, volunteers, and visitors to Reserve facilities and sites. Staff operate per the Reserve Safety Plan (Appendix R) which includes a matrix that identifies applicable mandatory Division and facility-specific safety documents including hurricane and disaster preparedness and response plans, relevant Departmental and UNCW standard operating procedures, and Reserve-specific standard operating procedures to address unique programs and situations both in the office and the field. Staff are provided with the necessary safety training, equipment, and supplies to ensure staff, volunteer, and visitor safety when working in the office and field. Safety briefings are provided at Reserve all staff meetings and prior to all Reserve-organized and led volunteer efforts and programs (Insert reference to stewardship and education actions).

It is critical that visitors understand site conditions and take the necessary precautions prior to visiting a Reserve site as the sites are often difficult to reach quickly in the event of an emergency given their remote locations and in some cases, accessibility only by boat. Site brochures and site information kiosks provide information about how to visit the sites safely.

Action 6: Demonstrate sustainable and best management practices through use of appropriate supplies, materials, and methods.

The Reserve seeks to lead by example utilizing sustainable and best management practices throughout its work while reducing its environmental footprint. This action provides a filter through which all programs and methods are developed, implemented, and evaluated. Staff acquires sustainable office and program supplies and materials and pursues reuse/repurpose opportunities for items that no longer serve their original purpose. Examples include utilizing reusable and biodegradable/compostable workshop supplies and meeting supplies that contain recycled materials, and using digital copies of materials when possible to avoid excess printing.

Best management practices are demonstrated through projects and work conducted at office facilities and sites as needed and opportunities present themselves. Reserve facilities are owned and managed by partners; staff participate in facility-related initiatives that align with this action as appropriate. Facilities constructed at offices that directly support Reserve needs or on sites will incorporate the NERRS Sustainable Building Principles. Examples of projects that employ and test best management practices include the living shoreline demonstration project at the Rachel Carson Reserve and the stormwater best management practices at the NOAA Beaufort Laboratory.

Methods that utilize technologies that promote efficiencies in data collection, analysis, and delivery will be pursued by staff to promote sustainability and best management practices related to staff time and data management. Examples include using tablets to collect field data and Bad Elf Surveyor to ground truth habitat mapping.

Action 7: Strengthen community and partner involvement in Reserve programs through LACs.

LACs meet at least annually at the request of the Reserve. The committees operate per the Local Advisory Committee Operating Procedures (updated in October 2013). Community membership on the committees will be updated in fall 2017. The Operating Procedures document will be reviewed in 2018. Research, education, and training updates will be incorporated more fully into the committee meetings throughout the implementation of this management plan to provide the committees with a broader perspective of Reserve operations at the sites and in the region.

Action 8: Leverage state and federal investments in the Reserve through internal and external funding opportunities to address needs and advance Reserve initiatives.

Programming and projects conducted by the Reserve are limited by staffing capacity and available discretionary funds. The federal funding provided through annual cooperative agreements and state appropriations used to match federal funds are maximized to address needs and advance Reserve initiatives through collaborative discussions at the Reserve and Division levels. While progress was made to increase state fiscal support of the Reserve as a result of the 2005 312 Evaluation, the Reserve and Division will continue to work to increase state fiscal support of the Reserve to reduce the l reliance on federal funds to operate the Reserve.

Reserve staff will continue to seek external funding for discrete projects either directly or in conjunction with partners to enhance capacity and discretionary funding to address needs and expand initiatives that would otherwise not be conducted due to fiscal constraints. Care will be taken to ensure that projects considered can be accommodated in addition to current workloads, address high priorities as identified in this management plan and take advantage of unique opportunities and partnerships.

Objective 4.4 Staff are recognized as valued experts in their fields.

Action 1: Provide professional development opportunities annually to enhance and expand staff skills through appropriate means such as trainings and attendance at professional meetings.

Professional development opportunities ensure staff knowledge and skills are current in order to incorporate the latest information and techniques into programs and innovate novel approaches to Reserve and coastal management. Funding is allocated annually in the NCNERR cooperative agreement to support travel to attend trainings and conferences in and out of state. Specific opportunities are identified, such as the N.C. Science Teachers Association, while retaining the flexibility to attend trainings and conferences as opportunities arise.

Action 2: Encourage staff participation in local, state, regional, and national committees and workgroups.

Participation in local, state, regional, and national committees and workgroups allows staff to share their expertise and provide a local community and N.C. perspective to the topics. These opportunities

also enhance professional development through peer to peer learning and programming through committee and workgroup activities and networking. Staff are encouraged to participate in committees and workgroups that are relevant to and expand expertise and advance NCNERR priorities. Examples of current committee and workshop participation in addition to NERRS examples highlighted previously include the N.C. Oyster Steering Committee, APNEP science and education committees, and the NCSSC.

Action 3: Encourage staff to provide technical assistance to target audiences.

Technical assistance enables staff to work with program target audiences, partners, and local communities to address mutually beneficial coastal management issues at the local, regional, and national level. Staff are encouraged to lend skills and expertise to enhance collaboration and develop and implement approaches to solve challenges or address needs. Examples of current technical assistance include CTP leadership in the Town of Beaufort Stormwater Advisory Committee; stewardship leadership in diamondback terrapin population monitoring within the Masonboro Island Reserve; and research program participation in a marsh vulnerability assessment to gauge resilience to sea level rise and technical assistance on this national coastal management issue.

Action 4: Continue to promote Reserve programs through presenting at conferences, conducting public field trips, participating in partner events, and hosting volunteer activities.

NCNERR visibility is enhanced, services utilized, and value recognized by partners, target audiences and the public through program offerings and staff participation in a variety of activities. Staff promotion of the NCNERR's purpose, programs, and sites occurs regularly through the actions described above and through outreach activities such as public field trips and festivals, volunteer training and engagement, and sharing current work at conferences and with partners.

Action 5: Organize and host a symposium to deliver NCNERR program highlights to a variety of target audiences.

The NCNERR will organize and host a symposium to summarize and showcase program highlights to target audiences. Reserve staff will determine the ongoing frequency of these events based on the success of the symposium. A Reserve research symposium was hosted in February 2012 that was well received and this effort will expand on that success to include all programs. A cross-sectoral workgroup will work with the NCNERR program coordinators to plan the symposium including exploring successful models employed by other reserves within the NERRS and partner organizations, and considering timing to ensure that the symposium complements the timing of other coastal conferences in N.C. Aligning the symposium with upcoming anniversaries will also be considered.

Action 6: Provide students with skills to advance NCNERR programs and to inspire stewardship of coastal and estuarine ecosystems through a structured mentoring program.

Student involvement in the NCNERR is highly valued by staff and students because it enhances students' skills and experiences and accomplishes ongoing NCNERR work and discrete projects. Staff work with students in a variety of capacities such as paid and unpaid internships, independent study projects, fellowships, and graduate student committees that span all programs within the NCNERR. A cross-sectoral workgroup will formalize NCNERR's current work with students through development of a structured mentoring program that outlines opportunities and establishes expectations of staff and students. The workgroup will explore existing mentoring programs and incorporate relevant elements to develop a program that meets the needs of students and the NCNERR to advance the work of the NCNERR and train future coastal management professionals.

Objective 4.5 Reserve communications are enhanced to increase audience engagement and program visibility and share important information.

Feedback obtained during a fall 2014 series of public input and LAC meetings conducted to inform the update of the NCNERR management plan revealed there is more work to be done to enhance program recognition, furthering the need to maintain consistent messaging across programs and sites for the purpose of improving the program's visibility. This feedback was re-enforced by the 2016 NERRS Blue Ribbon panel report. Additional themes that arose from the public input process included sharing more information about research, better understanding visitor use, and enhancing and leveraging partnerships. As a result, the Reserve will implement the following communications actions that are designed to ensure information about the Reserve and its programs reaches target audiences, increase understanding about research conducted by staff and partners, encourage responsible use of Reserve sites, and share information that is relevant to Reserve and coastal management. These communication actions and the content developed as part of the actions will address threats and stressors that are common across the four NCNERR sites and align with the NCNERR Strategic Plan Topical Areas. The Reserve will develop deliverables and use various communications platforms, including social, digital, and print media, to distribute information to researchers, educators, students, citizens, visitors, professionals, volunteers, and partners.

Action 1: Brand the Reserve through consistent messaging and product format.

Style guides developed for the NCNERR outline appropriate design and messaging for presentations, publications, flyers, informational signage at sites, etc. to improve consistency and a cohesive understanding of the NCNERR mission and programs to audiences throughout the state. Staff will use the style guides to develop all public-facing documents and products. NCNERR, NOAA, and DCM logos and language are incorporated into these deliverables as appropriate.

Action 2: Develop messages and products that highlight site research and relevant coastal and estuarine topics.

Reserve-led and partner research activities and project milestones are highlighted in the Reserve newsletter and on the Reserve's website and social media platforms. This content is strategically designed to translate scientific results for relevant target audiences and increase understanding of how the NCNERR sites are utilized for research by the Reserve and partners. Messages and products on coastal and estuarine topics are developed as needed. For example, data downloads and technical papers on topics such as SWMP, invasive species, and ecosystem services are available on the NCNERR website. Research communications can facilitate incorporation of work into education and training programs (See Objective 1.1 Action 3 and 1.4 Action 3). For example, research on the effectiveness of marsh sills to stabilize shorelines during storm events are incorporated into CTP living shorelines workshops, and interactive habitat maps may be used to enhance K-12 field trips to Reserve sites. By distributing information through these outlets, a wide-range of audiences, from teachers and K-12 students to coastal decision-makers and researchers to the public, are informed of partner and Reserve-led research.

Action 3: Share Reserve accomplishments, upcoming activities, publications, data and resources on relevant coastal and estuarine topics to target audiences through the Reserve newsletter, website, and social media.

Reserve accomplishments and upcoming activities are shared on the NCNERR website, where information about programs and sites is readily available and continuously updated to inform target audiences and help unify programs and connect program activities to Reserve sites. The NCNERR website provides general site and program information, along with interactive maps, responsible use policies, short articles featuring recent program initiatives, and a calendar of Reserve events. A downloadable research permit, list of publications, links to real-time weather, water quality, and GIS data are available to students, researchers, and decision-makers for free. Downloadable, age-appropriate curriculum is available on the NCNERR website for educators looking for ready-made lesson plans to share in their classroom. Reserve staff also participate in public events and provide free handouts with information directing audiences to the website for access to these electronic resources.

The Reserve newsletter is distributed tri-annually and includes articles focused on various aspects of the Reserve research, education, training, and stewardship programs. Social media posts on the Reserve Twitter and Facebook pages direct target audiences to resources available on the NCNERR website as well as other NCNERR platforms such as the YouTube Channel and Flickr page. Additionally, program updates, site conditions, responsible use policies, and educational information about coastal and estuarine ecosystems are posted on the Reserve's social media pages on a daily and weekly basis. These communications mechanisms are designed to engage and expand target audiences, including coastal communities, technical professionals, researchers, and state and federal agencies. Partnerships are key to the work of the Reserve. Therefore, communications products highlight these partnerships by describing the role the partner plays in a project and by promoting the work of the partner.

Action 4: Share rules and policies that encourage safety and promote responsible use of sites by visitors.

Reserve staff communicate and promote safe and responsible use of the sites to visitors through interpretive signs, handouts, and website and social media posts in addition to sharing information directly with visitor and community groups. Messages describe responsible use actions that uphold Reserve rules and policies to protect Reserve ecosystems and balance a variety of uses at the sites. Messages also seek to increase the understanding of the value of coastal and estuarine ecosystems at the sites and how responsible use is important in maintaining this value. Site specific messages are developed and shared to address unique visitor use situations. Safety guidelines will be enhanced for each site and communicated through the mechanisms described above. This action will be conducted in collaboration with stewardship staff and supports Objective 3.2 in the stewardship plan. These communication messages and mechanisms allow staff to promote the importance of the sites and educate visitors about minimizing impacts and ensuring their safety.

Action 5: Increase Reserve presence in local media by connecting with reporters to share Reserve accomplishments, program information and opportunities.

Reserve staff are continuously striving to improve the visibility of the Reserve program. One way to accomplish this is by enhancing connections with local reporters to share upcoming events and program information. Stewardship, research, education, and training events that are open to the public are added to community event calendars and broadcasted on the internet and radio. Program opportunities for volunteers and professionals are pitched to reporters for local television and print news in an effort to reach a broader audience and improve the visibility of the program within coastal communities.

Action 6: Enhance engagement and improve Reserve online communication by incorporating more visuals, creating infographics, and exploring additional digital media.

Eye-catching infographics explain responsible use policies and provide educational information about estuaries. Infographics are distributed via social media, posted on the NCNERR website, and included in the Reserve newsletter. All social media posts include a photo or video for the purpose of boosting engagement and increasing followers. Social media metrics have shown that posts with visuals generate a greater response. Priorities for new forms of digital media, such as short, educational videos, will be identified and implemented to expand and inform audiences about Reserve programs and sites. Video content is uploaded to the NCNERR YouTube channel, a platform that provides easy to track viewer metrics and allows for seamless sharing on social media.

Action 7: Use online analysis tools to evaluate audience engagement.

Various online metrics are used to measure audience engagement. Google analytics is used to track page visits, especially to site pages and data download and curriculum pages. These metrics keep staff informed of how data and products are being used by different audiences. Facebook and Twitter track post activity on a daily basis and YouTube tracks viewer activity. Information shared through these avenues is analyzed and used to inform communications strategies based on how target audiences respond to content. The Reserve newsletter is distributed via Constant Contact, an online email

marketing service, which tracks link clicks, email opens, and allows for sharing on Reserve social media outlets. Digital strategies for communicating Reserve information are enhanced based on feedback obtained through online analytics.

VII. NCNERR Strategic Plan Topical Areas

To strengthen alignment of NCNERR programs and efforts with NERRS Strategic Goals and address public input, the NCNERR selected three topical areas of national, regional, state, and local importance: water quality, coastal and estuarine protection, and coastal hazards resilience. These areas were informed by current work and input from Reserve staff, public and local advisory committee meetings, partner surveys, and education and training needs assessments. The topical areas will serve as additional focus and investment for the NCNERR management plan and will be addressed through a strategic and integrated process utilizing the capacity of the NCNERR programs and leveraging its partnerships. The NCNERR is uniquely positioned to address these topical areas using an integrated approach via its education, training, research, and stewardship programs and network of protected sites. Connecting with partners on broader initiatives through collaboration, data sharing, and communication allows the Reserve to expand the scope of work relating to each topical area. The impetus to focus on these topics and the ability of the NCNERR programs to address them through a collaborative approach is described in this section. Each topical area includes objectives and actions that build on the current strengths of the NCNERR programs, address NCNERR needs, and advance work in the topical areas across geographic scales. Actions described in the NCNERR program plans that support topical area actions are noted.

Water Quality

One of the most significant issues for estuaries nationally is water quality. According to the Environmental Protection Agency's National Coastal Condition Report, the water quality index for the nation's coastal and estuarine waters, is rated as "fair," mostly due to degraded water clarity or increased concentrations of dissolved inorganic phosphorus (DIP) or chlorophyll *a*. The report also shows that the largest coastal areas with poor water quality are along the Southeast Coast, from North Carolina to Florida, due to environmental stressors like increased nutrient concentrations and reduced water clarity (National Coastal Condition Report, 2012). Degradation of water quality is considered a threat and stressor at each NCNERR site, as listed in the Introduction chapter of the management plan. Due to the national significance and local relevance of water quality, the topic has been selected as an area of focus in the NERRS Strategic Plan and a topical area for the NCNERR Strategic Plan.

Decline in water quality in and around NCNERR sites is due, in large part, to point source pollution from wastewater discharges and non-point source pollution from stormwater runoff. Land development, land use change, and stormwater management practices all impact water quality at NCNERR sites and associated watersheds. Long-term water quality monitoring is necessary to document changes in water quality and to begin determining trends in water quality and their connections to various coastal processes. NCNERR has a 20-year history of water quality monitoring which began in 1995 with the initiation of the standardized NERRS System-Wide Monitoring Program (SWMP). NCNERR's long history of implementing SWMP protocols make it a

valuable resource to provide and translate the best available data on local water quality conditions while placing them within a national NERRS-wide context.

NCNERR research staff collect and analyze various water quality parameters, such as pH, turbidity, dissolved oxygen, temperature, salinity, and chlorophyll *a*. These monitoring data can be used by a myriad of stakeholders for a variety of purposes. For example, commercial and recreational fisherman can use near real-time local air and water temperature data for planning fishing trips, and teachers incorporate SWMP data into lesson plans to help students understand how ecosystems are affected by changes in water quality.

NCNERR water quality data can provide valuable information to agencies that track water quality conditions and events such as algal blooms, fish kills, and shellfish closures, all of which can serve as indicators of poor water quality within coastal and estuarine ecosystems. One of the goals of the 2015 N.C. Coastal Habitat Protection Plan, a document intended to guide regulatory agencies in the management of fishery habitats, is to enhance and protect North Carolina's water quality. The Reserve's ability to couple long-term monitoring data with management practices provides an opportunity to study the effectiveness of different management practices and collaborate with water quality stakeholders to improve these methods and inform policy.

The Reserve's long-term research and monitoring on water quality continues to add to a large, robust dataset. However, there is a need to synthesize these data to assess trends and identify mechanisms that cause changes in water quality at NCNERR sites. The Research Program is looking to expand abiotic and biotic SWMP-like monitoring to all four Reserves which would allow research staff to draw conclusions relevant to each site as it pertains to threats to water quality. The Reserve also needs to continue to seek and maintain partnerships that integrate these data into larger monitoring efforts, thus broadening the utility of this research. It is also important to make water quality data more accessible, promote its use, and clearly demonstrate how and why it is relevant so that the use of these data by researchers, teachers, and coastal decision makers is increased.

NCNERR will work to integrate water quality research into education, training, and stewardship programs designed to educate and engage target audiences, such as the general public, students, and decision makers, about best management practices and restoration activities that improve water quality.

Objective T1.1: Increase knowledge of short and long-term water quality trends using data collected through SWMP and other water quality monitoring methods.

Action 1: Research staff continues SWMP monitoring and explores opportunities to expand SWMP monitoring.

> The research program is completing transition to upgraded water quality monitoring equipment to ensure the continued collection of high-quality data. The Reserve has established an agreement with UNCW to add an additional SWMP-like station at UNCW's CMS dock within the Masonboro Island Reserve and renewed the MOU with the NPS to continue SWMP-like abiotic monitoring at the Rachel Carson Reserve (Appendix K). Expanding SWMP-like water quality monitoring to Currituck Banks to

include all four Reserve sites would both expand NCNERR's partnership base and collect important data relevant to threats to water quality across a wide range of waterbodies, salinity and tidal amplitudes, and coastal populations. Research and stewardship staff are engaging partners to explore the opportunity to expand water quality monitoring at this site.

- Additional details can be found in Research Program Actions 2.1.3 & 2.1.4.

Action 2: Research staff helps to advance Reserve staff understanding of water quality concepts and the utility of SWMP and water quality data through professional sharing opportunities.

The collaboration between research and other Reserve staff to translate research projects and results into products and programs serves as a professional sharing opportunity that advances staff knowledge of water quality concepts. The research program works closely with other Reserve staff to accurately transfer research results and water quality concepts in a timely manner for incorporation into a wide variety of Reserve programming (See Objective 1.2). Professional sharing also occurs when staff from other sectors accompany research staff in the field to help collect data and maintain equipment.

-Additional details can be found in Research Program Action 2.2.4, Training Program Action 1.4.3, and Education Program Actions 1.1.3.

Action 3: Research staff and partners analyze and synthesize SWMP data to identify locally, regionally, and nationally significant trends and patterns.

Water quality monitoring data are analyzed yearly as part of the required NERRS QA/QC process. More in-depth analyses and syntheses of the research and monitoring data will be conducted with input from Reserve staff and partners to identify water quality trends and patterns.

- Additional details can be found in Research Program Action 2.1.6.

Action 4: Research staff networks with existing partners and forges new partnerships to integrate SWMP data into local and state-wide water quality monitoring programs.

Research staff actively communicate about available datasets, program capabilities, and products relating to water quality monitoring to relevant end users in an effort to integrate this data into broader monitoring programs through stakeholder groups, work groups, professional meetings and conferences, research collaborations, and the research permitting process.

- Additional details can be found in Research Program Action 2.2.1.

Objective T1.2: Integrate water quality concepts and Reserve water quality research into Reserve programs and products to improve understanding and awareness.

Action 1: Education and training staff works with research staff to incorporate water quality concepts and SWMP and water quality data into curricular activities, workshops for professionals, and other education programs.

Research staff work with education and training staff to incorporate data, tools, techniques, and research results into education and training materials and programs. Water quality analyses and syntheses will be used to create products that benefit all NCNERR programs. Water quality concepts and research are incorporated into educational curricula, field trips, the Masonboro Island Explorer program, TOTE workshops, classroom visits and summer programs. SWMP monitoring data can inform the development of curricula for K-12 education programs and inform workshop attendees of local, regional, and national water quality trends. Education staff will work with research staff to incorporate mobile, user-friendly data interfaces into student and teacher activities as more accessible online SWMP water quality data is developed and tablets are available for field programs. The Reserve will continue to provide field trip and/or field study experiences that include water quality concepts and monitoring for K-12 and college students.

Collaborations between the training and research staff ensure that every training program begins with the scientific reasons why coastal resources are protected, including the ecosystem services they provide. Stormwater and low impact development are core training program offerings and include water quality concepts and trends to aid in understanding the need for water quality protection. Additionally, research staff disseminate information through 10 or more forums annually, sometimes in conjunction with training program activities.

- Additional details can be found in Education Program Actions 1.1.3, 1.2.1, Coastal Training Program Actions 1.4.1, 1.5.2, and Research Program Actions 2.1.6, 2.2.1, 2.2.4.

Action 2: Research staff collaborates with other Reserve staff to develop communications products designed to increase awareness of water quality concepts, the Reserve's role in monitoring water quality, and available data.

Communications staff will promote SWMP activity and the benefits of continuous long-term monitoring of water quality at Reserve sites to target audiences via the Reserve's Facebook pages and Twitter page. Reserve staff will work with research staff to incorporate water quality data into site and program presentations.

- Additional details can be found in Administration Program Actions 4.5.2, 4.5.3.

Action 3: Reserve staff engages participants in field-based stewardship activities that promote the importance of water quality and its protection.

Staff across all programs will engage volunteers and/or program participants to take part in hands-on stewardship activities that promote good water quality such as marine debris clean-ups and marsh grass plantings at Reserve sites. Staff or other experts will connect the importance of water quality and its protection to the field activity by providing brief educational explanations to the participants.

- Additional details can be found in Stewardship Program Action 3.1.4 and Education Program Action 1.1.3.

Objective T1.3: Improve water quality in Reserve site watersheds.

Action 1: Reserve staff collaborate with partners on projects that promote stormwater management, habitat restoration, living shorelines, and low impact development.

The Reserve partners with CCFHR, UNCW, and others on projects that improve water quality in Reserve site watersheds. Currently the Reserve and CCFHR work together on marsh monitoring and living shoreline projects, as well as a stormwater best management practices evaluation. Living shoreline projects are also completed with a variety of partners including state agencies, IMS and UNCW. The Reserve and UNCW partner on water quality monitoring as previously described. The Reserve partnered with N.C. Coastal Federation and UNCW on a project that reduced the impact of non-point source pollution in the Masonboro Island Reserve watershed through volume reduction. The Reserve, Duke University Marine Lab and partners in the Town of Beaufort are removing marine debris from the Rachel Carson Reserve through a NOAA Marine Debris funded project. Training staff provide technical assistance to local governments on stormwater management and low impact development.

-Additional details can be found in Administration Program Action 4.2.3.

Action 2: Coastal Training Program staff delivers trainings and technical assistance on water quality best management practices.

The training program works closely with partners to facilitate workshops and core trainings on topics that protect and enhance water quality, such as low impact development basics, stormwater management and living shorelines to encourage implementation within Reserve watersheds. The training program also provides technical assistance to local communities for improvements related to water quality.

-Additional details can be found in Training Program Actions 1.4.1, 1.5.2 and Research Program Action 2.1.6

Action 3: Reserve staff incorporates watershed concepts and impacts of human choices into program activities.

The training and education programs incorporate watershed concepts and impacts of human choice into various program activities such as workshops, field trips and curricula. Staff translates, distills and incorporates new information about watersheds and human impacts into educational materials and other Reserve products. Incorporating activities such as the watershed game and estuary pledge into these programs encourages engagement with the information and inspires local stewardship.

- Additional details can be found in Education Program Actions 1.1.3, 1.2.1, 1.2.3, 1.2.4, 1.3.1 and Training Program Actions 1.4.1.

Coastal and Estuarine Ecosystem Protection

North Carolina has 2.3 million acres of biologically rich coastal and estuarine ecosystems, more than any other state along the Atlantic seaboard. Healthy estuaries are critical for the continued survival of many species of fish and other aquatic life, birds, mammals, and reptiles. These systems function as nurseries, refuges, and foraging areas for commercially valuable fish and shellfish species. In 2013 the economic impact of North Carolina's commercial and recreational fisheries was over $2 billion (North Carolina's Coastal Habitat Protection Plan 2015). Estuarine habitats, like saltmarsh, seagrass, and oyster reefs, buffer wave energy and filter pollutants, which protects coastal communities from stormwater runoff, storm surge, and flooding. Healthy ecosystems support tourism and recreation, including kayaking, swimming, fishing, and birding, which are vital to North Carolina's coastal economy. Because of the many benefits that coastal and estuarine ecosystems provide to North Carolina, it's important to protect these ecosystems from the many stressors affecting them. Some of these stressors include sea level rise (SLR), invasive species, and coastal development, all of which can result in habitat loss and alterations in ecosystem function.

The NCNERR is well suited to address stressors impacting Reserve sites and surrounding watersheds by monitoring habitat change and developing, testing, and implementing methods for coastal and estuarine ecosystem protection. Habitat distribution and condition at NCNERR sites are evaluated through the NERRS Habitat Mapping and Change component of SWMP. Stewardship staff monitor invasive species, visitor use, presence and absence of species of special concern, and natural or anthropogenic influences that impact habitat quality and ecosystem function at Reserve sites.

While the Reserve is well equipped to assess habitat change, additional information is needed to understand how stressors influence the ecosystem services provided by changing habitats. This information will be used to inform and develop strategies on how to best protect coastal and estuarine ecosystems at Reserve sites and within their watersheds. A centralized online database is needed to document and maintain natural history records to more completely understand the condition of NCNERR sites to inform protection and resilience strategies and to demonstrate their ecological significance.

Using a strategic combination of education, training, and stewardship programming, supported by communications initiatives, the Reserve can encourage ecosystem protection using NERRS and NCNERR-generated science and best practices. Coastal and estuarine ecosystem protection at NCNERR sites is accomplished by collaborating with partners and recruiting volunteers for activities that restore and enhance habitats, including planting vegetation or treating invasive species. Reserve research and monitoring methods, along with best management practices that focus on protecting these ecosystems, are shared through the Reserve's Coastal Training Program, education programs, and volunteer opportunities. Through Reserve programs, the general public and users are educated about their impacts to natural resources and how to minimize them. Habitat restoration activities offered in conjunction with education and training opportunities focused on the value of coastal and estuarine ecosystems will foster public support for natural resource protection.

Objective T2.1: Improve understanding of Reserve ecosystems, including the ecosystem services they provide, the threats they face, and how to best protect them.

Action 1: Research and stewardship staff generate baseline data on Reserve ecosystems and potential stressors and document change through habitat mapping, monitoring programs, and natural history records.

Reserve staff conduct survey and monitoring activities to better understand Reserve ecosystems and condition. Various species of interest, such as the piping plover and diamondback terrapin, are monitored through joint efforts with Reserve partners. Activities are undertaken based on specific site needs to manage, enhance and restore habitats, while supporting the natural integrity of sites. The Reserve also works to address invasive, non-native and feral species on Reserve sites by conducting survey, monitoring and treatment activities. A centralized online database is being developed to document and maintain natural history records with existing geographic and photographic species records and continued observances on sites. Using abiotic and biotic monitoring programs, elevation monitoring and habitat mapping, research staff are documenting habitat change throughout Reserve sites.

- Additional information can be found in Stewardship Program Actions 3.1.3, 3.1.4, 3.1.5, 3.1.7, and Research Program Action 2.1.3.

Action 2: Research staff communicate Reserve research needs relevant to quantifying estuarine ecosystem services to partners and the research community and work with them to quantify estuarine ecosystem services and how services are impacted by stressors.

The Reserve is required to ensure that sites serve as research platforms. Research priorities, including those relevant to estuarine ecosystem services, are circulated among scientific and coastal management communities through informal communication in workgroup settings, the Reserve website, seminars, and NERRS Science Collaborative and Coastal Research Fellowship RFPs.

- Additional details can be found in Research Program Actions 2.1.1, 2.1.2, 2.3.1.

Action 3: Research and stewardship staff collaborate to design studies that address ecosystem protection and inform restoration and management projects.

Studies and monitoring of site resources and concerns help to inform protection and restoration efforts. Stewardship and research staff will work together to design studies that address visitor use of sites, protected species breeding productivity, invasive species impacts, and success of living shoreline projects. Research and stewardship staff will work to restore habitat at Reserve sites and assess the success of demonstration projects through continued monitoring. Species of interest are managed by conducting survey and monitoring activities, for example to study shorebird and sea turtle nesting success. Research staff will continue to work with stewardship staff and research partners to study the impacts of *Phragmites* at Currituck Banks Reserve. Habitat management activities are also undertaken to monitor the impacts of invasive species.

- Additional details can be found in Stewardship Program Actions 3.1.3, 3.1.4, 3.2.6 and Research Program Actions 2.1.1, 2.1.2.

Action 4: Reserve staff work with organizations involved in landscape-scale initiatives to further the protection and understanding of coastal and estuarine ecosystems.

The Reserve is engaged with several initiatives that leverage the NCNERR's network of sentinel sites and the enhance its capacity to address landscape-scale ecosystem changes. The research program continues to explore partnerships with organizations involved in the Alliance for Currituck Sound for opportunities to conduct monitoring at Currituck Banks Reserve. Stewardship staff participate in regional efforts to address habitat protection at landscape scales. Partnerships include the Onslow Bight Forum and Cape Fear Arch Conservation Collaborative, which are efforts to implement community conservation plans and promote stewardship of coastal and estuarine ecosystems regionally. Staff also participate in the N.C. Sentinel Site Cooperative, a NOAA-sponsored sentinel site program focused on the central portion of the coast, that works collaboratively and leverages resources across partners to provide research, monitoring, and information for addressing ecosystem coastal resiliency to flooding, inundation, and sea level rise.

- Additional details can be found in Stewardship Program Action 3.1.4.

Objective T2.2: Inform target audiences about the importance of coastal and estuarine ecosystems to inspire protection.

Action 1: Education staff collaborates with research and stewardship staff to inspire K-College audiences to appreciate and protect coastal and estuarine ecosystems through program offerings such as field trips, classroom visits, and educational programs and materials.

The Reserve will continue to provide field trip and/or field study experiences for K-12 and college students. Field trips are ecology-based nature hikes that present basic estuarine information. Education staff also work with Masonboro.org, Carolina Ocean Studies, and the New Hanover County School System to offer the Masonboro Island Explorer program that directly engages students with local ecosystem protection. Through local outreach in schools, Reserve staff conduct hands-on, inquiry-based activities that provide information about the Reserve and its habitats. The Reserve partners with the N.C. Maritime Museum to offer four summer programs for children that are held in the Reserve's facility in Beaufort with daily field trips to the Rachel Carson Reserve. Stewardship staff directly engage educators to provide information to promote safe and appropriate use of the sites while preserving natural integrity and minimizing human impacts. Site managers also recruit volunteers from local communities and educational institutions to assist with stewardship activities. The research program works with education staff to transfer research results that can be incorporated into the above mentioned activities.

- Additional information can be found in Education Program Actions 1.2.1, 1.2.2, 1.2.3, 1.2.4, Stewardship Program Actions 3.2.3, 3.3.1, and Research Program Actions 2.2.4

Action 2: Reserve staff participates in efforts to educate the general public and site users by providing educational materials through the Reserve website, public presentations and events, and interpretive signage.

The Reserve uses a breadth of communication strategies to engage the general public and site users with information pertaining to ecosystem protection. Messages and products are developed to highlight the

significance of site natural resources, visitor use guidelines, volunteer opportunities, programs and events, site research and relevant coastal and estuarine topics that are disseminated via the Reserve's website and social media platforms. The training and education programs also disseminate these messages and materials via public presentations, events, workshops and education program activities, such as field trips and teacher trainings. Reserve staff communicate and promote these messages to visitors through direct engagement, interpretive signs, handouts, and website and social media posts.

- Additional details can be found in Administration Program Actions 4.5.1, 4.5.3, 4.5.4, 4.5.5, 4.5.6 and Stewardship Program Actions 3.2.1, 3.2.3.

Action 3: Stewardship staff engages community volunteers in species monitoring, research, and protection projects, such as marine debris removal, habitat mapping, marsh grass planting, and other activities.

Stewardship staff provide opportunities for active community participation in Reserve activities on the sites which inspires current and potential site users to appreciate the importance of and support protection efforts for coastal and estuarine ecosystems. Reserve staff provides mentoring, training and hands-on field experiences to volunteers to advance their skills and knowledge of stewardship of coastal and estuarine habitats.

- Additional details can be found in Stewardship Program Actions 3.1.4, 3.2.4, 3.3.2.

Action 4: Training and education staff provide teachers and professionals with training on issues relevant to ecosystem protection such as low impact development, living shorelines, and coastal wetlands.

Education staff conducts hands-on, field-based educator workshops that promote estuarine literacy. Working with partners, the education program is able to offer educator professional development workshops, such as Coastal Explorations and Teachers on the Estuary, that provide training on issues relevant to estuarine and coastal habitat protection. Through programs like Seeds to Shoreline, education staff directly engage both students and teachers in marsh grass restoration projects. The training program offers a suite of core trainings and workshops for professionals on topics ranging from low impact development basics for water quality protection to living shorelines for estuarine protection.

- Additional details are available in Education Program Actions 1.1.1, 1.1.5 and Training Program Actions 1.4.1.

Action 5: Training and stewardship staff provide collaborative opportunities for the natural resource management community to share information and tools to improve management of coastal and estuarine ecosystems.

Training and stewardship staff strive annually to collaborate on a training on stewardship related topics, such as citizen science and volunteer management. Training and stewardship staff prepare for and implement community engagement and expert elicitation aspects of the NERRS Science Collaborative funded project using the Climate Change Vulnerability Assessment Tool for Coastal Habitats (CCVATCH).

- Additional details are available in Training Program Action 1.4.1 and Stewardship Program Action 3.3.2.

Coastal Hazards Resilience

The natural geography and topography of North Carolina's coastline make it vulnerable to coastal hazards, such as flooding, coastal storms, shoreline erosion, and SLR. Forty-two percent of the N.C. coastline is ranked as "very high" in terms of vulnerability to SLR (Assessment and Strategy of the North Carolina Coastal Management Program 2015). North Carolina's vulnerability to rising sea level magnifies other existing coastal hazards. The coupling of coastal storms and flooding lead to increased coastal erosion. With rising seas and more intense storms, large disruptions to barrier island systems are likely to occur (Climate Read North Carolina: Building a Resilience Future 2012). Three of the four NCNERR sites - Currituck Banks, Masonboro Island and Zeke's Island Reserves - are barrier island systems that are subject to these coastal hazards. The Rachel Carson Reserve has characteristics of both estuarine island and barrier island ecosystems, making it vulnerable to the same coastal hazards. The Reserve is well-equipped to assess the vulnerability of ecosystems at Reserve sites through SWMP and sentinel site infrastructure and monitoring, as well as species surveys and habitat mapping. The ability to assess vulnerability is important for planning and developing strategies to increase resilience of ecosystems and human communities to coastal hazards. NCNERR's capacity for local engagement can help connect the results of monitoring data at NCNERR sites to help the program and partners understand Reserve site and surrounding communities' vulnerability. Examples of this include NERRS tools to assess resilience of salt marshes to sea level rise and the Climate Change Vulnerability Assessment Tool for Coastal Habitats.

Hazards impacting North Carolina's coastal and estuarine ecosystems pose a significant threat to coastal communities. Twenty-eight percent of coastal county residents live in floodplains and the state has experienced some of the highest coastal storm damage in the country (Assessment and Strategy of the North Carolina Coastal Management Program 2015). In 2014, total damage from hazardous weather in North Carolina was over $54 million (NOAA National Weather Service). Improving knowledge and awareness of coastal community resilience is accomplished through education, training, research, and stewardship activities that translate monitoring program results and promote the importance of natural infrastructure. Natural, or green, infrastructure refers to dune systems, oyster reefs, vegetation, and other healthy habitats that offer multiple benefits to coastal communities, like storm protection and wave attenuation. Living shorelines offer one way to stabilize estuarine shorelines through the use of natural materials such as marsh plants and oyster reefs as an alternative to hardened structures, such as bulkheads. Efforts on a national and state level are focused on encouraging the use of living shorelines to protect property, restore shoreline habitat, and improve water quality and coastal resilience. DCM has identified living shorelines as a priority and its current work and accomplishments are described in the Living Shorelines Strategy and the Living Shorelines Accomplishment Report. Living shorelines are also identified as a priority habitat issue in the 2015 Coastal Habitat Protection Plan. The importance of this technique, these strategic documents and the NCNERR's role in research, education, and training ensures it will continue its efforts on living shorelines for estuarine shoreline erosion control.

There are a number of needs and opportunities associated with NCNERR's focus on coastal hazards resilience. One such need is to increase the capacity of sentinel site type monitoring to assess the impacts of coastal hazards on NCNERR sites beyond the current focus on salt marshes. It is crucial to understand the resilience of living shorelines and other shoreline stabilization methods to coastal hazards like storm events. Assessments to understand the vulnerability of ecosystems and human communities are needed to inform strategies to improve resilience. Clear and effective communication to various stakeholders, such as decision makers, marine contractors and other professionals who work in coastal communities is critical to implementation of resilience strategies.

Objective T3.1: Assess vulnerability of Reserve natural resources to coastal hazards and use results to inform management decisions.

Action 1: Research and stewardship staff continue to implement SWMP, sentinel site, and natural resource monitoring to understand vulnerability of species, habitats, and/or geographic areas.

The research program will continue conducting biological monitoring of emergent marsh vegetation and marsh elevation surveys at Rachel Carson, Masonboro Island and Zeke's Island Reserves. The research program has also completed habitat mapping of all Reserve sites with plans to map again over a 10-year period to assess habitat change. Research and stewardship staff manage species of interest by conducting survey and monitoring activities. Data generated from these efforts will be used in planned vulnerability assessments.

- Additional details can be found in Research Program Actions 2.1.3 and Stewardship Program Actions 3.1.3.

Action 2: Reserve staff and a collaborative team of land managers, researchers, and other relevant stakeholders identify and prioritize Reserve natural resources for vulnerability assessments.

The Reserve and partners at the North Inlet-Winyah Bay National Estuarine Research Reserve, SC (NIWBNERR) were recently awarded a NERRS Science Collaborative grant to facilitate the use of CCVATCH, a new vulnerability assessment tool. This tool will help the Reserves better understand coastal habitat vulnerability to changing climate conditions. The assessment will be applied to marshes at all four sites of the NCNERR (Currituck Banks Reserve, Rachel Carson Reserve, Masonboro Island Reserve, and Zeke's Island Reserve). Information from risk assessments conducted as part of the development of the NCNERR Disaster Response Plan will be incorporated into this assessment. Additional vulnerability assessments may be considered as the need arises and as resources are available.

-Additional details can be found in Stewardship Program Action 3.1.8.

Action 3: Reserve staff plans and implements strategies to improve resilience based on vulnerability assessments as resources are available.

The results of planned and future vulnerability assessments will be used to prioritize species, habitats, and/or geographic areas for development and implementation of strategies to improve resilience.

-Additional details can be found in Stewardship Program Action 3.4.3.

Objective T3.2: Increase understanding and communicate knowledge of the importance of natural infrastructure (e.g., oyster reefs, marsh, living shorelines) to coastal resilience.

Action 1: Research staff continues to conduct and explore opportunities to expand the Sentinel Sites for Sea Level Rise and Inundation application module of SWMP to assess the resilience of marshes to SLR.

The NERRS Sentinel Site Program and SWMP provide data for a number of indicators relevant to the resilience of marshes to sea level rise. These indicators can be applied at all Reserve sites, but three of the four Reserve sites require additional infrastructure. Research staff will explore funding opportunities and partnerships to fill gaps in infrastructure at Currituck Banks, Rachel Carson and Zeke's Island Reserves.

- Additional details can be found in Research Program Action 2.1.5.

Action 2: Research staff continues working with partners to evaluate the performance of living shorelines over time and during storms, and assess the impact of shoreline hardening on marshes.

Research staff, in partnership with CCFHR, will study shoreline resilience in areas where estuarine shorelines are stabilized by traditional structures, such as bulkheads, or by living shorelines, such as marsh sills. Research staff will explore collaborations to assess the performance of natural infrastructure during storms and to identify optimal materials for living shorelines in different conditions. The Research program partners with UNC-CH Institute of Marine Sciences and UNC-Wilmington to assess the resiliency of living shorelines to large storm events. Research staff will continue to explore additional opportunities to collaborate and expand this research.

- Additional details can be found in Research Program Action 2.1.6.

Action 3: Reserve staff uses vulnerability assessments and resilience strategies to educate communities and coastal decision-makers on what coastal hazards are and the importance of natural infrastructure for coastal resilience through educational materials, research presentations, training events, and hands-on stewardship activities.

The training program conducts workshops on living shorelines and natural infrastructure, informed in part by monitoring of shoreline stabilization structures. The training program has historically provided training on sustainable development and a recent needs assessment revealed requests for training on community resilience and preparedness to coastal hazards. The research program presents the Reserve's research and monitoring datasets, results and products to coastal decision-makers and other end users regularly through forums such as presentations at university seminar series. The education program needs assessment identified that more information regarding changing coastal conditions should be incorporated into future education materials. These concepts and current research and stewardship activities will inform the content of new and updated curricula. Community members are actively involved in

stewardship activities that contribute to coastal resilience, such as marine debris removal and marsh plantings. Results from vulnerability assessments will be incorporated into programs and products tailored to target audiences.

-Additional details can be found in Training Program Actions 1.4.1, 1.4.2, Research Program Actions 2.1.6, 2.2.1, Education Program Actions 1.1.2, 1.1.3, and Stewardship Program Action 3.1.4.

Action 4: Training staff delivers trainings on natural infrastructure including living shorelines and coastal wetlands.

The training program coordinates core trainings for decision-makers on a variety of topics, which include those pertaining to natural infrastructure. DCM promotes living shorelines as a shoreline stabilization option where site conditions are appropriate. The training program has worked collaboratively with DCM and other partners to craft trainings and outreach products regarding living shorelines, especially targeting property owners and marine contractors.

-Additional details can be found in Training Program Actions 1.4.1 and 1.4.2.

Action 5: Training staff assists coastal communities to implement actions that increase their resilience to coastal hazards through technical assistance.

Annually, the training program provides technical assistance to at least one local coastal community. This is done by establishing collaborative relationships with local communities within Reserve watersheds, determining communities' technical assistance needs, and then delivering the technical assistance. Technical assistance may come in the form of meeting planning and facilitation to engage stakeholders, community needs assessments and community outreach.

-Additional details can be found in Training Program Actions 1.5.1, 1.5.2.

Objective T3.3: Increase understanding of sea level rise implications for Reserve sites and coastal and estuarine ecosystems by participating in local, regional, and state initiatives.

Action 1: Reserve staff advance the work of the NCSSC through participation in its Core Management Team and research and training activities.

The Reserve and CCFHR enhance their respective research capabilities through collaborative partnerships addressing relevant coastal habitat and management-related questions. One such collaboration is joint participation in the NCSSC which addresses sea level rise impacts by leveraging NOAA trust resources, ecosystem monitoring tools and expertise. Research staff contributes research and monitoring data to the NCSSC Clearinghouse database and Cooperative initiatives. The NCSSC has developed a database of containing metadata on projects relevant to sea level rise and resilience along the coast of North Carolina.

The Research Program contributes projects metadata to this database and shares research project data to support Cooperative initiatives.

Through workshops and technical assistance, the Training Program delivers information regarding sea level rise and coastal hazards resilience to various stakeholder groups. From the 2014 needs assessment, the biggest training need identified revolved around community resilience/preparedness to coastal hazards which includes sea level rise. This need will be addressed in future Training Program activities.

-Additional information is available in Training Program Actions 1.4.2, 1.5.1, 1.5.2, Research Action 2.1.2 and Administration Program Chapter 4.4.1.

Action 2: Reserve staff support DCM initiatives to address sea level monitoring and resilience planning.

DCM plans to develop a North Carolina Coastal Community Resilience Guide that will include a vulnerability and needs assessment. The Reserve, N.C. Sea Grant, and regional planning organizations will be key partners in outreach to communities while preparing the guide, working with pilot communities, and training local communities in using the guide after it is released.

VIII. Facility Development and Improvement Plan

The NCNERR has a responsibility to provide the facilities necessary to implement the education, training, research and monitoring, and stewardship programs of the NCNERR in accordance with federal and state guidelines and laws. This facilities plan is organized by NCNERR site and describes the existing and needed office and laboratory facilities, equipment, on-site infrastructure, and exhibits for each location. Purposes of the facilities are described, and challenges and gaps are included in the needs sections. Existing SWMP infrastructure and needs are included in the research plan.

The NCNERR's focus on its sites and programs and the geographic distribution of the NCNERR along the coast heavily influence the facilities plan, resulting in the program's effective implementation of office and laboratory facilities utilizing partnerships. The Reserve currently operates from three offices due to the geographic distribution of the sites: the northern office in Kitty Hawk supports the Currituck Banks site; the central office in Beaufort supports the Rachel Carson site; and the southern office in Wilmington supports the Masonboro and Zeke's Islands sites (Figure 21). All office and laboratory facility buildings are located off-site (northern and central offices) or within the buffer (southern office) to avoid and minimize impacts to the sites. The buildings are leased or shared with partners to promote collaborative opportunities and maintain economical prudence. Upkeep of office buildings and grounds is included in lease and program support costs and as such, the NCNERR does not employ office and laboratory facility maintenance staff.

Equipment is owned and maintained by the NCNERR for implementation of the program. On-site infrastructure is kept to a minimum as described in the public access plan to protect site ecosystems and provide public access and interpretation. Exhibits are an opportunity to increase awareness of the NCNERR in the local communities and with only one exhibit currently in place, needs and possible partnerships are described to fill gaps. Partnerships are the preferred method for exhibits given the type and location of the NCNERR's office and laboratory facilities, and opportunities at highly visible locations and the ability to reach target audiences.

The needs sections within this plan detail planned facilities and facility upgrades that may be considered within the scope of this management plan. Accomplishing a number of these needs relies on establishing new partnerships or augmenting current partnership agreements as well as securing external funding. As office and laboratory and exhibit needs are pursued in conjunction with partners, efforts will be made to ensure that construction activities and resultant facilities encourage sustainable practices and meet the NERRS Sustainable Building Principles. These include: integrated design & sustainable siting; water efficiency; energy efficiency; materials and resource conservation; indoor environmental quality; and operational efficiency. On-site infrastructure that may be pursued during the scope of this management plan will be designed and sited such that projects meet the applicable NERRS Sustainable Building Principles.

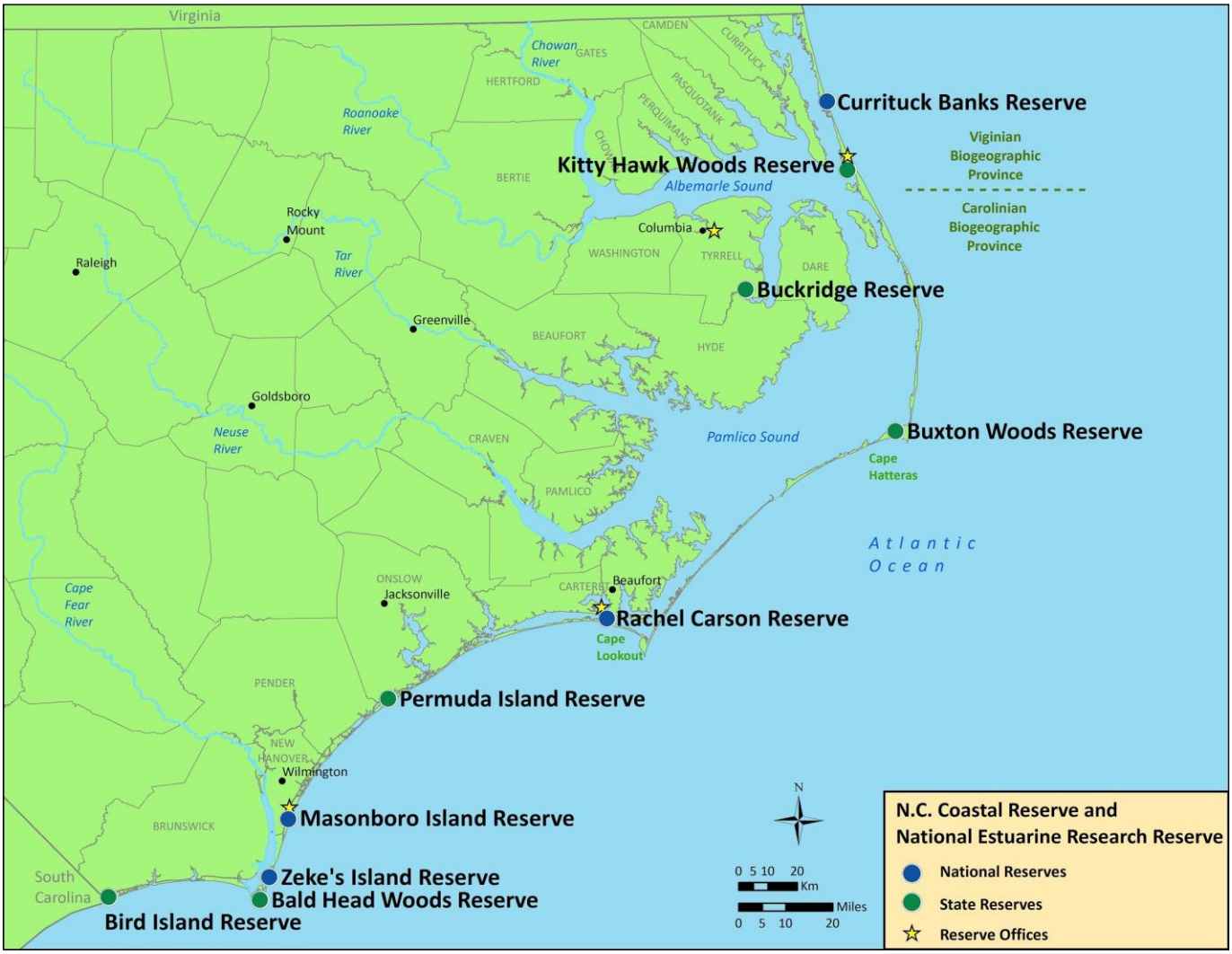

Figure 21. North Carolina National Estuarine Research Reserve Sites and Offices Map

Facility, Equipment, On-site Infrastructure, and Exhibit Descriptions and Needs

Currituck Banks Reserve

Office and Laboratory Facilities:

Existing: Office space is leased from the Town of Kitty Hawk to house the Northern Sites Manager (Appendix S), lease effective through 2017), who manages the Currituck Banks site of the NCNERR and two state sites (Kitty Hawk Woods and Buxton Woods Coastal Reserves). The office is located approximately 25 miles south of the Currituck Banks site (Figure 22). The office is approximately 700 ft^2 and contains field and office storage space, small common meeting space, and three work stations. Boat and vehicle storage is also provided at the office. Public meetings and education events are held at partner facilities such as the Town of Kitty Hawk Town Hall and WRC's Outer Banks Center for Wildlife Education in Corolla, just a few minutes south of the Currituck Banks site.

Figure 22. Reserve Northern Office

Needs: The office space currently leased from the Town of Kitty Hawk is workable but does not meet long-term needs. These long-term needs include co-location with partner(s) conducting complementary work to provide a peer network for staff and enhance collaborative opportunities and safety; several offices; available laboratory space; and indoor/outdoor storage for vehicles, boats, and field equipment. Given the limited Reserve staff and the lack of maintenance staff, it is the preference of the DCM to develop and maintain a long-term partnership agreement with a local or state agency for a facility that meets the long-term needs identified above in which the agency maintains ownership of the facility and the DCM pays an established fee for use. The Reserve Program Manager, Northern Sites Manager, and DCM staff will explore partnership opportunities with local or state agencies and organizations to locate permanent, suitable office and lab space within an existing facility to accommodate the needs of Currituck Banks.

Equipment

Existing: The northern office has one boat used for stewardship and research, a 16 ft. Jones Brother semi-V hull equipped with a four-stroke 50 hp Johnson outboard engine. The N.C. Division of Motor Fleet Management leased vehicle is a 2007 four wheel-drive Grand Jeep Cherokee. The Northern Sites office is

equipped with computers, a camera, GIS/GPS, a utility trailer, foot-powered kayak, and tools needed for site management and maintenance.

Needs: The northern office does not have any identified equipment needs at this time. When it is time to replace the Motor Fleet Management vehicle, staff will pursue getting a truck that is better suited for the work conducted from this office. Equipment needs will be evaluated if additional staff are located at this office to meet the needs identified in the administrative plan.

On-site Infrastructure

Existing: A concrete parking lot with a rain garden provides access to the Currituck Banks Reserve from N.C. 12. From the parking lot, visitors may walk along the 1/3-mile boardwalk through the maritime forest to Currituck Sound. Plants and trees are identified by small signs along the boardwalk. Interpretive signs were installed along the boardwalk in 2006. A 1.5-mile primitive trail departs from the boardwalk and heads north through the maritime forest with benches located along the trail. Currituck County holds an access easement on a portion of the Reserve to facilitate pedestrian access along its multi-use path to the oceanfront beach and maintains the fences and gates along this easement.

Needs: To increase visitor awareness of the Reserve and its appropriate use, a variety of signage needs exist. Types of signage needed include: rules signs, informational signs about parking lot policies, boundary identification signs, and trail markers. There is a need for an elevated interpretive area at the end of the primitive trail to better protect habitats while enjoying the viewscape of Currituck Sound. The boardwalk will need to be resurfaced as the treated lumber is demonstrating age and wear.

Exhibits

Existing: There are no exhibits currently for the Currituck Banks Reserve.

Needs: Staff will explore the feasibility of installing an exhibit about the Currituck Banks Reserve at nearby partner and public access facilities to increase understanding of the program, site, and appropriate use of parking lot.

Office and Laboratory Facilities

Figure 23. Reserve Central Office

Existing: The joint NOAA-NCNERR administration building at the NOAA Beaufort Laboratory on Pivers Island was completed in 2007 and Reserve staff has been operating from this facility since July of that year (Figure 23). This location provides quick access to the Rachel Carson Reserve that is located across Taylor's Creek from the island. The facility is two stories and totals 17,270 ft^2. The Reserve occupies 2,405 ft^2 of office space including the teaching classroom. The auditorium and large conference room are shared with NOAA for workshops and meetings, in addition to a shared office storage area located next to the auditorium. The NCNERR office space contains eight offices, two cubicles, a reception area and a small conference room providing space for the Reserve Program Manager, Education Coordinator, Central Sites Manager, CTP Coordinator, and Research Coordinator as well as temporary staff and interns. The NCNERR uses 2 outdoor sheds on Pivers Island to store field equipment. The Reserve has two boats and currently leases dock space from the DUML for the 17' Jones Brothers and utilizes the NOAA floating T-dock for the 27 ft. Carolina Skiff passenger vessel. An agreement for this facility partnership with CCFHR at the NOAA Beaufort Laboratory is under development.

Needs: The administration building was designed for education and training programs prior to the Reserve's reorganization in the early 2000s. As a result, the central office does not comprehensively serve all program needs and new needs have arisen since occupation of the building. The Reserve Program Manager participated in the development of the CCFHR Master Plan which seeks to address facility and program needs of all parties on the CCFHR campus on Pivers Island (December 2008). Federal appropriations have limited NCCOS' ability to implement the Master Plan. The following needs are an updated list of what was included in the Master Plan. Planning for and implementation of these needs will be conducted collaboratively with NCCOS leadership and staff.

Laboratory space: The research and stewardship programs do not currently have designated laboratory space at the central office; research and stewardship activities are currently staged in the teaching classroom. Six hundred square feet of laboratory space is needed to support the research and stewardship programs at the Rachel Carson Reserve including calibration and post-sample processing of water quality monitoring sondes, sample processing, and marine operations. The space should include a laboratory bench, sink, electrical outlets and internet access, and space for a flammable cabinet, refrigerator/freezer, and cart.

Outdoor classroom: An outdoor classroom will support Reserve K-12, public education, and training programs conducted at or initiated from Pivers Island, taking advantage of the natural setting and close proximity of the Rachel Carson Reserve and Gallants Channel. The space should include a covered area with benches to seat approximately 20 people at one time. The classroom should also have locking storage bins to house educational materials and a sturdy chalkboard and display area. The location of the classroom would offer views of the estuary habitat, allowing for a dynamic, experiential teaching space. CCFHR also has an interest in an outdoor meeting facility and this space will be designed to address needs of both organizations.

Boat docks: A boat lift is needed at the CCFHR floating T-dock to better accommodate the Reserve's 27ft. Carolina Skiff. CCFHR and Reserve staff will work together to develop a long-term dock plan that addresses mutual needs.

Equipment

Existing: The central office is equipped for a variety of program-related tasks. The Reserve owns two boats that are housed at this office: a 17 ft. Jones Brothers boat equipped with a 50 hp Yamaha outboard motor for research and stewardship purposes, and a 27 ft. extra-wide Carolina Skiff with rails and seats for passengers and equipped with a Suzuki 250 hp outboard engine for education programs and general purposes. In addition, the office has a N.C. Division of Motor Fleet Management leased 2007 four wheel-drive Dodge Durango, a utility trailer, and two kayaks. Computers, projectors, copier, plotter, color printers, and keypad polling units (60 cards, 2 receivers, and 1 "response anywhere card") are owned by the Reserve for staff use. Water quality testing equipment and twelve microscopes are maintained for use with student groups. The Reserve also owns three cameras and GPS units for research and stewardship projects.

Needs: A new 17-19 ft. flat-bottomed skiff is needed to replace a 20-year-old vessel that currently supports stewardship and research operations at and around the Rachel Carson Reserve. Replacement kayaks are also needed. Equipment needs will be evaluated if additional staff are located at this office to meet the needs identified in the administrative plan and as office and laboratory facility needs are addressed.

On-Site Infrastructure

Existing:

Nature trail: The nature trail consists of two primitive loops that guide visitors through representative habitats found at the site. A brochure and audio podcasts accessible through QR codes describe posted points of interest.

Boardwalk: A boardwalk crosses Carrot Island and is located across Taylor's Creek from the WRC's Lennoxville Road public boat ramp. The boardwalk is approximately 500 ft. in length, allowing visitors to view the cross-section of habitats on the island and terminates with an observation deck overlooking the North River

Channel. The boardwalk was constructed in 2007 of composite decking and railings. Interpretive signs highlight the different habitats and species located along the boardwalk.

Living shoreline demonstration site:
Living shorelines prevent erosion through strategic placement of natural substances, like vegetation and oysters. In many settings, living shorelines represent an effective and relatively inexpensive approach to long-term shoreline stabilization. The Reserve has been involved in the implementation of several demonstration sites.

The living shoreline project at the east end of Carrot Island on the Rachel Carson Reserve was led by researchers from the Reserve and CCFHR. Scientists at IMS Sciences installed oyster shell parallel to the shoreline to encourage reef formation, and volunteers planted saltmarsh cordgrass behind the oyster reefs. Additional partners included the N.C. Coastal Federation and the DCM. Reserve and CCFHR staff continue to monitor the project to evaluate success and additional steps that may be taken.

Needs:

Signage: To increase visitor awareness of the Reserve and its appropriate use, a variety of signage needs exist. Types of signage needed include: rules signs, informational signs, boundary identification signs, and trail markers. Interpretative signs at the boardwalk also need to be replaced due to sign degradation.

Dredging pipes: The pipes at Town Marsh used by the COE for remnant dredging activities need to be removed for safety purposes as this area of the Reserve is heavily used for student and public field trips and for recreation.

Exhibits

Existing:

N.C. Maritime Museum: The display at the North Carolina Maritime Museum contains information about the Rachel Carson Reserve as well as more general information about North Carolina's coastal habitats. The display also features a description of ecosystem services that estuary and coastal habitats provide and a robust shell collection that allows for an interactive learning experience.

Living shorelines: The Reserve assists in monitoring two demonstration sites on Pivers Island and regularly uses the sites for education and training purposes.

NOAA Site (Pivers Island): The living shoreline on the east side of Pivers Island was constructed in collaboration with the DMF and volunteers from the NOAA Beaufort Laboratory and DUML. It consists of marsh plantings and loose oyster shell that now supports a live oyster reef.

Duke Site (Pivers Island): With funding from NOAA, the N.C. Coastal Federation constructed a stone sill on the west side of Pivers Island to replace a failing asbestos bulkhead and abandoned flounder containment pens. Oysters were placed at the base of the sill and the site behind it was graded and planted with native vegetation.

Stormwater best management practices on Pivers Island: A variety of stormwater best management practices (BMPs) installed on the NOAA and DUML campuses demonstrate ways to more effectively manage and improve the quality of stormwater runoff on Pivers Island. The BMPs include stormwater wetlands, bioretention cells, rock check dams, cisterns, and a permeable parking lot. Performance of the BMPs is monitored by NOAA and Duke staff. Informational signs are located at select sites informing visitors of the function of the BMPs. The CTP uses these sites as a field trip in workshops related to stormwater management and low impact development. This project was funded by the N.C. Clean Water Management Trust Fund through a grant to the DCM.

Needs: There are no needs identified at this time.

Masonboro Island Reserve

Office and Laboratory Facilities

Existing: The Masonboro Island and Zeke's Island Reserves and programs implemented at the sites are managed from the southern office at CMS (Figure 24). The CMS is located across the Intracoastal Waterway from the Masonboro Island Reserve providing quick access to that site and is included as buffer within the Masonboro Island site boundary. While NCNERR has had a presence at CMS since the early days of the program, staff have been operating from upgraded dedicated office and laboratory space at CMS since May 2008. The space is approximately 1450 ft^2 and contains four offices, a laboratory for research and monitoring operations, a common area/workspace for shared equipment, computers, and supplies, and a storage area/mud room. CMS has conference rooms and an auditorium that are regularly used by staff for meetings and outreach presentations. There are also two 300 ft^2 storage sheds at CMS that are used for storing Reserve field equipment. The Reserve has dedicated use of a boat lift on the CMS docks that is sufficient for a 24 ft. vessel. The office houses the Stewardship Coordinator, two Research Specialists, and temporary and seasonal staff. The Reserve Manager maintains a shared satellite office at CMS.

Figure 24. Reserve Southern Office

Educator professional development workshops and coastal training workshops held in the region utilize partner facilities free of charge to best meet the needs of the individual programs. These include the New Hanover County Arboretum, New Hanover County Government Complex, Fort Fisher State Recreation Area Visitor Center, and the North Carolina Aquarium at Fort Fisher.

Needs:
Planning for and implementation of the needs below will be conducted collaboratively with CMS leadership and staff.

Indoor storage space for field and transportation equipment: 1200 ft^2 of dedicated indoor storage space is needed at CMS to replace and consolidate the one old and one new existing storage sheds that are workable but do not meet current needs. A replacement facility or space should include the following for a more effective and efficient work area: garage for the John Deere utility vehicle and all-terrain vehicle, storage space for kayaks, beach bikes, research and monitoring equipment, signs, tools, and boat and field chemicals, fuel cabinet for boat gasoline, and a work bench. The facility or space should be climate controlled and equipped with electricity.

Rainwater cistern and boat/vehicle washing station: A rainwater cistern and boat/vehicle washing station at CMS will reduce water consumption and energy costs associated with municipal water processing and transport, thereby supporting NERRS Sustainable Building Principles. Rainwater harvested from the roof of the operations wing will be captured in a cistern and used for boat and vehicle washing. Planning and design of this facility will involve students through a partnership between NCNERR, CMS operations, and UNCW's Sustainability Committee. The facility will be utilized by both NCNERR and UNCW and serve as a demonstration for the visiting public.

Office space expansion: Additional office space is needed in the long-term to accommodate permanent and temporary staffing needs. Temporary and seasonal staff currently share one office, and use the common work area and a workspace in the laboratory during the peak field season. At these times, existing office space is over capacity. An expansion of existing office space into adjacent space as it becomes available will allow for a more productive work environment, maintain a cohesive work unit, and provide safer working conditions in which staff are not conducting office work in the laboratory and are able to exit from existing offices through a hallway rather than the laboratory.

Equipment

Existing: The Wilmington office is equipped for a variety of Reserve program-related tasks. The NCNERR owns three vessels designated for research and stewardship that are housed at the Wilmington office: a 19 ft. Jones Brother's Bateau equipped with a 90 hp Mercury outboard engine, a 16 ft. Carolina Skiff equipped with a Yamaha 30 hp outboard engine, and a 24 ft. Carolina Skiff boat equipped with a 115 hp Yamaha outboard engine. In addition, the office has a N.C. Division of Motor Fleet Management leased four wheel-drive Nissan Pathfinder, seven kayaks, John Deer utility vehicle, utility trailer, two beach bikes, and an all-terrain vehicle for staff and equipment transportation. Computers, color printer, plotter, water quality and meteorological dataloggers, autosamplers, telemetry equipment, handheld GPS units, RTK Trimble GPS unit, 30 keypad polling units, cameras, and necessary software and supplies needed for maintaining equipment are also on location.

Needs:

A new plotter is needed to replace a 2003 model. A new replacement for the 19 ft. Jones Brother's Bateau and trailer are needed to support stewardship and research operations. Equipment needs will be evaluated if additional staff are located at this office to meet the needs identified in the administrative plan.

On-Site Infrastructure

Existing:

Signage: The Masonboro Island site has informational signage and bulletin cases, site identification signs, rules signs, and site markers. There is also an informational sign and bulletin case with a site description at Trails End Park in New Hanover County.

Nature trail: There is a primitive nature trail on Masonboro Island that includes trail markers with QR codes that provide visitors with interpretive content.

Needs:

Signage: To increase visitor awareness of the Reserve and its appropriate use, a variety of signage needs exist. Types of signage needed include additional rules signs, informational signs, boundary identification signs, and trail markers.

Nature trail: Raised boardwalks over areas submerged at high tide, interpretative signs, and a viewing platform at the trail's highest elevation are needed to fully equip this trail and provide visitors with an increased understanding of the habitats present at the Masonboro Island Reserve. A kayak trail will also increase visitor awareness of the Reserve, its ecosystems, and appropriate use as well as enhance the visitor experience.

Exhibits

Existing: No exhibits currently exist that serve the Masonboro Island Reserve or the local community.

Needs:

Exhibits at UNCW: Exhibits targeting UNCW faculty, staff, and students will increase awareness of the NCNERR and will include information on research, education, and stewardship opportunities and needs, SWMP data availability, and the research permit process. Exhibit locations to be considered include the lobby at CMS and at science buildings on the main campus to promote partnerships throughout the University. NCNERR staff will discuss opportunities with the CMS director and other appropriate University leaders. Such exhibits will support the Masonboro Island and Zeke's Island Reserves as well as the NCNERR as a network.

Exhibit at Wrightsville Beach: Partnerships will be explored to develop and locate an exhibit at an existing facility at Wrightsville Beach targeting the general public. The exhibit will increase understanding of the NCNERR and Masonboro Island Reserve, why it is protected and how it is used by researchers, educators, and the public, promote responsible use of the Reserve, and describe the importance of estuaries. The Masonboro Island Reserve is south of Wrightsville Beach across Masonboro Inlet and is visible from its southern tip.

Zeke's Island Reserve

Office and Laboratory Facilities

The Zeke's Island Reserve and Masonboro Island Reserve are managed from the same office and laboratory facility. See existing and needs descriptions for the Masonboro Island Reserve.

Equipment

The Zeke's Island Reserve and Masonboro Island Reserve are managed from the same office and laboratory facility and therefore, staff utilize the same equipment to implement programs at both sites. See existing and needs descriptions for the Masonboro Island Reserve.

On-Site Infrastructure

Existing:

Signage: The Zeke's Island site has informational signage at the WRC boat ramp at Federal Point and site identification and rules signs on the site. An additional informational sign is located at the Fort Fisher State Recreation Area near an overlook platform at the terminus of a natural trail that provides views of the Zeke's Island Reserve.

Needs:

Signage: To increase visitor awareness of the Reserve and its appropriate use, a variety of signage needs exist. Types of signage needed include additional rules signs, informational signs, interpretive signs, boundary identification signs, and trail markers.

Nature and kayak trails: A nature trail with interpretive signs and a kayak trail will increase visitor awareness of the Reserve, its ecosystems, and appropriate use as well as enhance the visitor experience.

Exhibits

Existing: No exhibits currently exist that serve the Zeke's Island Reserve or the local community.

Needs:

Exhibits at UNCW: Exhibits targeting UNCW faculty, staff, and students will increase awareness of the NCNERR and will include information on research, education, and stewardship opportunities and needs, SWMP data availability, and the research permit process. Exhibit locations to be considered include the lobby at CMS and at science buildings on the main campus to promote partnerships throughout the University. NCNERR staff will discuss opportunities with the CMS director and other appropriate University leaders. Such exhibits will support the Masonboro Island and Zeke's Island Reserves as well as the NCNERR as a network.

Exhibit at N.C. Aquarium at Fort Fisher: A partnership will be explored with the N.C. Aquarium at Fort Fisher to develop and locate an interactive, real-time data exhibit at the Aquarium targeting the general public. The exhibit will display data telemetered from SWMP stations located at the nearby Zeke's Island Reserve, share the importance of maintaining good water quality, and how the public can serve as water quality stewards.

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Appendix T

Public Input Process for the NCNERR Management Plan 2017 - 2022

This appendix summarizes the public input process used by the NCNERR to inform the 2017-2022 NCNERR Management Plan update. Input was gathered through the following forums during the update process:

- Public meetings were held in fall 2014 to explain the purpose of the Reserve and the management plan update, and solicit comments from Reserve users, community members, and the general public about programs and management of the four NCNERR sites (Currituck Banks, Rachel Carson, Masonboro Island, Zeke's Island). This was also an opportunity for the public and Reserve staff to engage in a "Q & A" about the Reserve's mission, goals, and programs.
- Focus groups were held in fall 2014 with the Reserve's local advisory committees for the four NCNERR sites. Facilitators with OCM guided committee members through structured exercises to identify site-specific management issues and review Reserve-wide strategic planning goals and priorities. Follow-up reports and conversations at additional committee meetings kept the committees engaged throughout the update process.
- An online survey of Reserve-wide partners was conducted during November 2014 to gather input from programmatic partners at the federal, state, and regional level on issues related to the Reserve's role in addressing North Carolina's coastal management priorities.
- An education and training needs assessment was conducted in fall 2014 by the education and training programs to determine appropriate target audiences, programs, and trainings for future education offerings.
- NCNERR local advisory committees for the four sites provided input on the draft NCNERR Strategic Plan section in spring 2015.
- The full draft management plan was reviewed by the four NCNERR local advisory committees in March 2017. Committee members were provided the draft plan in advance of the advisory committee meetings and the meetings served as a venue to discuss and comment on the draft. Committee members were also given the opportunity to submit written comments.
- The Reserve's education advisory committee and other partners also had the opportunity to provide input on the draft management plan in spring 2017.
- *Coming in April 2017:* The full draft management plan, updated to address local advisory committee and other partner input, will be presented to the N.C. Coastal Resources Commission at its April 2017 meeting.
- *Coming later in 2017:* The Department of Environmental Quality will review the draft management plan and then NOAA will complete a technical and content review. A NOAA-required 30-day public comment period will be held on the draft management plan following NOAA's review and prior to its finalization and be announced in the Federal Register. Interested parties will be encouraged to submit comments electronically or at the public meetings held in the northern, central and southern regions of the coast during the comment period.