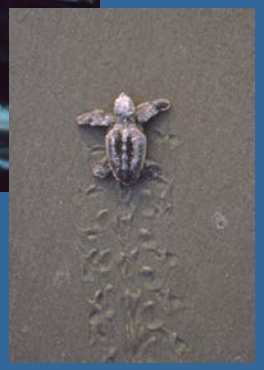
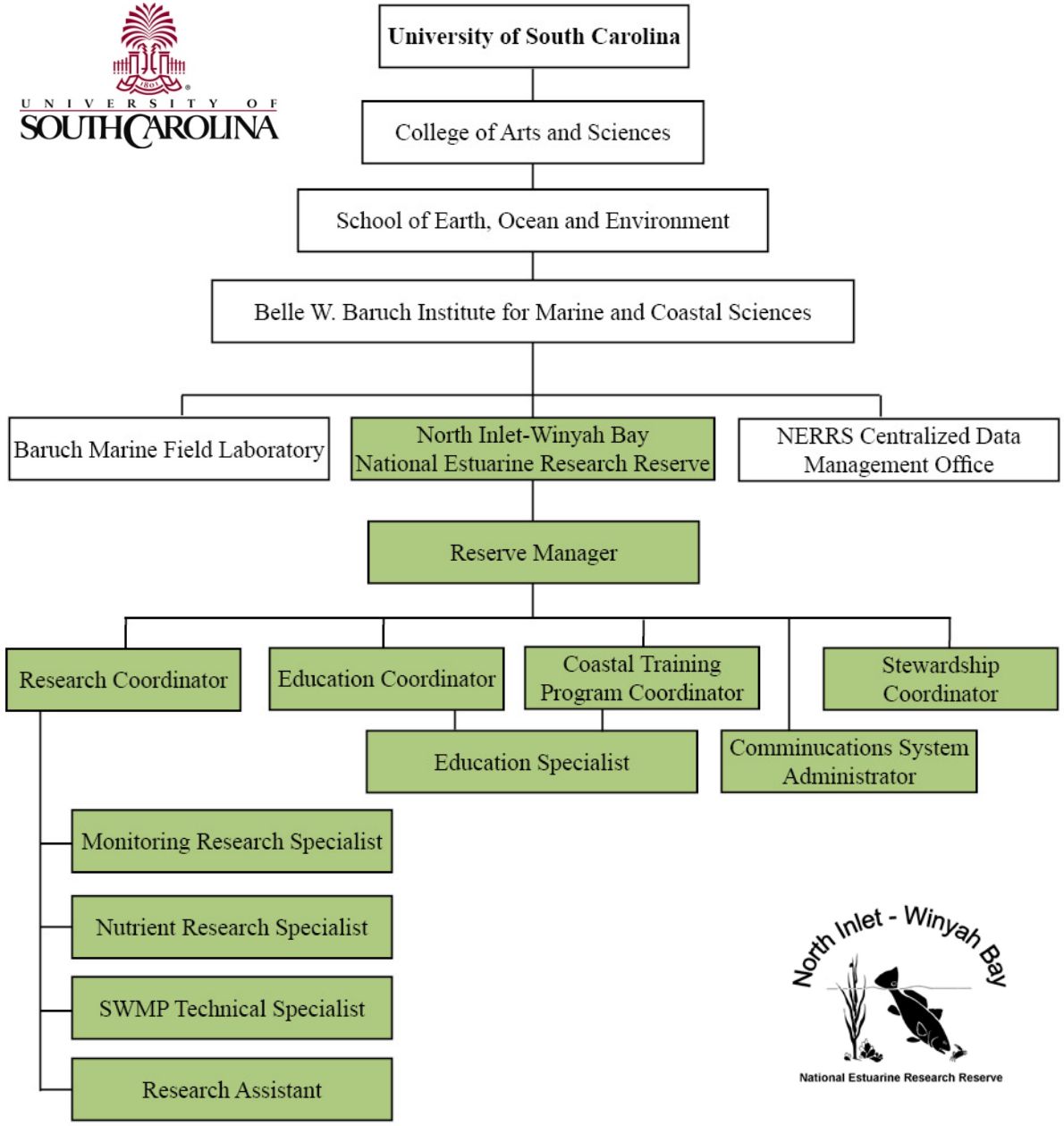
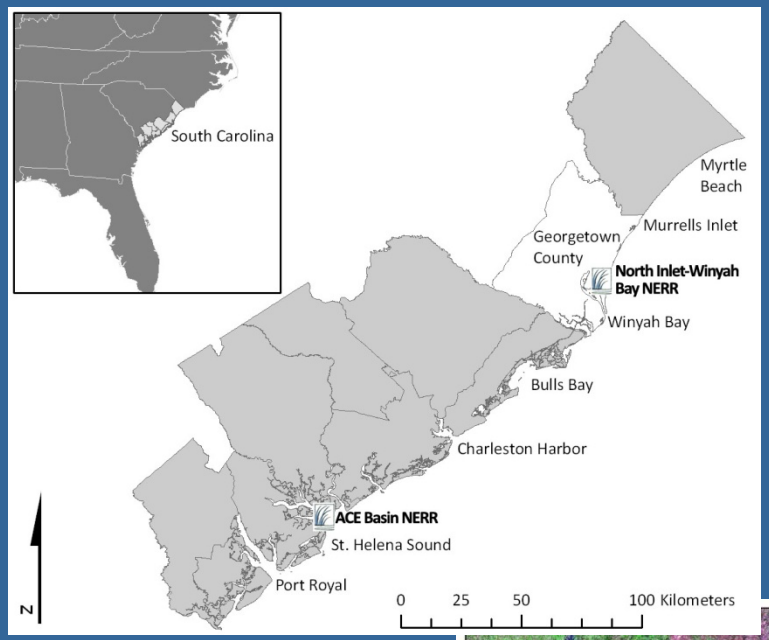
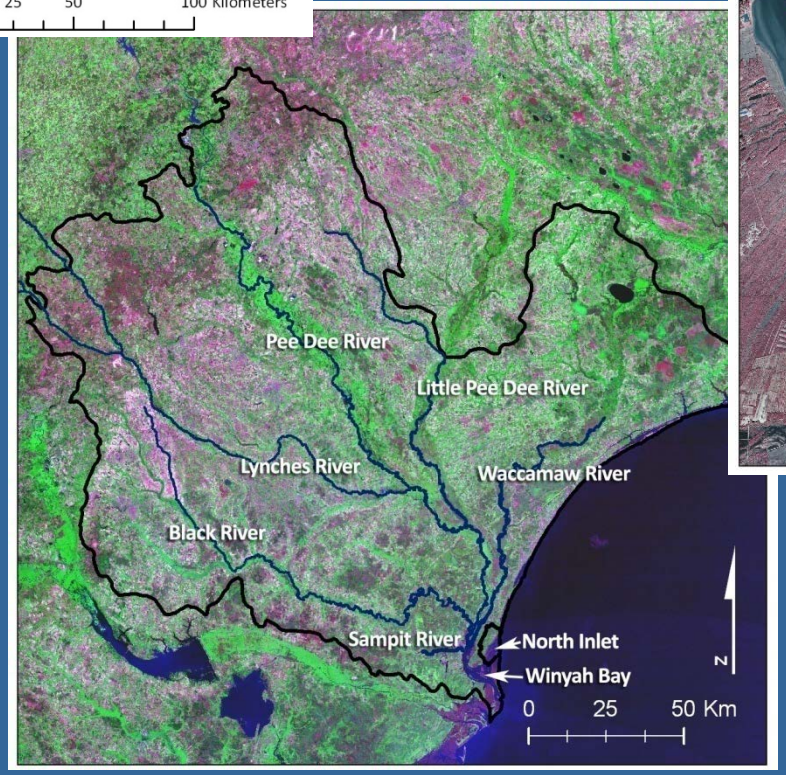
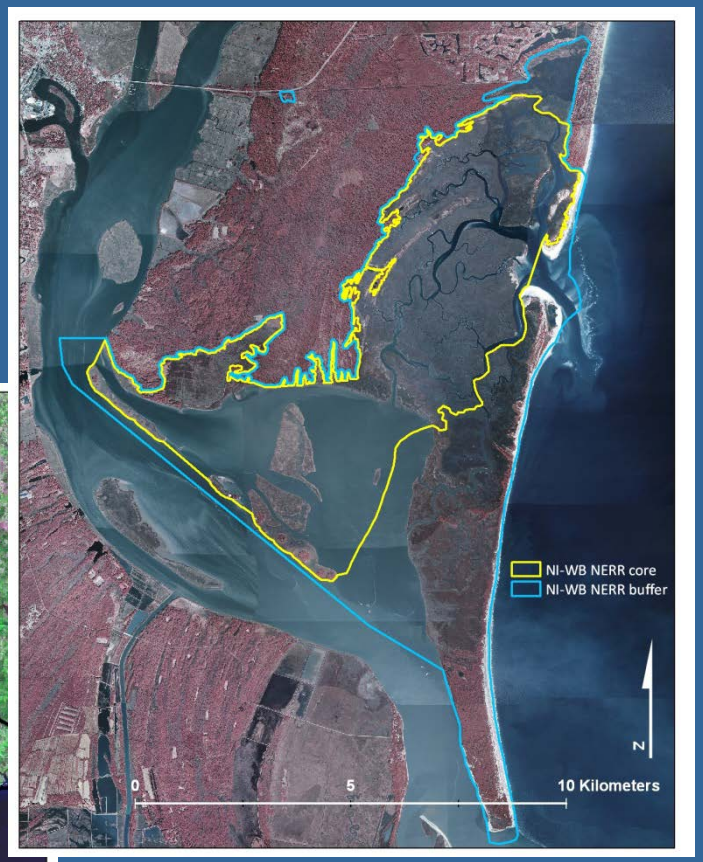
NORTH INLET-WINYAH BAY
National Estuarine Research Reserve
BELLE W. BARUCH INSTITUTE FOR
MARINE BIOLOGY & COASTAL RESEARCH
in cooperation with the
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION




University of South Carolina
College of Arts and Sciences
School of Earth, Ocean and Environment
Belle W. Baruch Institute for Marine and Coastal Sciences
Baruch Marine Field Laboratory
North Inlet-Winyah Bay National Estuarine Research Reserve
NERRS Centralized Data Management Office
Reserve Manager
Research Coordinator
Education Coordinator
Coastal Training Program Coordinator
Stewardship Coordinator
Education Specialist
Comminucations System Administrator
Monitoring Research Specialist
Nutrient Research Specialist
SWMP Technical Specialist
Research Assistant
North Inlet - Winyah Bay
National Estuarine Research Reserve


South Carolina
Myrtle Beach
Murrells Inlet
Georgetown County
North Inlet-Winyah Bay NERR
Winyah Bay
Bulls Bay
Charleston Harbor
ACE Basin NERR
St. Helena Sound
Port Royal
0 25 50 100 Kilometers
N

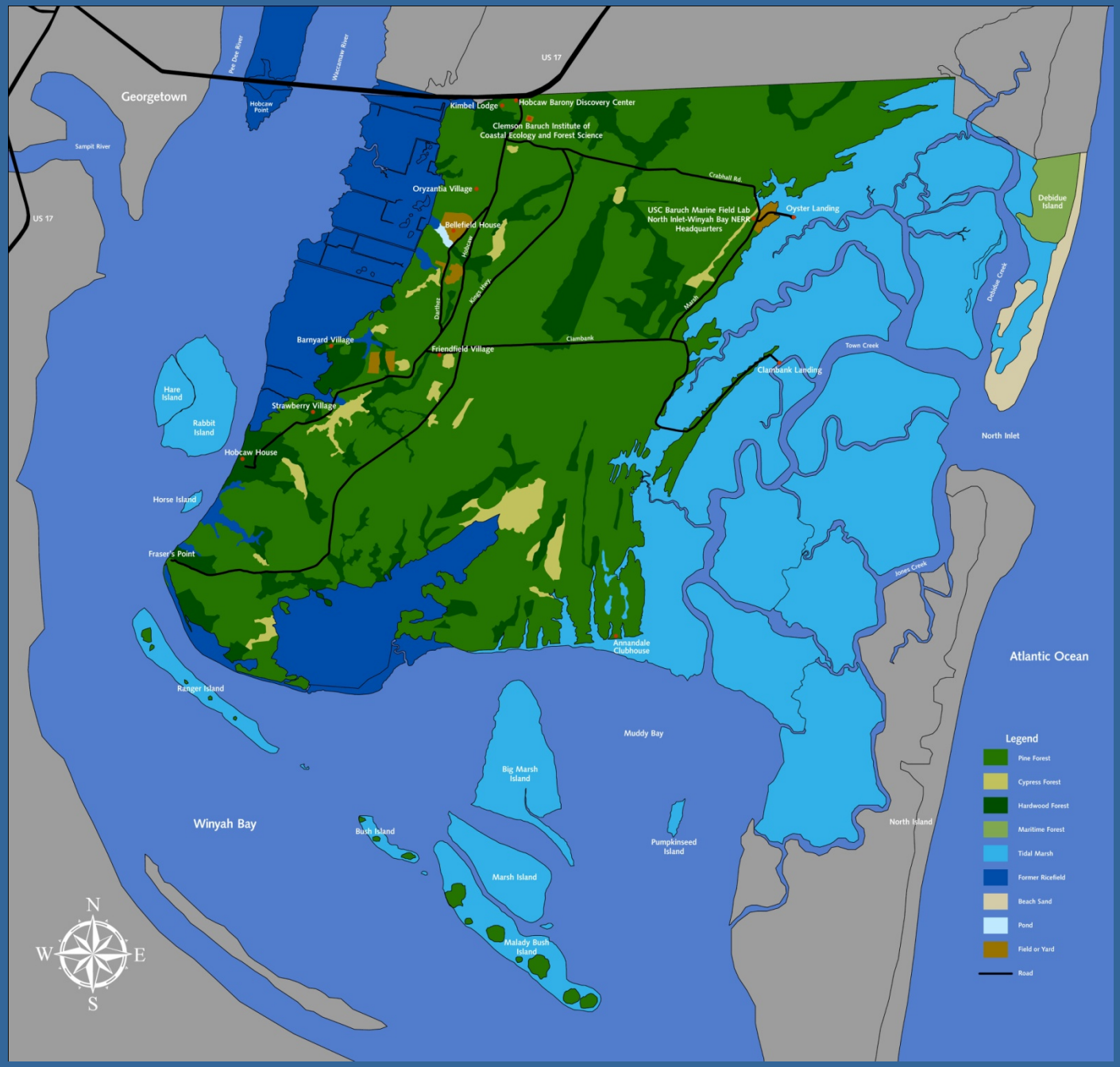

Pee Dee River
Little Pee Dee River
Lynches River
Waccamaw River
Black River
Sampit River
North Inlet
Winyah Bay
0 25 50 Km
N


NI-WB NERR core
NI-WB NERR buffer
0 5 10 Kilometers
N

Hobcaw Barony

17,500 acres

Owned by the Belle W. Baruch Foundation



Key Partners on Hobcaw Barony

The Belle W. Baruch Foundation

Owns and manages the Hobcaw Barony property and partners with the North Inlet-Winyah Bay NERR to operate the Hobcaw Barony Discovery Center

University of South Carolina

Belle W. Baruch Institute

for Marine and Coastal Sciences

Operates the Baruch Marine Field Laboratory and North Inlet-Winyah Bay National Estuarine Research Reserve

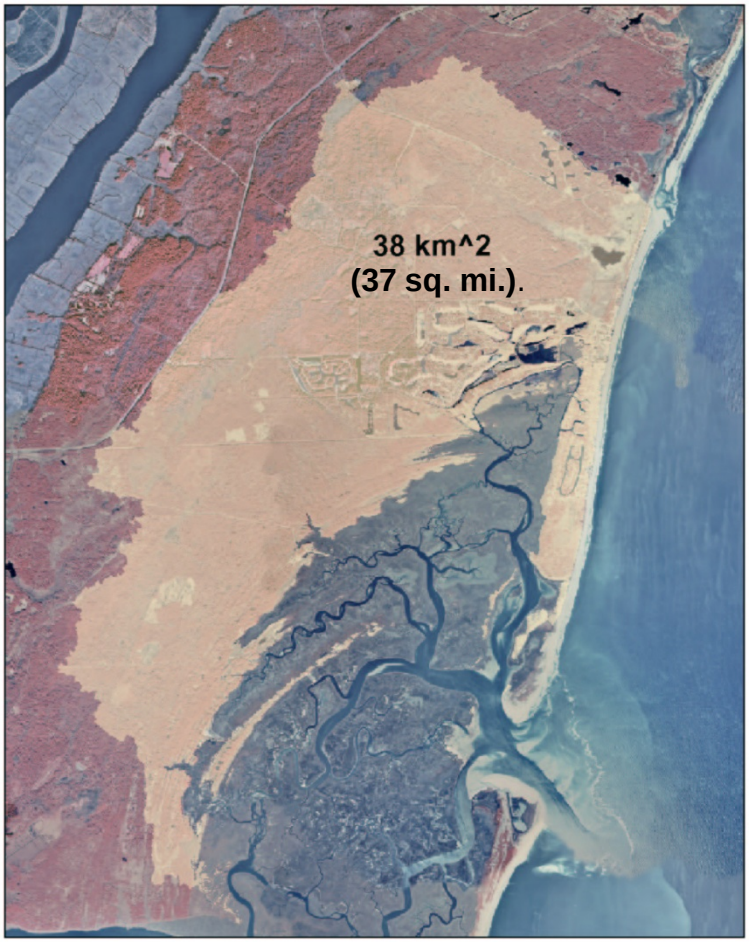
Clemson University

Belle W. Baruch Institute

of Coastal Ecology and Forest Science

Operates a research laboratory and conducts coastal wetland and forestry research and education

North Inlet Watershed



Key Issues for the North Inlet-Winyah Bay NERR

With cross-cutting implications for management, research, education and stewardship

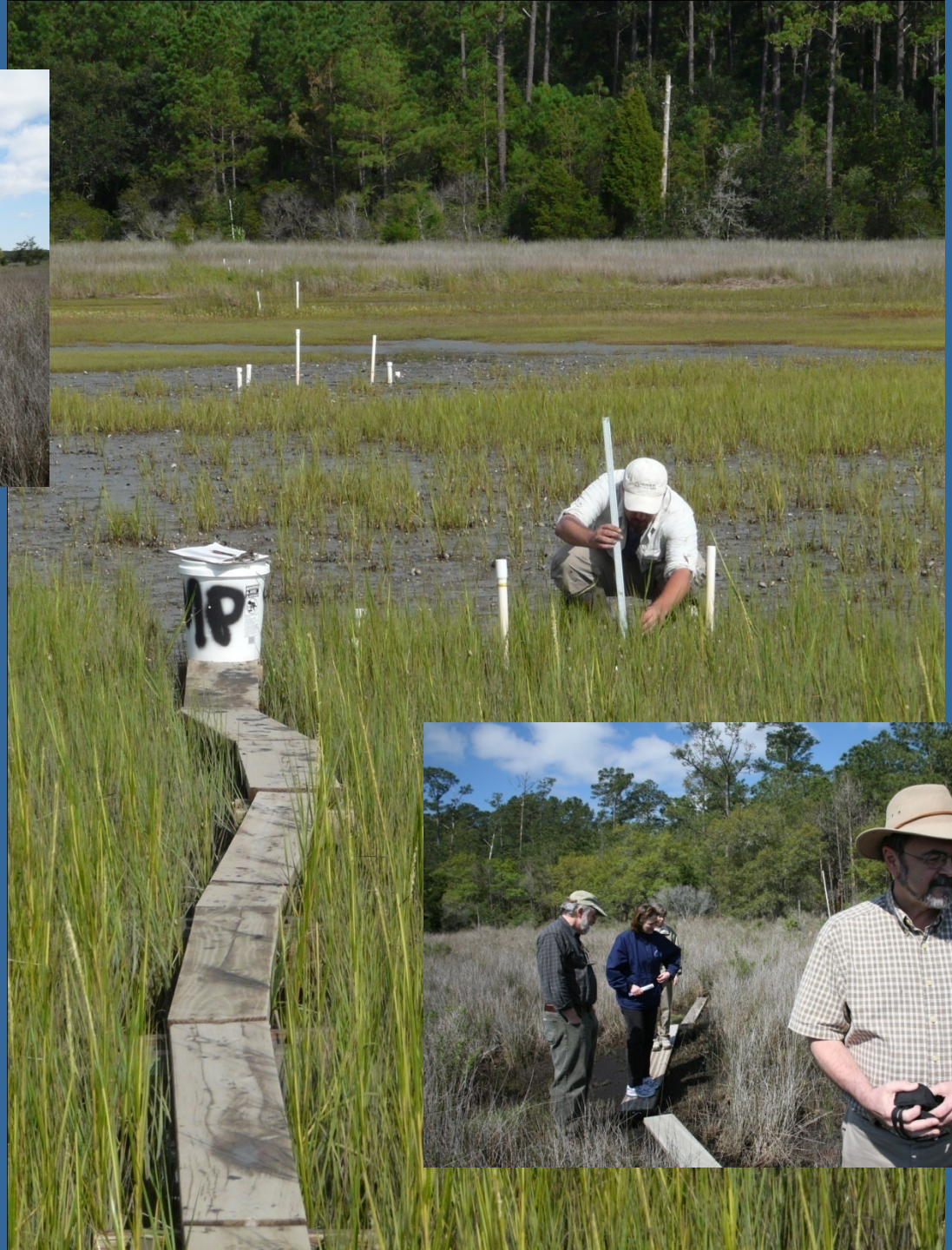
Impacts of coastal growth on water and habitat quality and ecological communities

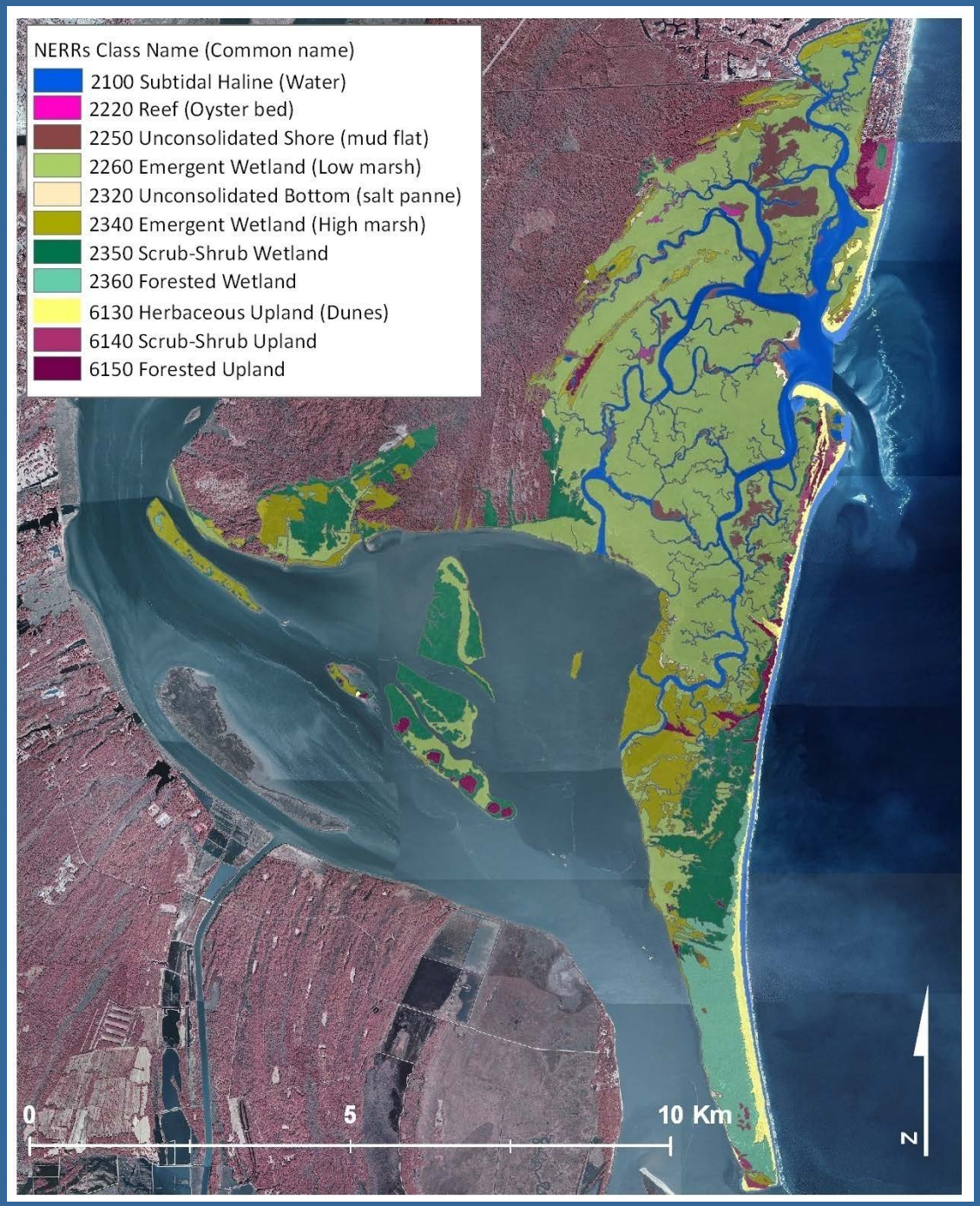
Impacts of naturally occurring long-term and episodic climatic events on coastal ecosystems and human communities

Impacts of invasive species and habitat loss on biodiversity

Long-term emergent vegetation study

NERRs as "Sentinel Sites" for Climate Change





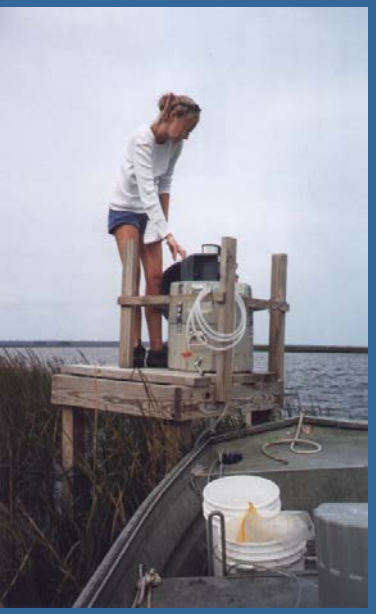
Habitat Mapping and Change Analysis

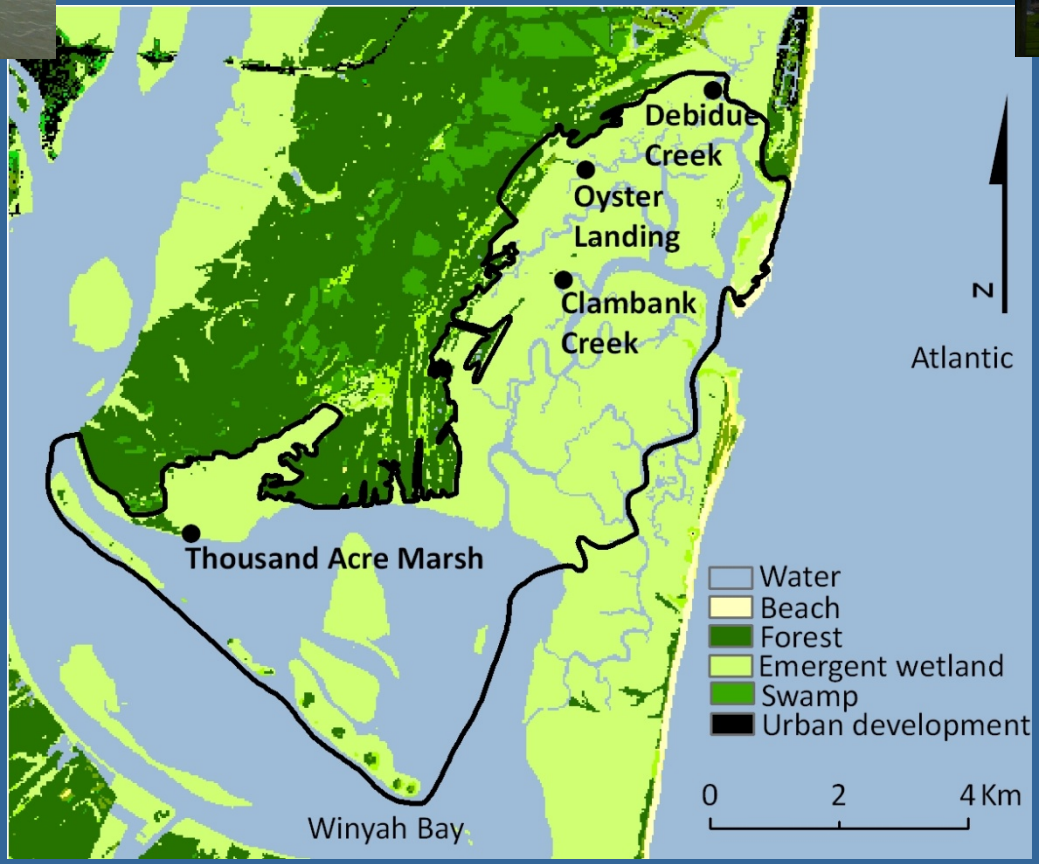
Long-term fauna studies:
nekton, plankton, benthos

NERRS System-wide Monitoring Program

Water Quality – Physical parameters (temperature, salinity, pH, DO, turbidity, depth) are measured every 30 minutes with YSI automated data loggers.

Weather –Temperature, humidity, rainfall, wind speed and direction, barometric pressure, solar radiation and PAR, measured and logged at 15-minute intervals, feed in real-time to a website.

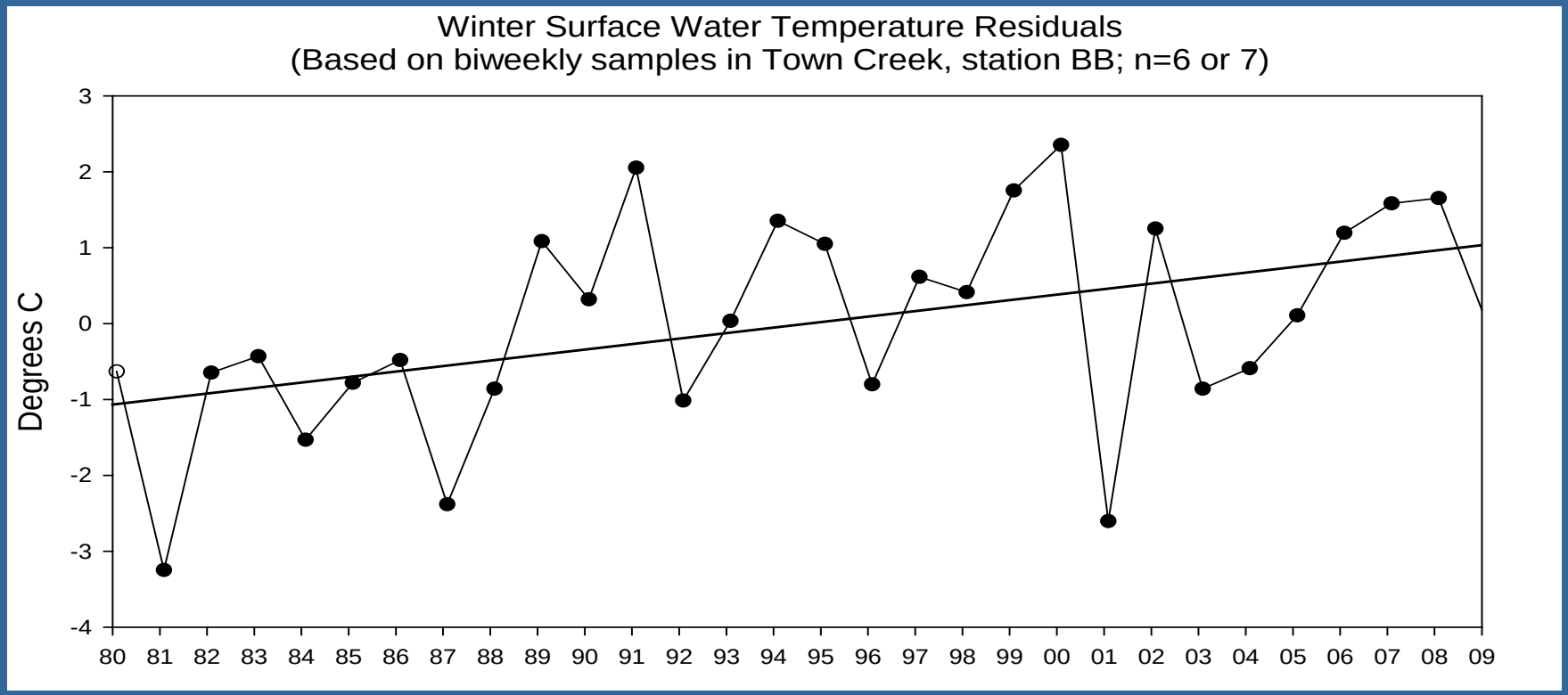




Water Chemistry – Water samples are taken over a 24-hour period and analyzed for nutrients, suspended solids, dissolved organic carbon, and chlorophyll-a every 20 days at each of 4 stations.

Winter water temperature at North Inlet estuary, SC 1980 – 2009

significant increase: non-linear regression $p = 0.01$
change: + 2.1° C long-term average: 11.1° C



Winter water temperatures: significant positive correlation with NAO index, $r = 0.46$ $p = 0.01$

Climate related changes evident in North Inlet over the past 30 years

- increasing water temperature , especially in winter:
  significant correlation with NAO index

- decreasing salinity trend due to episodic events:
  increasing frequency of El Nino events in winter- spring
  and tropical storm events in summer-fall

- decreasing river discharge

- increasing sea level

- increasing *Spartina* marsh production with sea level rise

- decreasing zooplankton abundance correlated with increasing
  temperature and decreasing salinity

- expansion in the period of larval production of some species

- earlier immigration of some winter shrimp and fish larvae

- increasing abundances and changing growth rates of some of young
  fishes and shrimps within the nursery

The Discovery Center

Educational Gateway to Hobcaw Barony

Yard stick

Changing Coastlines

What You Do Matters!

Be part of the solution to global warming:

- Use less gasoline—walk, bike, use fuel-efficient vehicles, and carpool whenever possible
- At home, use energy-efficient windows and doors, bulbs, and appliances
- Reduce, reuse, and recycle

Planet Earth has experienced changes in its temperatures throughout time, and these changes affect sea level and coastlines. South Carolina's coast was 120 miles inland near present-day Columbia 55 million years ago, a period when the earth's surface was mostly free of ice. Just 21,000 years ago, the Carolina coast was 50 miles seaward of its present location. Since this last ice age, the earth has experienced a period of rising sea level.

How Global Warming Affects Sea Level

Waters expand with warmer temperatures, resulting in increases in sea level. The melting and freezing of the polar ice caps also influences sea level. Climate and global temperatures are affected by a variety of natural processes, including the earth's orbit, tilt, and wobble, all of which impact how much solar radiation reaches the earth's surface. Greenhouse gases in the atmosphere—such as water vapor, methane, and carbon dioxide—store heat and warm the earth's surface.

There is consensus in the scientific community that Earth will experience a relatively rapid sea level rise over the next century, and that human activity, largely through emissions of greenhouse gases, is a major driving force.

1 meter = 3.28 feet

In this exhibit, the projected sea rise estimate of one meter by the year 2100 shown in this exhibit represents a compromise between conservative estimates, which do not include ice melt, and more realistic models that incorporate the melt of polar ice caps in their calculations.

Mean High Water Levels, Georgetown Waterfront

A sea level increase of one meter would dramatically impact the local landscape.

Georgetown, South Carolina Coastal Area

This map shows the mean high water levels for the year 2005 and the year 2100—with a projected sea level increase of one meter (3.28 feet).

Pawleys Island Chapel, 2009.

In the Year 2100

Mean High Water Levels, Pawleys Island, South Carolina

Mean High Water Levels, North Inlet, Hobcaw Barony

Cathoe's Fish House, 2009

In the Year 2100

Appreciation is expressed to the NOAA Coastal Services Center for assistance in producing these graphic images and visualizations. Georgetown County, South Carolina provided aerial imagery and elevation data. Landsat Natural Vue Imagery was provided by MDA Federal Inc.

National Estuarine Research Reserve Wing of the Baruch Marine Laboratory, 2009

In the Year 2100

Climate Change Studies at Hobcaw Barony

How do salt marshes respond to increases in sea level? How will plant communities in marshes and edge forests change as salt water moves inland and upstream? How are increases in temperature affecting life in the estuaries? These are just a few of the many climate change questions that scientists are exploring on Hobcaw Barony.

Fast-forwarding Sea Level Rise to Predict Impacts on Marshes

Ingenious Device Aids Predictions

This invention, affectionately known as the Marsh Organ, fast-forwards the effects of sea level rise by artificially exposing marsh plants to varied periods and levels of inundation similar to what they might experience with higher sea levels in the next 50 to 100 years. Scientists look at plant growth and survival under these created sea level scenarios, using the results to predict the impact of sea level rise on marsh plant communities. Preliminary models indicate that a good portion of North Inlet's marshes will not be able to keep up with sea level rise and will be replaced with open water.

Metabolism Chamber Measures Marsh Health

On the Waccamaw River, scientists are introducing saltwater to freshwater tidal marsh study sites to determine potential impacts of future sea level rise and increasing salinities on river marsh communities. Metabolism chambers measure the "breathing" of the entire marsh community—including plants, insects, fungi, and soil bacteria—allowing comparison of freshwater- and saltwater-impacted sites.

Measuring Dissolved Oxygen for Plankton Metabolism Study

Long-term biological monitoring studies of estuarine plankton (drifters) and nekton (swimmers) carried out by Baruch scientists can detect changes in these communities resulting from climate change. Changes in periods of reproduction and timing of migrations for shrimp and fish species have been correlated with increasing water temperatures. Long-term studies of bacterioplankton metabolism are conducted to quantify how carbon cycling within tidal creeks responds to changes in temperature and organic matter inputs from the salt marsh that are linked to climate change.

Long-term Approaches for Studying Climate Change

Monitoring the Effects of Sea Level in Plant Communities

The North Inlet-Winyah Bay National Estuarine Research Reserve has established long-term marsh monitoring sites to understand how salt marsh plant communities change over time in response to sea level rise. Researchers visit these sites, which are located from the creek edge to the forest, in late summer to determine plant composition, density, and height. Groundwater is tested monthly for salt content and nutrient levels. Sediment Elevation Tables provide precise measurements of the rate of change in marsh sediment height relative to sea level.

Bands Measure Tree Growth at Crab Hall Swamp

These low-lying freshwater wetlands are susceptible to upland runoff, tidal flooding, saltwater intrusion, and other global climate change phenomena. These forests are among the most sensitive to sea level rise and increased drought or flood frequency, and are readily impacted by sudden or long-term exposure to the slightest levels of salinity. Long-term studies by Clemson University researchers are yielding insights into how climate change may impact cypress-tupelo swamps. Scientists measure tree growth and survival, water levels and salinities, and regeneration success.

The green porcelain crab *(Petrolisthes armatus)*, which usually lives in more tropical waters, is quite common in South Carolina intertidal oyster reefs in years when winter water temperatures are mild. Range extensions are being documented for many species through long-term studies in North Inlet.

"South Carolina's Changing Shoreline: Implications for the Future" Summary Report

Samantha Bruce, Nicole Saladin, Stefanie Simpson, Rebekah Walker Szivak, April Turner

5/17/2010

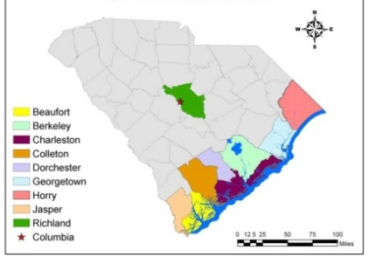
Workshop Series Target Audience

This section provides summary figures and tables from the three workshops, which characterize workshop attendance based on where participants are from, and what their professional roles are.

The South Carolina map below (figure A) highlights the eight coastal counties and one inland county that participated in the SCCIN Shoreline Change Workshops.

Figure A: SCCIN Shoreline Workshop Counties

Projection: NAD 1983 State Plane South Carolina



The Shoreline Change Workshop participant categories are listed below (table A1) along with the affiliations grouped within them. The list is exclusive of the workshop planning team representatives. The total number of workshop series attendees from each category is also given.

Table A1: Shoreline Change Workshop Series Participants

Category	Affiliations Included	# of Attendees
Elected/Appointed Officials	Town/County Councils, Commissions, and Boards, State House of Representatives	39
Planning/Zoning	Town/County/Regional Planners, Planning/Zoning Administrators, Natural Resources Managers, GIS Technicians	32
Public Works	Engineers, Stormwater Technicians, Stormwater Utility Managers	7
State Government	S.C. DHEC OCRM, S.C. DNR, S.C. Sea Grant Extension	4
Nonprofit	Coastal Conservation League, The Nature Conservancy	2
Sub-Government	Beaufort Conservation District	2
Private Sector	Landscape Architects, Property Owners Associations, Realtors	3
Academics	Clemson University, University of South Carolina	4
		Total: 93

Workshop Series Outcomes

After discussion of community shoreline change risks, participants were asked to vote on the risk or risks they felt were most important in their community. Participants were allowed three votes, and were able to cast all three votes for a single risk or distribute their votes as they saw fit. The risks voted on were grouped into themes for ease of making comparisons (table 1a).

Table 1a: Prioritized Risk Themes from Participant Voting Exercise.

Risk Themes	Risks
Damage/loss of property/infrastructure	Damage/loss of public/private property; loss of infrastructure; large scale destruction due to severe weather
Economic impact	Economic losses (loss of tax base, revenue, property values); insurance costs; increased economic costs (for flood control, repairing/maintaining infrastructure); loss of federally funded flood insurance; flood insurance rate increases; siltation of port harbor, mouths, navigation; negative effect on tourism and fishing industries; continued beach renourishment expenses
Flooding	Flooding (severity/frequency)
Impact to water resources	Contamination of surface and ocean water; salt water intrusion; stormwater runoff & pollution; impact to drainage facilities further inland
Loss of habitat & natural storm protection	Loss of habitat/species; threats to wildlife/habitat and general environmental degradation; erosion of beach/dune system; wetland losses; impact to vegetation; armoring estuarine shoreline
Sociological	Losing ability to use beach for recreational purposes; reduced quality of life; movement of baseline, setback line; residents/social & community; public health
Other	Accreted land and managing it for the future; increased density on beaches

Following a discussion of the challenges/barriers to addressing shoreline change in coastal communities, participants were asked to vote on the challenges/barriers they perceived to hinder their community the most. As with voting on the risks, participants were allowed three votes, and were able to cast all three votes for a single risk or distribute their votes as they saw fit. The challenges/barriers voted on were grouped into themes for ease of making comparisons (table 1b).

Group Activity: Hazards Profile
Using the flood and the elevation maps
• Highlight areas on the maps that you have seen flooding.
• Where do you think future flooding will occur based on sea level rise trends?

Roadmap for Adapting to Coastal Risk
NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

lid at hobcaw pervious surfaces

lid at hobcaw semi-hardened shoreline

Thursday
April 22, 2010

COASTAL OBSERVER

Pawleys Island,
South Carolina

Waccamaw Elementary

Rain garden puts environmental education into students' hands

By Sarah L. Smith
Coastal Observer

It was hard work, Waccamaw Elementary students said, but as they planted flowers and bushes in their new rain garden, they knew they were helping the Earth.

"That's why I'm here," Camille Henry, 9, said.

She and 28 other third-graders planted 72 native species in a plot next to the school's gym on Wednesday.

Funded by a $4,900 grant from Wal-Mart, the rain garden will be a hands-on learning tool in science lessons, principal Vervatine Reid said.

Staff from the North Inlet-Winyah Bay National Estuarine Research Reserve and Coastal Waccamaw Stormwater Education Consortium coordinated the planting, and taught faculty and staff about the importance of filtering water before it heads into lakes and oceans.

The two organizations will continue to provide information on watersheds and stormwater for teachers to use long after the garden is established, according to Lindsay Thomas, the education coordinator for the research reserve.

> **"You had to dig this big hole and make it deep and wide, and basically it took forever."**
>
> **Madeline Lanford**
> *Student*

"They're never too young to learn about the environment. There's an endless list of activities that can go on," Thomas said.

At Georgetown High School, students use their rain garden to check the levels of chemicals in runoff. They've also made rain barrels to collect the water.

Other schools with gardens have students do research projects on different aspects of stormwater.

Waccamaw Elementary students didn't know what they'll do with the garden yet, but they were excited about getting the plants in the ground and maybe getting a little dirty.

Before students got involved, employees of the county's stormwater department starting digging while volunteers and school staff hauled the plants outside.

Tanya Ackerman/Coastal Observer

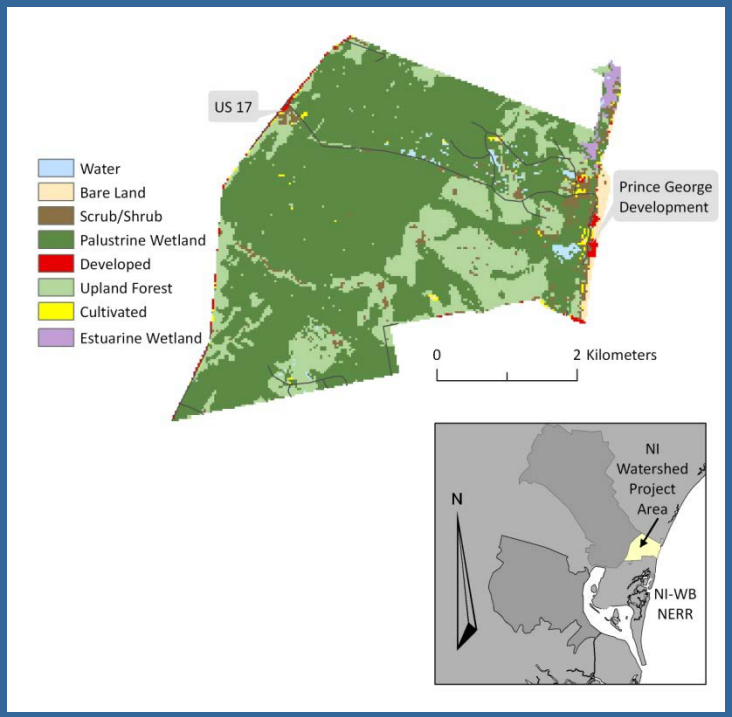
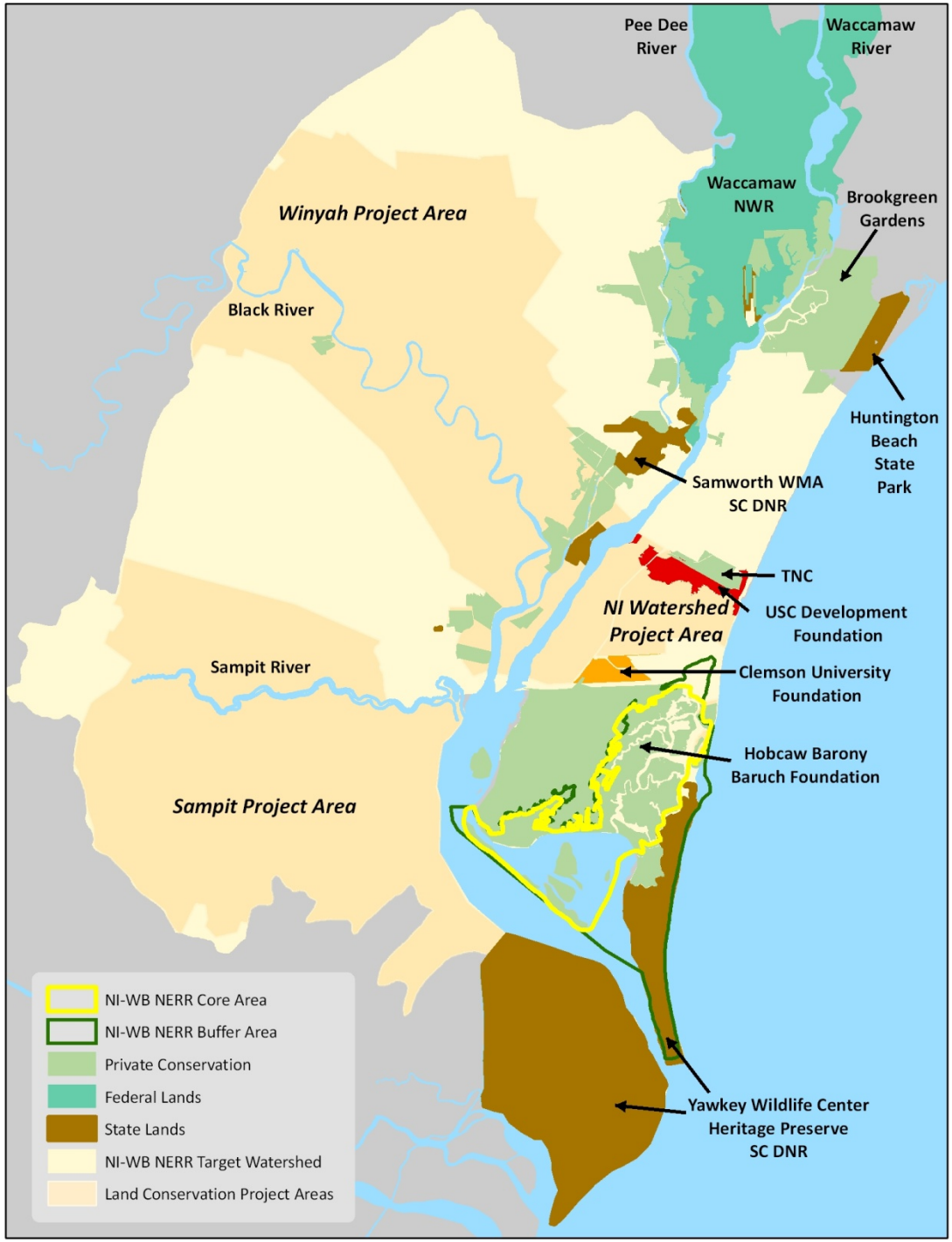
Rowan Besse, 9, Reagan Sellers, 9, and Breanna Salvino, 8, got a little dirty planting a rain garden at Waccamaw Elementary School.

Thomas directed pot placement and showed students how to dig holes. There weren't enough rakes and shovels to go around, so students took turns.

Clothes were soon streaked with dirt as students placed dogwoods, butterfly plants, an all-spice bush, possum haw, yaupon

See "Rain," Page 17

Rain Garden Partnership: North Inlet-Winyah Bay NERR, Coastal Waccamaw Stormwater Education Consortium, Georgetown County Stormwater Division, Wal-Mart, Waccamaw Elementary School

Land Conservation Project Areas

CELCP Opportunities?