

# 2018-2022 Management Plan

JACQUES COUSTEAU NATIONAL ESTUARINE RESEARCH RESERVE



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## EXECUTIVE SUMMARY

*This document describes the priorities that the Jacques Cousteau National Estuarine Research Reserve (JC NERR) will use to address key goals and objectives over the next five years from 2018-2022. These priorities are provided for each of the core areas, as well as for new and emerging issues, challenges, and opportunities. Of paramount importance will be to provide information and deliver programs and technical support in response to three primary management issues:*

- Improve resilience of coastal ecosystems and communities to anthropogenic and natural drivers of environmental change
- Monitor response of coastal ecosystems to habitat change and alteration
- Develop processes governing connectivity of habitats and communities from watershed to ocean

Our research, education, stewardship and outreach programs will address these issues by integrating management information, science, and educational programs with real-world experiences and training, and by addressing the following key goals:

**Research:** Enhance coastal management programs through application of sound scientific research and monitoring that assess drivers of environmental change in estuarine and wetland ecosystems, including environmental change, eutrophication, habitat loss and alteration, invasive species, and other factors.

**Coastal Training:** Provide science-based information for decision-makers to inform management of coastal ecosystems and communities.

**Education and Outreach:** Advance environmental appreciation, scientific literacy, and the ability to make science-based decisions that positively impact the estuaries, watersheds, and communities along the nation's coasts.

**Stewardship and GIS:** Provide information, services, and infrastructure for research, education, and outreach in support of sustainable natural resources and communities.

We also will maintain a philosophy of acting locally and thinking nationally. The JC NERR will continue to deliver its innovative programs locally, and disseminate information at the state and federal levels with the assistance of key partners. Lands within the JC NERR are publicly owned and managed by local, state and federal agencies. As a result, a significant level of resource protection is in place. For this reason, JC NERR programs have focused on research, education, coastal training, and stewardship. These areas of emphasis will continue over the next five years.

To advance the Vision and meet our Mission, the JC NERR must address a suite of challenges associated with:

- Environmental Change
- New and Emerging Technology
- Increasing Demand for JC NERR Programs and Services/Engagement of New Partnerships and Collaborative Opportunities, and
- Sustainable Funding in a Dynamic Budget Environment

### **Environmental Change**

A key challenge is the emerging threat to reserve lands from environmental change, especially sea level rise. In some areas, no path exists for marsh habitat to migrate. In areas that do offer migratory opportunities, the cost of acquiring lands can be very expensive. To address environmental change more broadly, JC NERR initiatives will focus on assessing the drivers of environmental change in estuarine ecosystems, including climate change effects (e.g., sea-level rise, erosion, and inundation), habitat loss and alteration, eutrophication, and invasive species. This will be addressed through the continued development of a Sentinel Site capacity at the Reserve. Sentinel site efforts will focus on biomonitoring of emergent salt marsh plant communities, mapping of marsh surface features, larval fish studies, among other work. This research will generate critical information for coastal wetland management strategies, along with scientific and economic data, models, and visualization tools to understand projected outcomes under future sea-level rise scenarios.

Another major effort at the JC NERR with respect to environmental change will be to interact more closely with land management agencies. One specific way is through the Seamless Network Initiative that the JC NERR initiated with a variety of federal and state agencies. This network may be expanded to include international partners in the future.

Finally, a key environmental challenge will be to develop timely tools and information that demonstrate the value of coastal and estuarine habitats, and the ecosystem services they provide to communities. A preliminary study is underway at the JC NERR to develop a first order valuation of key habitats to community resilience. More efforts will be required to provide the level of detail and science-based information that communities can use to inform their planning efforts.

### **New and Emerging Technology**

Autonomous underwater vehicles (AUVs), small underwater robots capable of operating independently, are increasingly being used to collect physical, chemical, and biological information in the marine environment. Recent efforts have been made to expand this technology by combining it with acoustic telemetry – tagging and tracking animals with sonic tags – to provide information on the distribution and movements of marine fish and other sea life. This information is needed to improve our understanding and management of the coastal environment. The JC NERR will also working towards the integration of a network of passive acoustic (VEMCO) receivers at each of the SWMP stations to provide greater resolution and understanding of the behaviors of ecologically and economically important fauna within and among reserve waters.

Unmanned aerial systems (UAS) will be evaluated for their research and data collection applications. The JC NERR is working with NOAA on a project to evaluate the effectiveness of UAS platforms to produce multiple mapping data and products in marsh and dune systems. In addition to this product the JC NERR will be exploring opportunities to partner with the Rutgers University UAS department to collect high resolution aerial imagery and elevation data within the JC NERR. The high-resolution data will aid in habitat classification and change monitoring, resulting in a useful management product for the JC NERR partners.

### **Increasing Demand for JC NERR Programs and Technical Assistance**

The demand for JC NERR programs, services, and technical assistance continues to increase. With a relatively small staff, and the likelihood that significant new resources will not be available to hire new staff, the Reserve must maintain strong partnerships with existing organizations and identify new

partners that can help meet this demand. Reserve staff will have to identify programs that have become “routine” to deliver, work with partners to deliver these, and thus create time to address emerging issues and new program opportunities. Existing partnerships with academic institutions, local, state and federal agencies, and nongovernmental organizations have been and will continue to be used to meet the increasing demand and support collaborative program efforts across sectors and disciplines.

Nontraditional partnerships will also be explored, particularly with groups that benefit from the work of the Reserve. Examples include hunting and fishing organizations, chambers of commerce, the real estate and insurance industries, and coastal recreation groups.

### **Sustainable Funding in a Dynamic Budget Environment**

Significant challenges faced by the JC NERR include the lack of growth in the operating budget. This situation compels staff to seek external funding for projects and programs that may not align completely with reserve priorities but do generally benefit coastal stakeholders. The staff is very skilled and successful in leveraging external grants, but when grant responsibilities continue to grow, along with core reserve responsibilities, the demands on staff time and effort can be daunting. Compounding this situation is the demand for the JC NERR staff to accept leadership positions in national organizations and service on NERRS committees, thus stretching the capacity of a relatively thin but highly competent staff that are recognized leaders in their respective fields.

## **AWARDS AND ACHIEVEMENTS**

In the past five years, the JC NERR has had significant achievements in all core sectors. These advancements would not have happened without the talent, creativity, perseverance, and dedication of our hard-working staff and volunteers. Together, we educate the public about the benefits of the Reserve, equip decision-makers with the knowledge and tools they need to prevent loss during catastrophic events, and use emerging and innovative technologies. We empower communities by engaging citizens and students in environmental stewardship, and we continually improve our outreach through program integration. For all projects and programs, the JC NERR strives for local relevance and national impact. Below is a list of recent awards and achievements.

### **Awards**

#### National Award of Merit (2015)

The JC NERR/Tuckerton Seaport was recognized as a leader in community recovery following Superstorm Sandy.

#### National Medal for Museum and Library Service (Finalist) (2015)

This is the highest honor given to museums and libraries by the Institute of Museum and Library Services, which recognizes institutions for exceptional community service. This award was given to the Tuckerton Seaport, in partnership with the JC NERR and our Life on the Edge (LOE) exhibit.

#### Floodplain Management Leadership Award (2015)

The JC NERR received this award on October 22, 2015. The award acknowledges significant strides to reduce losses in floods with comprehensive flood management, including the areas of education, policy, government, litigation, outreach, and research.

#### NERRS National IMPACT Award (2016)

This award was presented to the JC NERR staff for outstanding leadership and skill in the areas of coastal resilience and coastal stewardship.

### **Achievements**

#### Coastal Training

The JC NERR has developed tools and information to educate and empower community officials, and to make communities less vulnerable to storms, flooding, and sea level rise. We have received national recognition for our superior leadership in coastal stewardship and resilience.

#### Education

Using novel technologies, the JC NERR's education program targets students of all ages, backgrounds, and experience levels. One of our most innovative teaching tools is underwater robotics, which are remotely operated and autonomous underwater vehicles (AUVs). These robots add an interactive, highly engaging element to our STEM curriculum. Educators have adopted our robotics information into their own curricula, citing an advantage in teaching the sciences, where they can convey information to students with real world, real-time data.

#### GIS/Stewardship

The JC NERR developed a standard protocol to evaluate shoreline changes in response to traumatic,

episodic events. This protocol, which has been successful in our own practice, has been adopted by more than 20 National Park Service areas, along with US Fish and Wildlife Service (USFWS) refuge areas in the Northeast, Mid-Atlantic, and Southeast regions.

#### Land Acquisition

The JC NERR made great progress in acquiring priority lands identified in the 2009-2014 Management Plan. All but one parcel was acquired in the “Wading and Mullica River Wetlands” acquisition project, which is a long-term plan. Conservation of these special ecological places reflects accomplishment of the JC NERR and shows that the JC NERR has the power to preserve and protect New Jersey's valuable areas.

#### New Technology

The JC NERR has also made significant progress in bringing novel technology to the classroom and its real-world endeavors. Bringing innovative programs and current science to our classrooms has given New Jersey's students a greater understanding of their environment. JC NERR is also using underwater robotics to support its marine science research.

#### Research

A study examining factors contributing to the eutrophication of Barnegat Bay was essential in forming and shaping management strategies. Research and monitoring of the Tuckerton Peninsula characterized the basic structural and functional elements of the Reserve sentinel site for sustainability and resilience applications. JC NERR staff facilitated a number of studies on aquatic animal (fishes, turtles, and crabs) use of habitat, migration, population connectivity, response to climate change, and interactions with fisheries.



## EMERGING ESTUARINE CHALLENGES



### **Environmental and Climate Change**

The characteristics and evolutionary trends of the estuarine system will be at the forefront in responding to the drivers of sea-level rise, negative sediment budget, increased storminess, and human modification of this highly dynamic land-water interface. Whether part of the natural environment or part of the built environment, the estuarine system will be adapting to the products of climate change through spatial shifts and modifications of surface characteristics that will drive short-term variation and long-term changes in the structure and function of biotic communities and habitats. A primary challenge will be to provide metrics on the spatial and temporal dimensions of change to provide a solid basis for the development of strategies and mitigation measures to accommodate the variety of natural and cultural impacts. As seen in the post-Sandy recovery period, there are opportunities to evaluate the vectors of the impacts and to aid in the identification of steps toward improved resilience. The dynamic nature of the estuarine margin, surface, biotic communities, and habitats offer numerous opportunities for the JC NERR to generate local knowledge and to communicate its value in the development of essential management strategies.

### **Coastal Flooding**

As sea levels rise, coastal flooding does too. No longer is coastal flooding only caused by a strong storm or hurricane. Flooding now occurs with high tides, precipitation that cannot drain, a stiff wind blowing from the right direction, land subsidence, and the loss of natural barriers. Coastal flooding can simply be road closures, backed up or overwhelmed storm drains, and compromised infrastructure. It can cause

inconveniences like having to take a different route to work, park your car further uphill, and/or adjusting your schedule around the tides.

A recent Scientific and Technical Advisory Panel (STAP) [report](#) published by Rutgers University updates the localized sea level rise amounts and corresponding probabilities to inform stakeholders and coastal decision-makers about what immediate and long-term planning horizons should be for. It is also useful for decision-making. The amount of sea level rise projected along the NJ coastline considers both large global scale processes (e.g. fossil fuel emissions, ocean warming, and glacier and ice sheet loss) as well as New Jersey-specific effects such as the rate of tidal rise over the past 100 years and the rate of land sinking (subsidence).

Based on a year 2000 baseline, the STAP report found that coastal areas of New Jersey will likely experience sea-level rise between 1.0 and 1.8 feet prior to 2050. The amount of sea-level rise predicted to occur after 2050 depends upon future global greenhouse gas emissions. Under a high-emissions scenario (“business as usual” scenario), it is likely that coastal areas of New Jersey will experience between 2.4 and 4.5 feet of sea-level rise by 2100. Under a low-emissions scenario, it is likely that coastal areas of New Jersey will experience between 1.7 and 3.1 feet of sea-level rise by 2100. The STAP report indicates that sea-level rise of 10 feet of sea-level should be considered with a low probability, but it is possible.

Higher sea levels will increase the baseline for flooding from coastal storms and, therefore, increased impacts. In other words, a weak storm of the future will have the equivalent flooding impact of a historic stronger storm due to the higher baseline water level caused by sea level rise. Future strong storms could have even heightened impacts beyond what has been experienced to date. Flanked by the Atlantic Ocean, Barnegat Bay, Great Bay, and the Mullica River, much of the lands within the JC NERR are low lying and highly exposed. This exposure means that fluctuations in tidal levels through surge events and rising sea levels pose significant challenges for the JC NERR.

### **Water and Habitat Quality**

Water quality of the Mullica River-Great Bay Estuary (MR-GBE) has traditionally been excellent because of the limited development and industrial activity in the Mullica River Watershed. Nutrient loading has not been excessive from anthropogenic sources (e.g., farmlands), and the nutrients that enter upriver typically are not effectively utilized by autotrophs in the Mullica River due to light limitation in the water column. Periodic upwelling in coastal ocean waters of the JC NERR results in episodes of low dissolved oxygen. These ephemeral events can contribute to short-term water-quality changes in the lower estuary. Increasing precipitation projected by climate change models will pose future water quality challenges because accelerated runoff driven by the precipitation will likely deliver greater amounts of nutrients and contaminants to the estuarine system.

In contrast to the relatively pristine water quality of the Mullica River-Great Bay Estuary, the Barnegat Bay-Little Egg Harbor Estuary (BB-LEH) is eutrophic, being impacted by nutrient enrichment from a highly populated and developed coastal watershed. Conversion of natural land covers to urbanized landscape in the BB-LEH Watershed has accelerated nutrient loading to estuarine tributaries, leading to cascading water-quality and biotic impacts in the estuary. Little Egg Harbor, which lies entirely within the boundaries of the JC NERR, has experienced increasing frequency of algal blooms and declining seagrass habitat in recent years due to nutrient enrichment of the system. Eutrophication remains the greatest threat to the water quality, habitats, and ecosystem services of the Barnegat Bay-Little Egg Harbor Estuary.

The JC NERR research and monitoring program will track short-term variability and long-term changes in water quality and habitat characteristics of estuarine and watershed environments of the reserve as part of the SWMP program. Habitat mapping and assessment of land use and land cover changes will be

important components of this work. The JC NERR will assess and coordinate estuarine water quality via system-wide monitoring (SWMP) monitoring, and it will continue to make systematic, long-term observations of habitat conditions. Currently, there are four continuously operating SWMP water quality monitoring stations in the Mullica River-Great Bay Estuary. One challenge is to establish additional SWMP water quality monitoring stations in Little Egg Harbor. Output products of the research and monitoring program will foster greater understanding of the relationship between disturbance/change and physical, chemical, and biological processes required to sustain biotic communities and resources in the system. They will provide significant new information for decision-makers tasked with developing management plans to increase resilience of the coastal zone in response to climate change and anthropogenic impacts.

## RESERVE SYSTEM INTRODUCTION



### **Purpose and Scope of Updated Management Plan**

Since its establishment in 1997, the [Jacques Cousteau National Estuarine Research Reserve](#) (JC NERR) has managed New Jersey's coastal environments through science, education, and stewardship. This mission drives the goals, objectives, and strategies that address critical coastal management issues in the Mullica River-Great Bay Watershed and the New Jersey coastal zone. Our 2018-2022 Management Plan builds upon past successes and provides a vision for managing future challenges and addressing priority concerns. It demonstrates our commitment to the NERRs system and outlines actions to protect our valuable natural resources in the face of environmental change and emerging ecological issues.

As evidenced by recent natural disasters, rising sea levels and increased flooding from coastal storms, New Jersey's people, places, and economy face dynamic challenges. Reports from the Federal Emergency Management Agency (FEMA) show that in addition to taking lives, natural disasters take a financial toll. In 2005, according to FEMA, Hurricane Katrina cost \$108 billion in cleanup. Hurricane Ike cost our nation \$29.5 billion, and Superstorm Sandy resulted in a \$50 billion loss. Despite these sobering statistics, there is hope to reduce future vulnerability to coastal storms. Studies show that every \$1 spent on resiliency planning saves \$4 in response and recovery costs and over \$3.5 in costs for the US Treasury on lost tax revenue and disaster recovery expenses. In the next five years, the JC NERR plans to reduce the negative impacts of violent storms through public education, preparedness training, and development of adaptation and mitigation strategies. In addition, we propose to identify and track the processes and activities governing change and stability of coastal systems.

To achieve these goals, programs at the JC NERR will focus on three key management issues:

- Improve resilience of coastal ecosystems and communities to anthropogenic and natural drivers of environmental change
- Monitor response of coastal ecosystems to habitat change and alteration
- Develop an understanding of processes governing connectivity of habitats and communities from watershed to ocean

Our research, education, and outreach programs will address these issues by integrating management information, science, and educational programs with real-world experiences and training.

We also will maintain a philosophy of acting locally and thinking nationally. The JC NERR will continue to deliver its innovative programs locally and disseminate information at the state and federal levels with the assistance of key partners. Lands within the JC NERR are publicly owned and managed by local, state, and federal agencies. As a result, a significant level of resource protection is in place. For this reason, JC NERR programs have focused on research, education, coastal training, and stewardship. These areas of emphasis will continue over the next five years.

## **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, 16 USC. Section 1461) to augment the Federal Coastal Zone Management (CZM) Program. The CZM Program is dedicated to comprehensive, sustainable management of the nation's coasts. As of 2016, the Reserve system consists of 29 reserves nationwide, and two states are in the process of designating reserves. Collectively, the system protects 1.3 million acres of estuaries through stewardship, research, education, and training.

### **NERRS Vision**

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

### **NERRS Mission**

As stated in governing regulations, 15 C.F.R. Part 921.1(a), the NERRS mission is to: practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas.

### **NERRS Strategic Goals**

Federal regulations, 15 C.F.R. Part 921.1(b), provide five specific goals for NERRS:

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

The 2017-2022 *Reserve System Strategic Plan* emphasizes, both as a system and as individual reserves, common guiding principles:

- Engage local citizens, students, and communities in science-based stewardship of coastal estuaries and watersheds
- Use science-based collaborative approaches to address complex coastal management problems
- Create meaningful partnerships to enhance program success and estuary health and resilience
- Lead by example through innovation, investigation, and application of best management practices, planning strategies, and behavioral change
- Facilitate the use of best available science to inform management decisions
- Understand and utilize stakeholder needs to guide program implementation

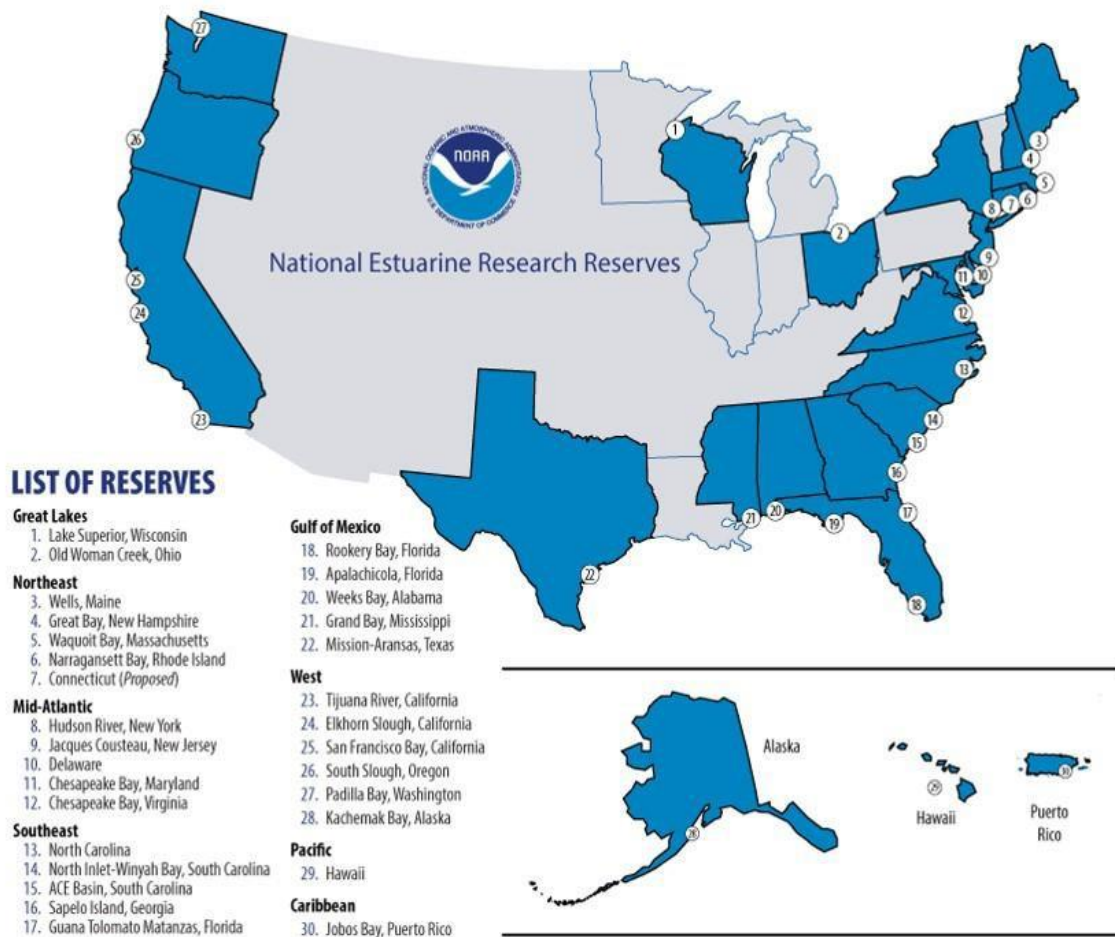


Figure 1. NERRS Network by Region.

The Reserve System, which is a nationwide network of 29 reserves, (*Figure 1*) employs their unique approach on three strategic focus areas of great importance to coastal communities: climate change, water quality, and habitat protection. These challenges are exacerbated in coastal counties where over half of the US population lives, and where residents have a direct impact on land use changes and coastal ecosystems affecting their health and the ecosystem services they provide (NOAA and US Census Bureau 2013).

**Environmental change** is a constant throughout the nation with varying regional impacts. Impacts to communities will be exacerbated in the future by changes in sea levels/lake levels, inundation and flooding from storms, and changes to freshwater flows. Coastal flood damages are expected to increase significantly during the 21<sup>st</sup> century as sea levels rise and socio-economic development increases the number of people and value of assets in the coastal floodplain (NAS 2014). The reserves are well positioned to study the impacts and vulnerabilities of estuaries and coastal communities, support adaptation strategies and mitigate impacts through greenhouse gas reduction and carbon sequestration.

**Habitat protection** is essential given that more than 80,000 acres of coastal wetlands are being lost on average each year (Dahl and Stedman 2013). This figure has increased from 60,000 acres lost per year calculated during their previous study. Primary causes were attributed to development, human activities, salt water intrusion, or inundation highlighting the need for increased wetland protection and restoration activities. The reserves are well suited to map, monitor, and study habitat changes, as well as develop, implement and serve as a test bed for protection and restoration approaches. The system allows transferability of these best practices through coastal training and community education programs.

**Water quality** is vital for coastal ecosystems and communities to thrive. The most recent assessment by NOAA, the US Environmental Protection Agency (US EPA), and the US Department of Agriculture indicates that estuaries are threatened by eutrophication and algal blooms which are strongly influenced by population growth and land use practices (Bricker 2007). The Reserve System-Wide Monitoring Program (SWMP) is a foundational component in understanding trends in estuaries and provides critical information to local municipalities to assess flooding risks, evaluate conditions contributing to harmful algal blooms, inform decisions on local public health risks and advisories, and determine regulatory policies for nutrient criteria and management of invasive species, as well as many other applications. As a place-based network of protected areas, the Reserve System is uniquely positioned to build on their success and address these issues through the goals and objectives in this plan.

## **NERRS SYSTEM GOALS AND OBJECTIVES**

### **Protecting Places**

**Goal:** Enhance and inspire stewardship, protection, and management of estuaries and their watersheds in coastal communities through place-based approaches.

- **Objective 1:** Coastal practitioners will enhance resiliency of reserves and their watersheds through improving the protection and function of coastal habitats
- **Objective 2:** Communities and individuals will have an enhanced connection to estuaries and coastal ecosystems to promote stewardship and care of the resources
- **Objective 3:** The Reserve System will strategically expand to increase the number of representative estuaries across the nation

### **Applying Science**

**Goal:** Improve the scientific understanding of estuaries and their watersheds through the development and application of reserve research, data, and tools.

- **Objective 1:** The Reserve System will expand monitoring of relevant and emerging bio-physical and socio-economic parameters and increase capacity to track the effects of changes in land use, coastal development, and climate
- **Objective 2:** Reserves and coastal researchers will increase their collaborative research to address the needs of decision-makers and stakeholders
- **Objective 3:** Scientific, management, and educational audiences will know about and be able to effectively use reserve research, data, and products to understand the effects of climate and land-use change on estuaries, ecosystem services, and human well-being

### **Educating Communities**

**Goal:** Advance environmental appreciation, scientific literacy, and the ability to make science-based decisions that positively impact the estuaries, watersheds, and communities along the nation's coasts.

- **Objective 1:** Coastal residents and visitors will increase their awareness and ability to improve stewardship of estuaries, coastal watersheds, and their communities
- **Objective 2:** Educators and students will better understand and use Reserve System and NOAA resources for place-based and inquiry-based learning
- **Objective 3:** Coastal decision-makers and environmental professionals understand and can apply science-based tools, information, and planning approaches that support resilient estuaries and coastal communities
- **Objective 4:** The next generation of coastal professionals and environmental stewards is expanded and motivated through access to programs and facilities that facilitate research, resource management, and educational opportunities

### **Biogeographic Regions**

NOAA has identified 11 distinct biogeographic regions and 29 sub-regions in the US. Each contains several types of estuarine ecosystems (15 C.F.R. Part 921). When complete, the Reserve system will contain examples of estuarine hydrologic and biological types characteristic of each biogeographic region.

### **Reserve Designation and Operation**

Under federal law (16 USC. Section 1461), a state can nominate an estuarine ecosystem for Research Reserve status provided the site meets the following conditions:

- The area represents its biogeographic region, is suitable for long-term research, and contributes to the biogeographical and typological balance of the System
- The law of the coastal state provides long-term protection for the proposed Reserve's resources to ensure a stable environment for research
- Designation of the site as a Reserve will serve to enhance public awareness and understanding of estuarine areas, and provide suitable opportunities for public education and interpretation; and
- The coastal State has complied with regulations issued by the Secretary of Commerce (SOC)

Reserve 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. If the proposed site is accepted into the Reserve system, it is eligible for NOAA financial assistance on a cost-share basis with



the state. The state exercises administrative and management control, consistent with its obligations to NOAA, as outlined in a memorandum of understanding. A Reserve may apply to NOAA's Estuarine Reserves Division (ERD) for funds to support operations, research, monitoring, education/interpretation, stewardship, development projects, facility construction, and land acquisition.

### **NERRS ADMINISTRATIVE FRAMEWORK**

The Office for Coastal Management (OCM) administers the Reserve system. OCM designates and operates Reserves, supports Reserve operations and system-wide programming, undertakes projects that benefit the Reserve system, and integrates information from individual Reserves to support decision-making at the national level. As required by federal regulation, 15 C.F.R. Part 921.40, OCM periodically evaluates Reserves for compliance with federal requirements and with the individual Reserve's federally approved management plan. OCM currently provides support for the three system-wide programs: System-Wide Monitoring Program (SWMP), the Coastal Training Program (CTP), and the Teachers on the Estuary (TOTE) program. NOAA provides support for Reserve initiatives on restoration, invasive species, K-12 education, and Reserve specific research, monitoring, education and resource stewardship initiatives, and programs.

### **System-Wide Programs**

Every reserve in the NERRS system contributes to collective programs and priorities. Each reserve develops local programs and priority issues to address local concerns. System-wide programs are carried out using standard protocols. Presently, the national system contains three distinct programs:

#### Sentinel Site Program including a System-Wide Monitoring Program

The SWMP quantifies variations and long-term changes in water quality, habitats, and land use/land characteristics in designated estuaries and estuarine ecosystems to generate effective coastal management. JC NERR aims to make data publicly available to citizens, decision-makers, and community leaders. We will collect thorough, timely integrated data (of water, weather, vegetation, and nutrients) in estuarine environments and provide trend analyses of data.

#### Coastal Training Program

The CTP trains decision-makers along the nation's coastlines. Using current science and skill-building exercises, it helps officials improve their coastal management and make wise choices regarding coastal resources. CTPs reserve-wide use standard evaluations and performance tools to ensure CTP training is successful. Evaluations also show national trends in reserve needs, effective communication, and local capacity.

#### Teachers on the Estuary Program

Teachers on the Estuary is an avenue for local teachers to get to know their 'home' estuary and for teachers who are knowledgeable about their 'home' estuary to increase their understanding of estuarine and watershed issues by learning about a different estuarine system. The TOTE program makes direct connections for teachers from the watershed to the estuary using NOAA/NERRS programs and data. The goal of TOTE is to improve teachers' (and ultimately students') understanding of the environment using examples from the local region and provides resources and training to allow teachers who are not from the area to find out more about their own estuaries and associated watersheds. The trainings are hands-on and investigative and guide teachers to be able to encourage student driven projects. Teachers will be included in planning the design of the program and participating teachers will have follow up meetings to share information as well as ongoing coaching from NERRS staff.

### Graduate Research Fellowship Program

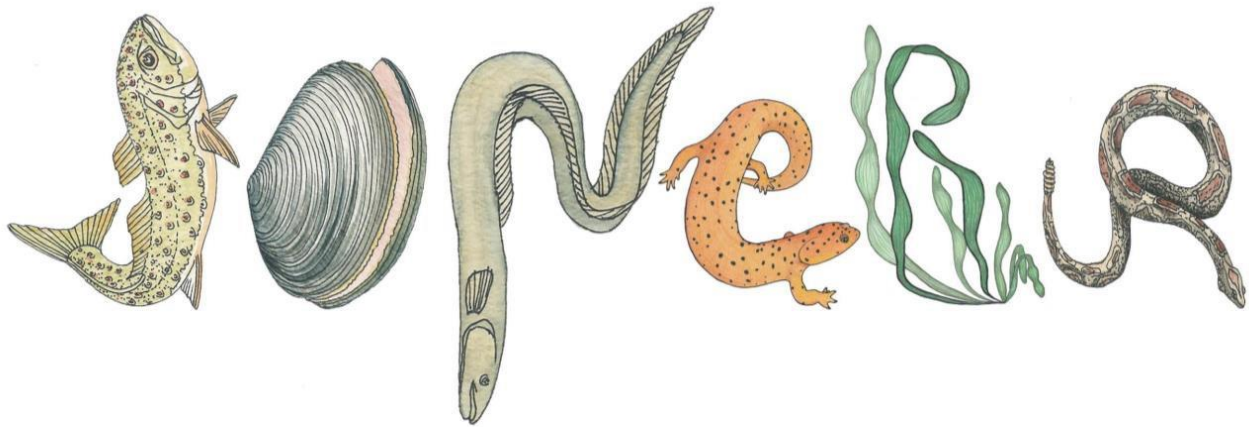
In addition to the three core programs described above, the NERRs has managed a Graduate Research Fellows (GRFs) program in the past. Graduate students have played an important role in the research activities of the JC NERR program. These talented students increased the research capacity of the JC NERR and, as in the case of GRFs at other NERRS sites, provided exposure for the reserve to the scientific community. The JC NERR served as a viable training ground for these future professional estuarine scientists. Their efforts not only advanced site-level priorities but also addressed subjects of local, regional, or national significance. In addition, their work also targeted important coastal resource management issues related to the watershed, fisheries, and pollution.

Five GRFs conducted research projects at the JC NERR between 2007 and 2013. These are listed below. They were all integrated into priority activities of the JC NERR by their advisors and the research coordinator, including land use and disturbance in JC NERR watershed areas (Inga P. La Puma), finfish studies and fisheries implications (Turnure and Pravatiner), climate-change impacts on larval fish (Caridad), and pollution (PAHs) in estuarine waters of the JC NERR (Wolfson). Results of their research projects also have value to scientists conducting similar research in other estuarine systems.

- 2007: Inga P. La Puma - Assessment of land use and disturbance scenarios in the Jacques Cousteau National Estuarine Research Reserve: mechanisms for sustaining resources within the estuarine ecosystem
- 2007: Jason Turnure - Delineating habitat resources for weakfish, *Cynoscion regalis*: biotelemetry and passive acoustic approaches (Turnure et al. 2015a, b)
- 2009: Joan H. Pravatiner - Exploring habitat usage and migration of winter flounder, *Pseudopleuronectes americanus*, using acoustic telemetry (Grothues et al. 2014)
- 2011: Jamie F. Caridad - Climate change impacts on larval fish composition of the Mullica River-Great Bay Estuary New Jersey
- 2011: Sarah J. Wolfson - Biodegradation of PAHs from creosote treated lumber in the BB-LEH Estuary

Should future funds become available, the JC NERR will re-establish this program with an improved design and expanded role for the students that engage them in the full suite of reserve programs and activities.

## JACQUES COUSTEAU RESERVE INTRODUCTION



## Jacques Cousteau National Estuarine Research Reserve

### Introduction

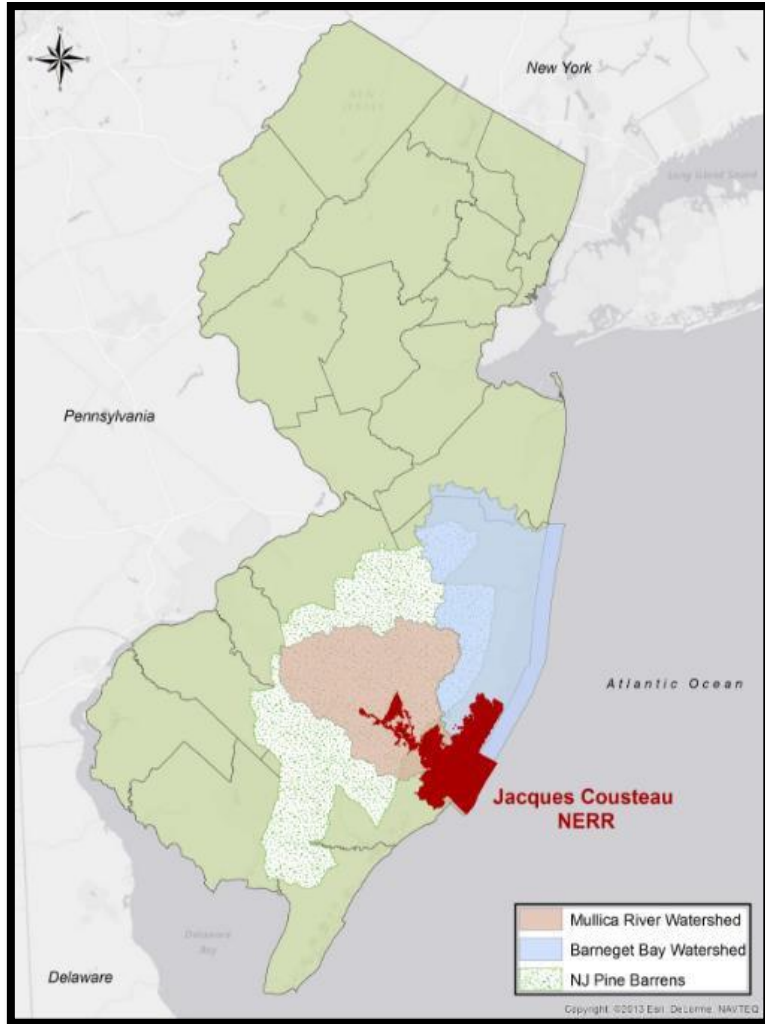
The JC NERR, established in 1997, resides in southern Barnegat Bay and the Mullica River-Great Bay estuary. It was dedicated to avid naturalist [Jacques Cousteau](#) and was the 22<sup>nd</sup> of 29 reserves set aside as a protected area within the national reserve system. The Reserve is managed primarily by Rutgers University (New Jersey Agricultural Experiment Station), with assistance from local partners and NOAA's Office for Coastal Management.

### Location/Physical Setting

The JC NERR encompasses land in the New Jersey Pinelands National Reserve, coastal plains, and barrier islands (*Figure 2*). It is among the most pristine estuaries in the densely populated northeastern United States. The Reserve covers 116,116 acres ranging from the Pinelands forest ecosystem to wetlands and barrier islands (JC NERR Site Profile Appendix A). This acreage is increased from the management plan due to more accurate data, not due to boundary expansion. Human development in the JC NERR is approximately 1%, making it one of the least disturbed estuaries in the northeastern United States. Within the JC NERR's borders is an array of diverse habitats including terrestrial, aquatic, and wetland areas. This territory enables ongoing research and studies focused on finfish, striped bass, and other wildlife.

### History

Since the 1600s, many have called the Mullica River-Great Bay region home. Evidence of life here dates back over 8,000 years, with over 1,000 sites in the Pine Barrens and over 100 sites along the Mullica River. The first settlement in the Mullica River-Great Bay region dates back to 1697, when Finnish settler Eric Palsson Mullica purchased land from neighboring Swedish settlements along the Delaware River. Most early settlers in the region were from Sweden. In the late 1690s, several parcels of land were sold in present-day Tuckerton. Mullica obtained one of these pieces of land in what is now Lower Bank on the Mullica River. The European settlers shared this territory with the Leni Lenape, a large group of Native Americans known as "Delawares" to the settlers. The Lenape tribe occupied parts of Delaware, southeastern Pennsylvania, and southern New Jersey. They were skilled game hunters and harvested finfish and shellfish. In 1758, the remaining Lenape in New Jersey were moved to a 3,000-acre reservation called Edgepillock or "Brotherton." The reservation was located at the headwaters of the Mullica River in present-day Indian Mills, Burlington County. The Lenape relocated to New York State in



**Figure 2.** *JC NERR Physical Location.*

1801. They later moved to Oklahoma.

This area was also an important trade center. Prior to the Revolutionary War, there were approximately 30 homesteads spanning from Tuckerton up the Mullica and Wading Rivers. By 1735, there were 35 to 40 dwellings. Commerce boomed by the mid-18<sup>th</sup> century with sawmills on each of the Mullica River's four branches. A dam was built on the Batsto River in 1765. A gristmill and more sawmills emerged in the early 1700s. The first ship was built in 1724, starting a long shipbuilding history. Pirating and privateering trade began concurrently, with ships deployed to raid British ships and support contraband activities. On September 30, 1778, British forces destroyed the fort at Chestnut Neck. However, their flagship ship "Zebra" with Captain Henry Collins in command ran aground and was abandoned, which terminated their plan to continue up the Mullica River and destroy Batsto Village. The crew did manage to destroy the village of

Chestnut Neck, killing several men and taking prisoners too. The Chestnut Neck Battle Site is on the National Registry of Historic Places.

The industrial and commercial ventures along the Mullica River and Great Bay region drew on the natural resources of both the land and water. Goods were transported along Mullica River for shipment to New York, Philadelphia, and the West Indies. Iron furnaces, crafted in Batsto and Atsion, provided musket and cannon balls for American troops in the American Revolution and the War of 1812. In 1814, a glass industry emerged in the Pine Barrens. Cotton mills, saw mills, and paper mills followed suit.

Native Americans practiced horticulture and southern New Jersey's agricultural practices took off. Most homes built during the 18th and 19th century were farmsteads. Work was seasonal and consisted of subsistence farming. The cranberry industry started in 1835 and is still flourishing today. Blueberries, a New Jersey specialty, were first cultivated in the Pine Barrens in the 1800s. In the mid-1800s, trucks delivered local produce to markets.

The JC NERR is home to several places and artifacts that are listed on the New Jersey and National

Register of Historical Places. Some notable locations are the Crab Island Fish Factory, an island factory used to process menhaden; the Great Bay Boulevard Native American shell mound; and the historic Little Egg Harbor US Life Saving Station #23, now the location of the Rutgers University Marine Field Station. The NJ Historic Preservation Office documents these locations, as well as several others, on the NJ Cultural Resource GIS Online Map: LUCY ( <http://www.nj.gov/dep/hpo/1identify/gis.htm> ). Additional information on historic places within the JC NERR can also be found on the NJ Register of Historic Places: [https://www.nj.gov/dep/hpo/1identify/nrsr\\_lists.htm](https://www.nj.gov/dep/hpo/1identify/nrsr_lists.htm) .

## **Ecological Attributes**

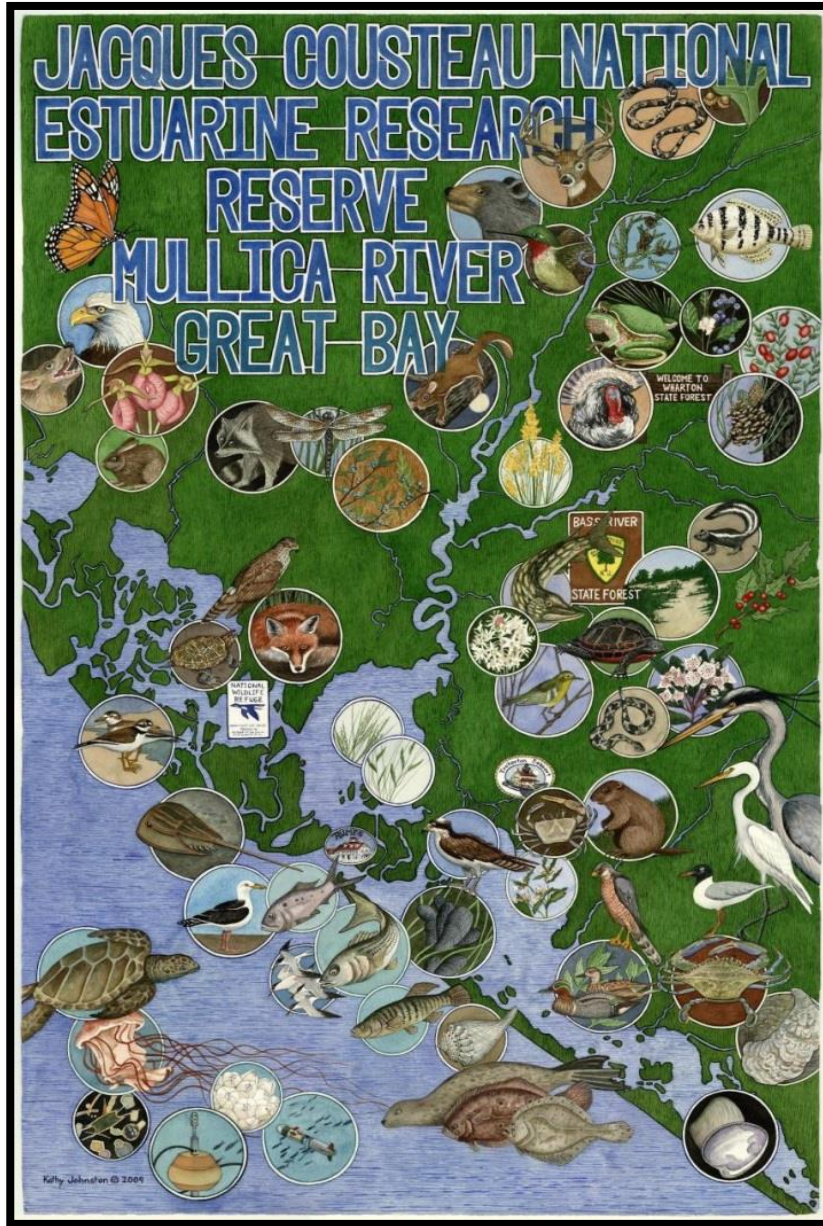
### **Upland Forests**

The upper headwaters of the Mullica River contain white cedar swamps, Sphagnum bogs, and cranberry bogs. The difference in moisture conditions gives rise to two distinct floristic complexes- upland forests and lowland forests. The upland areas support two major vegetation types, namely pine-oak forests and oak-pine forests. The dominant tree is the pitch pine. In no other region of North America does the pitch pine cover such an extended area. Fire plays an integral role in determining the composition of upland areas. Differences in resistance to fire damage, shade tolerance, and reproductive strategies govern the selective action of fire on various plant species. Both pitch pine and oaks can re-sprout from dormant buds lying beneath the soil surface. Upland streams are brown from the humic acids of decaying vegetation, with flow generally slow due to the gentle topography. Stream water has an average pH of 4.4. It is low in alkalinity and high in humic compounds. In the upland forests, the water table is generally two or more feet below ground level and may be as deep as 60 to 70 feet. This contrasts sharply with the lowlands, where water is near or above the surface during part of the year. Upland areas provide habitat for several orchids and insectivorous plants. Resident vertebrate amphibian and reptilian species include the tiger salamander, wood turtle, timber rattlesnake, pine snake, and the Pine Barren frog. The southern bog lemming and bird species including the barred owl and the red-headed woodpecker also inhabit this area.

### **Lowland Habitats**

Lowland forests are composed of Atlantic white cedar, red maple, pitch pine, black gum, gray birch, sassafras, and sweet bay magnolia. Cedar swamps and sphagnum bogs are scattered throughout the pine lowlands, and a dense canopy formed by the cedars builds the understory. Reptiles such as the bog turtle; and amphibians such as the long-tailed salamander and the eastern mud salamander live here. Brackish marshes have cattail, salt reed grass, and three-square rush. Bird species include osprey, peregrine falcon, black duck, ruddy duck, great blue heron, egrets, terns, skimmers, and common gulls and marsh birds such as herons, ibises, sparrows, warblers, bobolinks, and godwits. Tidal salt marshes form an extensive and functionally significant component of the margin between the pinelands and Great Bay. High salinity salt marshes, dominated by stands of saltwater cordgrass, salt meadow grass, and spike grass occur near the coast and along the lower Mullica River. Abundant insect and spider fauna of the marsh surface are studied, especially planthoppers. Dominant fish of the marsh surface pools include killifishes and silversides. Fish of the subtidal creeks are much more diverse and seasonally variable. Coastal habitats feature dunes, barrier islands, and open water environments. Dune covered regions are generally characterized by an herbaceous community with dune grass, goldenrod, searocket and, in protected areas of the back dune, beach heather. Barrier islands such as Little Beach and its associated salt marsh islands represent a major nesting, migration, and wintering area for waterfowl, marsh birds, and shorebirds. Species commonly found here include grebes, herons, egrets, brants, bitterns, rails, sandpipers, gulls, terns, skimmers, and piping plovers. Several osprey nests are on the island, as well as a rookery of black-crowned night herons.





### Aquatic Habitats

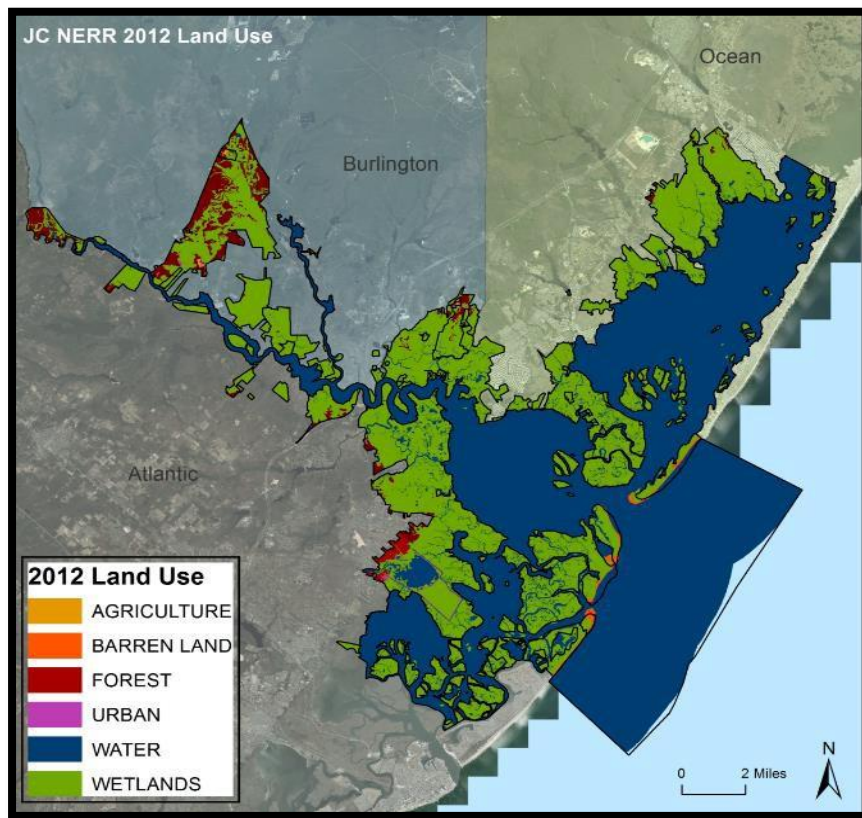
A wide range of aquatic habitats exists in the JC NERR, the most extensive of which consists of open waters covering more than 27,000 hectares (ha) (Figure 3). As demonstrated by its unique aquatic ecosystems, the Mullica River-Great Bay Estuary is of special ecological value. Contiguous estuarine waters include Little Egg Harbor, Little Bay, Reeds Bay, and Absecon Bay. These estuarine waters support numerous planktonic, nektonic, and benthic organisms.

### Key Species

Rich and diverse plant and animal communities inhabit watershed areas of the JC NERR. Scientists have documented 275 species of macroinvertebrates, 91 species of fish, and 350 species of algae living in and around the Mullica River and its tributaries. Watershed habitats support many species of shorebirds, wading birds, waterfowl, raptors, and songbirds.

Amphibians, reptiles, and land mammals also utilize wetlands, riparian buffer, and upland habitats of the JC NERR and the contiguous pinelands. A number of finfish species in the JC NERR (e.g., bluefish, weakfish, summer flounder, winter flounder and shellfish (e.g., blue crabs, and hard clams) are of recreational and commercial importance. The Great Bay is a major migratory stop and wintering area for many waterfowl, shorebirds, and raptors. During winter, the waterfowl population exceeds 70,000 individuals including more than 40 distinct nesting colonies for 15 species. The estuary supports 61 species of finfish.

Major anadromous fish are the striped bass, alewife and blueback herring. Shellfish populations are extensive, including the American oyster in the Mullica River, hard clam in Great Bay and Little Egg Harbor, and surf clams in the coastal ocean.



**Figure 3.** JC NERR Land Use

### Climate and Weather

The JC NERR has a typical temperate Mid-Atlantic climate. Seasons are well defined, but seasonal air temperatures vary considerably from year to year. The coldest temperatures occur during January and July has the warmest temperatures. Winter temperature range from 0-2.2°C and average summer temperatures range from 22-24°C. The Atlantic Ocean moderates seasonal air temperature extremes in the lower drainage basin and in open estuarine areas. Farther inland, away from ocean's air, temperature extremes can be great. Winter temperatures have

dropped below -20°C in the Pine Barrens, and summer temperatures occasionally exceed 38°C. Winds predominate from the northwest and southwest during the year, while prevailing winds from December through March are from the northwest. Southerly onshore winds dominate in the late spring and summer. Wind velocities are generally less than 15 km/hr. Warm tropical air masses from the south and southwest bring hot, humid weather conditions during summer. Afternoon sea breezes reduce summer temperatures within 10-15 km of the shoreline.

In winter, northwesterly winds develop from high-pressure areas with very cold air masses over central Canada and the northern Great Plains of the United States. Periodically, surges of cold air masses flow southeastward across the eastern United States and affect the study area. These surges diminish in spring as the jet stream retreats northward. Spring winds are replaced in summer by warm and humid southerly breezes originating from a large, subtropical high-pressure area (a semi-permanent feature) centered near Bermuda in the Atlantic Ocean. Autumn brings stationary or slow-moving high-pressure areas that originate as cold, shallow highs over Canada and stagnate over the eastern United States as warm highs (Havens 1998). Precipitation, mainly in the form of rain, averages between 100-122 cm/yr. in the region and is distributed relatively evenly year-round. Nor'easters commonly develop in winter and thunderstorms strike in spring and summer. Nor'easters typically develop in waters off the southeast coast of the United States and move north and northeast producing strong winds, heavy surf, and occasional tidal flooding. Thunderstorms are generally of high intensity and short duration.

Extratropical storms and hurricanes arise during late summer and early fall, although they often pass east of the reserve. They can generate destructive winds and considerable precipitation that causes

serious flooding problems, soil erosion, and structural damage. The Gulf Stream influences local weather conditions. This warm-water current parallels the eastern seaboard, heating the overlying air and creating a front along the coast. Subsequently, surface low-pressure systems can form as jet stream disturbances move over this newly formed temperature gradient. Heavy rains and strong winds often ensue because of the large amount of moisture from the ocean and the aforementioned temperature gradient of the coastal front. Strong winds from the east and northeast associated with these storms may cause barrier beach erosion, overwashes, and back-bay flooding. In severe storms, wind gusts have exceeded 90 km/hr. and sustained winds have reached 80 km/hr. During any given calendar year, three to five coastal storms typically occur in the region, with the most severe storms observed in the fall.

### **Evaluating and Tracking Climate Conditions**

A number of weather stations collect meteorological data in the region. The National Weather Service (NWS) at Pomona (~16 km west of Atlantic City; elevation 19.5 m) monitors weather conditions 24 hours a day and has a comprehensive meteorological database dating back to 1943. Other official NWS observation sites in the Pine Barrens include Belleplain State Forest (9.1 m elevation), Chatsworth (30.5 m), Hammonton (25.9 m), Indian Mills (30.5 m), Lakehurst Naval Air Station (39.0 m), Mays Landing (6.1 m), McGuire Air Force Base (43.6 m), Pemberton (24.4 m), and Toms River (3.0 m) (Havens 1998). Locally, the Oyster Creek Nuclear Generating Station (in the Barnegat Bay watershed at Forked River) has collected data since 1966. The US Coast Guard Station on Long Beach Island at Barnegat Light also collects meteorological data. Finally, a Campbell Scientific Weather Station operated by Stockton University in partnership with the JC NERR records meteorological data near Nacote Creek as part of the NERRS System-Wide Monitoring Program. Havens has reviewed the climate in the region (1998).

### **Key Economic Activities in the Area**

The diverse ecosystems around the JC NERR and its temperate climate support a range of seasonal and year-round economic activities. Historically, this region has been utilized for shipbuilding and trade, farming, harvesting, and fishing. Currently, coastal tourism is one of the largest sources of revenue in New Jersey. According to the American Community Survey (ACS), the four coastal counties in New Jersey account of six of every 10 tourism dollars spent in the state. Tourism gives over 400,000 state residents' jobs each year. Many of those jobs derive from ecotourism, including hunting, fishing, and wildlife viewing. According to ACS, keeping regional wetlands intact has the potential to revitalize the local fishing industry, and it will retain the state's valuable tourism professions.

### **Value to the Community**

#### Human Population

The Barnegat Bay Watershed had 588,721 people in 2015 (United States Census Bureau). Future population predictions based on municipal zoning files, PMA regulations, and Coastal Area Facility Review Act (CAFRA) rules for the Barnegat Bay Watershed range between 783,231 and 896,920 people (Lathrop and Conway 2001).

In 1990, the Mullica River Watershed had a population of 76,383 people (0.182 people per acre). In 2000, the population increased to 83,501 or 0.199 person/acre, which is an 8% increase in population over ten years. Future population predictions based on municipal zoning files, PMA regulations, and CAFRA rules for the Mullica River Watershed range between 110,472 and 123,680 people. This would represent a 32% to 48% percent increase in population from 2000 with a resultant density between 0.263 and 0.294 person/acres respectively.

A 2012 ACS study reported 19,992 residents in Little Egg Harbor and 8,164 in Mystic Island (which is part



of Little Egg Harbor). The area's population is primarily Caucasian (96%); 2% identifies as African-American and 1.4% is Asian. The median age is 45.3 years old. Latinos are the largest ethnic minority with a resident population of 5.8%. The Hispanic population in Mystic Island is 9%. Of LEH's residents, 9% live below the poverty line; that number is 10% in Mystic Island. 44% of the LEH population has a high school degree. 26% have some college education, and 10% have a bachelor's degree. In 2015, the population of Tuckerton, NJ was 3,377. Most residents (93%) identify as white. The largest minority groups are African American (0.75%) and Hispanic (.09%).

Over time, population levels in LEH and Mystic Island have fluctuated. Presently, the population is declining. A primary reason is relocation and home sales because of flooding and storm damage. The NJ Blue Acres program proposes buying out approximately 100 of the area's most "at-risk" properties. Of that amount, 28% are seasonal or second homes.

### **How JC NERR Benefits the Community**

The JC NERR benefits the community by providing science to support coastal management, quality education, training for professionals, engagement via stewardship, and physical exhibits. Another asset of the Reserve is to enhance public health. According to the ACS report:

*"Open spaces bring a wide range of environmental and health benefits. Open space provides an outlet to relieve mental stresses and maintain physical health. In addition, open space helps maintain a healthy environment as it can reduce flooding and air pollution that occurs at increased levels in urban environments."*

Improved physical health is one such benefit of the JC NERR. With its pathways, trails, and open areas, the JC NERR encourages physical activity. Open space, according to ACS, reduces the risk of heart disease, obesity, and stroke. The JC NERR offers a reprieve from the car culture that dominates many suburban areas in the United States, which benefits mental health. Access to fresh air invites relaxation, refreshment, and stimulates social interactions. The open areas of the JC NERR combat air pollution, which is one of the leading causes of death in New Jersey. Illnesses such as respiratory problems, asthma, and pneumonia correlate directly with air quality; healthier air equals healthier people. Furthermore, the vegetation and greenery in open spaces abates contaminants and helps regulate temperatures.

The Tuckerton Seaport/JC NERR Visitor Center acts as an economic engine for the area, drawing 103,000 visitors (38,000 for onsite tours and an additional 65,000 for community events) who regularly combine a trip with lunch, dinner, or local shopping in the surrounding area as well as fueling up their automobile or boat before heading back home. For a town with only 3,000 residents this influx of spending is significant. Many visitors attending Seaport/JC NERR Visitor Center often combine a visit with an overnight or extended stay at a local B & B, campground, or hotel. Overall, the Seaport/JC NERR Visitor Center's estimated annual impact on the local economy easily exceeds \$3,000,000.

### **Challenges and Stressors**

#### Historic

Historic challenges to the JC NERR include a dynamic coastal environment altered by human activity and natural processes, mounting pressure for economic development, and continuing migration of the state's population to the coastal zone. Ecologically, human alterations to the surrounding environment include habitat alteration, water quality degradation from pesticides from agricultural practices, and runoff from land that affects flora and fauna in the region.

### Current and Emerging Challenges

According to a 2013 [NOAA report](#), science shows that human-induced environmental change is impacting coastal systems and communities, and the consequential societal impacts will only increase. The NERRs report analyzed socioeconomic, demographic, and infrastructure data to quantify the social sensitivity of reserves and all US coastal communities to climate change. Climate sensitivity, says the report, refers to whether and how a reserve or group of reserves will be affected by a change in climate conditions, measured over the particular environmental or social geography.

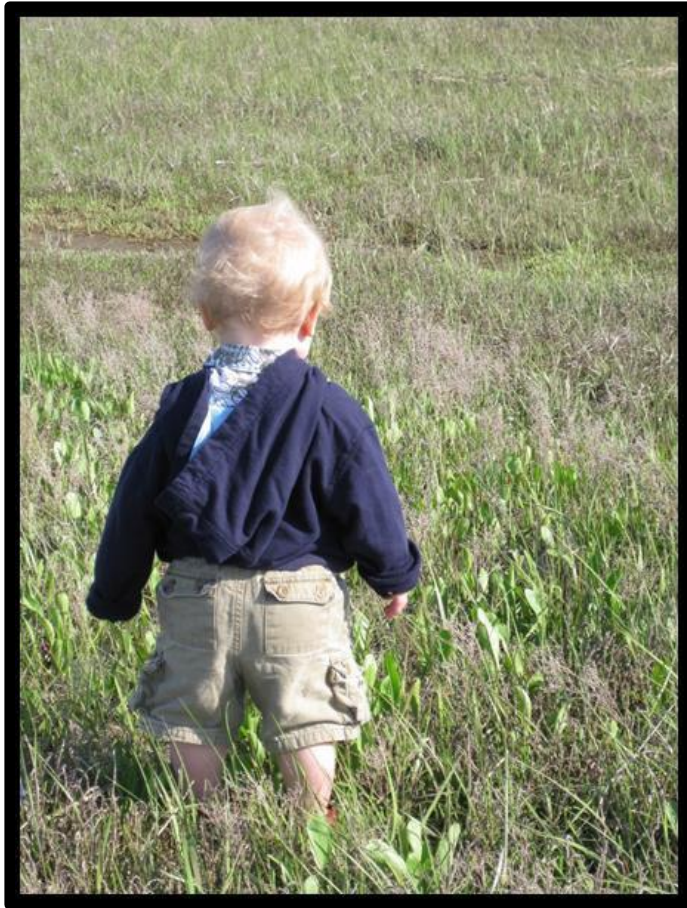
### Reserve Vulnerability and Sensitivity to Impacts

In a [site-specific report](#), NOAA predicts the JC NERR will experience substantial economic and ecological impacts from climate change. Levels of ecological stress will rise, and jobs may be lost as our oceans and shore areas are damaged. Key stressors will include habitat loss, habitat fragmentation, and coastal shoreline erosion. Sediment deficiencies and atmospheric deposition will also negatively affect JC NERR. Human contributions to ecological stress include past land use, development, population growth, fertilizers, pesticides, shoreline modification, filling wetlands, and commercial harvesting.

### Boundary

The JC NERR has no immediate plans to expand the reserve boundary. However, reserve staff will explore opportunities for expansion during the period of this management plan, especially with respect to opportunities that enable wetland migration in response to rising sea level, as well as opportunities to address management issues in northern Barnegat Bay. Some additional considerations regarding future expansion opportunities are provided in the Boundary and Land Acquisition section.

## JC NERR VISION, MISSION, GOALS, OBJECTIVES, AND STRATEGIES



**Vision:** To operate a center of expertise that informs coastal management and promotes stewardship of coastal watersheds, estuaries, and communities through science and public education.

**Mission:** To improve the management of New Jersey coastal environments and communities through science, education, and stewardship.

### **Goals, Objectives, and Strategies**

**Goal 1. Research:** Enhance coastal management programs through application of sound scientific research and monitoring that assess drivers of environmental change in estuarine and wetland ecosystems, including environmental change, eutrophication, habitat loss and alteration, invasive species, and other factors.

#### **Objectives**

- Characterize estuarine and wetland ecosystems and services to support ecosystem- based management

- Maintain a Sentinel Site program to determine the ecosystem condition of Reserve estuaries and wetlands delineate the key natural and anthropogenic drivers of change
- Delineate connectivity of coastal habitats and communities in the Reserve
- Disseminate research and monitoring results and other pertinent information to local and regional decision-makers to enhance coastal resilience of natural and built communities

### **Strategies**

- Conduct innovative research and monitoring to track changes in estuarine and wetland structure and function linked to natural and anthropogenic stressors
- Maintain a data repository that is accessible to coastal stakeholders
- Collaborate with Coastal Training and Education staff to translate research findings to target audiences
- Communicate research and monitoring results through publicly accessible media

**Goal 2. Coastal Training:** The Coastal Training goal of the JC NERR is to provide science-based information for decision-makers to inform management of coastal ecosystems and communities.

### **Objectives**

- To provide science-based resources and information relevant to coastal ecosystems and community management issues
- To develop decision support tools and reserve products in response to local and regional management information needs
- To provide training and technical assistance that builds community capacity in science based decision-making
- To promote best practices, delivery of science-based information, and relevant training opportunities for coastal decision-makers

### **Strategies**

- Develop and utilize decision support tools to inform coastal decision-makers
- Conduct coastal training workshops and technical assistance opportunities in response to local and regional information needs
- Coordinate programs and activities through a variety of topically relevant partners
- Implement performance measures and program evaluations to guide and improve JC NERR products, programs and services

**Goal 3. Education and Outreach:** Advance environmental appreciation, scientific literacy, and the ability to make science-based decisions that positively impact the estuaries, watersheds, and communities along the nation's coasts.

### **Objectives**

- Increase awareness, understanding and knowledge leading to science based management and stewardship of estuaries, coastal watersheds and marine ecosystems
- Establish formal and informal education programs for K-16 audiences
- Provide teacher training workshops and programs for the public

## Strategies

- Provide hands-on classroom and field enrichment experiences, curriculum and information materials tailored to the needs of a wide range of audiences with an emphasis on estuarine, coastal watersheds, marine ecosystems and JC NERR research focus areas
- Develop educational programs that emphasize local, regional and national coastal issues and the interrelationships of coastal habitats and human activities while promoting individual responsibility
- Link on-site and off-site programs to the research, environmental monitoring and stewardship programs of the JC NERR and NERRS
- Increase understanding and appreciation for the JC NERR and NERRS by participating in outreach events, communication and marketing activities
- Promote awareness of the value of estuaries through diverse media including public exhibits, Reserve website, newsletter, local newspapers, brochures and social media
- Develop partnerships with land management partners and other local, regional and national partners that enhance education opportunities

**Goal 4. Stewardship and GIS:** Provide information, services, and infrastructure for research, education, and outreach in support of sustainable natural resources and communities.

## Objectives

- To provide resource managers with GIS data layers to support coastal management decisions and identify priorities for land acquisition
- To demonstrate the ecological, economic, historical, and cultural importance of estuaries to coastal ecosystem health and community resilience
- To protect, conserve, and restore estuarine habitat and water quality

## Strategies

- Identify the best available information, tools and technology for environmental decision-making
- Train resource managers in the use of GIS and Geodetic GPS technologies
- Track land use/land cover and habitat change in the Mullica River-Great Bay estuary and surrounding watershed
- Establish JC NERR as a sentinel site for demonstrating approaches to respond to effects of climate change and sea level rise

# RESEARCH AND MONITORING PLAN



## Introduction

Reserve system goals as defined in federal regulations, 15 C.F.R. Part 921.1(b).

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
5. Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas

## How JC NERR Will Meet These Goals

The JC NERR provides a well-sampled venue with advanced technology to support Research and Monitoring (RM) by staff and partner programs. The RM staff generates an array of work products in support of the JC NERR operation, including databases on research and monitoring projects, written reports, peer-reviewed publications, presentations, and research grants. Staff members participate in research and monitoring activities in the field and laboratory to address important coastal management issues. They interact and collaborate with federal, state, county, and municipal government agencies and organizations, as well as coastal communities and school systems, to engage these entities in research and monitoring activities within the JC NERR. In addition, the staff facilitates provision of academic and logistic services for undergraduate and graduate students at universities to complete research within the JC NERR. Staff members collaborate with the JC NERR Coastal Training Program and Education Program staff to translate results of research and monitoring projects to target stakeholders, community audiences, and K-12 schools. Dissemination of research and monitoring results enhances public understanding of coastal management issues and their resolution. Input from the JC NERR RM Program enables coastal managers to implement science-based decision-making to protect resources, sustain communities, and address other coastal management issues.

JC NERR research and monitoring projects will focus on several priority areas to enhance coastal

management programs through application of a suite of research and monitoring initiatives that assess key drivers of environmental change in estuarine systems, including climate change effects (e.g., sea-level rise and inundation), coastal storms, natural and human-induced habitat loss and alteration, invasive species, and eutrophication. One anticipated perturbation is the closing/decommissioning of the Oyster Creek Nuclear Generating Station (OCNGS) in the Barnegat Bay, planned for October 2018, with a concomitant 95% reduction of thermal effluent. Innovative research and monitoring projects will be conducted to track changes in estuarine and watershed structure and function to assess ecosystem vulnerability, sustainability, and resilience. The Research Coordinator (T. Grothues) will work with other members of the JC NERR research and monitoring staff, and external partners, to ensure successful completion of research and monitoring projects involving the collection and processing of field and laboratory data, data analysis, and preparation of technical reports and peer-reviewed publications in the scientific literature. The research and monitoring staff will also work collaboratively with other sectors of the JC NERR to provide support for outreach and education programs.

### **Research Goals, Objectives, and Actions**

**Goal:** Enhance coastal management programs through application of sound scientific research and monitoring that assess drivers of environmental change in estuarine and wetland ecosystems, including environmental change, eutrophication, habitat loss and alteration, invasive species, and other factors.

### **Objectives**

- Characterize estuarine and wetland ecosystems and services to support ecosystem-based management
- Maintain a Sentinel Site program to determine the ecosystem condition of Reserve estuaries and wetlands, delineate the key natural and anthropogenic drivers of change, and develop remedial plans to mitigate impacted ecosystems for long-term sustainability
- Delineate connectivity of coastal habitats and communities in the Reserve
- Disseminate research and monitoring results and other pertinent information to local and regional decision-makers to enhance coastal resilience of natural and built communities

### **Strategies**

- Conduct innovative research and monitoring to track changes in estuarine and wetland structure and function linked to natural and anthropogenic stressors
- Maintain a data repository that is accessible to coastal stakeholders
- Collaborate with Coastal Training and Education staff to translate research findings to target audiences
- Communicate research and monitoring results through publicly accessible media

### **Program Capacity**

#### **Staff**

*Research Coordinator*

*SWMP Technician*

*Field Researcher*

*Field Researcher*

### **Volunteers**

JC NERR volunteers are involved in a variety of research projects, citizen science activities, and field work

within the Reserve. Volunteer involvement with JC NERR and Rutgers University Marine Field Station (RUMFS) research projects falls under the purview of contributory projects. Based on definitions put forth by NOAA's Citizen Science Community of Practice, contributory projects are researcher-driven-data-collection projects designed by scientists for which volunteers contribute data, collect samples, and/or record data.

### **Key Partners**

The JC NERR RM staff regularly interacts with partner government agencies (municipal, county, state, and federal agencies), nonprofits (e.g., Save Barnegat Bay (SBB), Pinelands Preservation Alliance (PPA), and other organizations), National Estuary Programs (NEPs) (e.g., Barnegat Bay Partnership (BBP) and Partnership for the Delaware Estuary), and academic institutions (e.g., Rutgers, Stockton, Monmouth, and Montclair Universities). The staff also interacts periodically with independent research laboratories and other environmental organizations involved in local, regional, or national estuarine issues. Considerable collaboration on coastal research and monitoring projects takes place between JC NERR staff and several federal agency partners, notably the National Park Service (NPS), US Geological Survey (USGS), NOAA, and USFWS. Much of this collaboration involves projects on wetlands habitat, natural buffer, shoreline erosion and protection, environmental change, flooding, and sentinel site sustainability.

### **Facilities**

A majority of the research and monitoring space are located at the Rutgers University Marine Field Station (RUMFS) on Great Bay near Little Egg Inlet. The JC NERR operates two coastal research vessels, the R/V *Mullica Explorer* and the R/V *Resilience*. The *Mullica Explorer*, a 20 ft. Maritime Skiff, is docked at RUMFS, and laboratory and field equipment/instrumentation used by the Research and Monitoring staff are located at RUMFS. Ready access to the *Mullica Explorer* at RUMFS enables JC NERR researchers to effectively complete research and monitoring projects and enhance support of field-based education programs. The R/V *Resilience* is a 25-foot Parker Deep Vee Hull vessel with twin 200 HP 4-stroke outboard motors. It is equipped to support benthic sampling, habitat characterization, fisheries investigations, SCUBA operations, and research with autonomous undersea vehicles. Several other small boats, docking facilities for larger vessels, analytical laboratories, a running seawater lab, dive locker, and a multi-bed dormitory and classroom are also available. RUMFS is heavily utilized for research and monitoring projects, particularly during the summer months. These projects are conducted by faculty, postdocs, graduate and undergraduate students, technical staff, interns, technicians, and visiting scientists. Rutgers University provides facilities maintenance to the administrative offices in New Brunswick, the Coastal Center in Tuckerton and the Marine Field Station. This support includes the grounds, interior and exterior building maintenance, and structural building maintenance. Rutgers employs full-time maintenance support staff to oversee work on all the mechanicals and facilities in Tuckerton. RM staff maintain offices at the JC NERR Coastal Center, in addition to full-time offices at offsite locations.

### **Program Components**

#### Scope of Research and Monitoring

The focus of the JC NERR RM Program is to identify and track short-term variability and long-term changes in the physical-chemical characteristics, habitats, biotic resources, and integrity of estuarine and coastal marine waters to inform coastal zone management (Kennish 2008). Important components of the program are water quality monitoring, biomonitoring, ecosystem assessment, population and community ecology, habitat characterization, and land use and land cover analysis. Investigations of climate change and habitat protection will continue. The JC NERR provides critical delineation and



coordination of estuarine water quality activities, and it serves as the platform for making systematic, long-term observations of vital ecosystem conditions. Research and monitoring activities of the JC NERR fall within four distinct areas:

1. Water quality monitoring (abiotic and biotic factors)
2. Habitat and biotic community characterization
3. Watershed land use and land cover analysis
4. Climate change

These activities foster greater understanding of the relationship between disturbance/change and physical, chemical, and biological processes required to sustain biotic communities and resources in the system.

Key management information needs, especially with respect to habitat loss and alteration, effects of environmental change and sea-level rise on coastal communities and resources, connectivity of habitats and communities, and resource conservation, are supported with advanced coastal and estuarine research and observing capabilities at relevant temporal and spatial scales. An important objective is to promote the Reserve as a long-term research and monitoring study site for use by federal, state, local, private, and academic institutions.

### **Sentinel Site Development**

The Tuckerton Peninsula is a 2,000-ha *Spartina* salt marsh system that separates the BB-LEH and MR-GB estuaries in New Jersey. It is also the designated sentinel site of the JC NERR for the detection and monitoring of environmental change such as coastal habitat responses to sea level rise, major storms, and inundation (Kennish et al. 2014a, b). The JC NERR sentinel site is part of a coastal network of sentinel sites established by NOAA's National Estuarine Research Reserve Program in the Mid-Atlantic and other regions of the country to understand the short- and long-term trends in coastal marsh condition locally, regionally, and nationally. One major goal is to assess the sustainability of the Tuckerton Peninsula salt marsh to climate change effects, which will generate vital information for New Jersey's coastal communities. This important marsh habitat is protective buffer that reduces the vulnerability of coastal communities to sea-level rise, storm surge, and flooding. It also provides an array of other ecosystem services including groundwater storage, contaminant filtration, biogeochemical cycling, carbon sequestration, habitat formation (for fish assemblages, bird populations, and other biota), and migratory pathways (for shorebirds, horseshoe crabs, and other sensitive species that rely on the marsh system for survival).

### **JC NERR SWMP Monitoring Stations**

Four System-Wide Monitoring Program (SWMP) water quality monitoring stations have operated in the JC NERR since 1996. These SWMP stations occur along a salinity gradient of the Mullica River-Great Bay Estuary at Lower Bank, Chestnut Neck, Buoy 139 and Buoy 126 in close proximity to the Tuckerton Peninsula salt marsh system. Data collected at these SWMP stations are important for correlation with spatial and temporal changes in salt marsh habitat and wetland elevation at the sentinel site. These will continue to serve as the core SWMP stations in the Reserve.

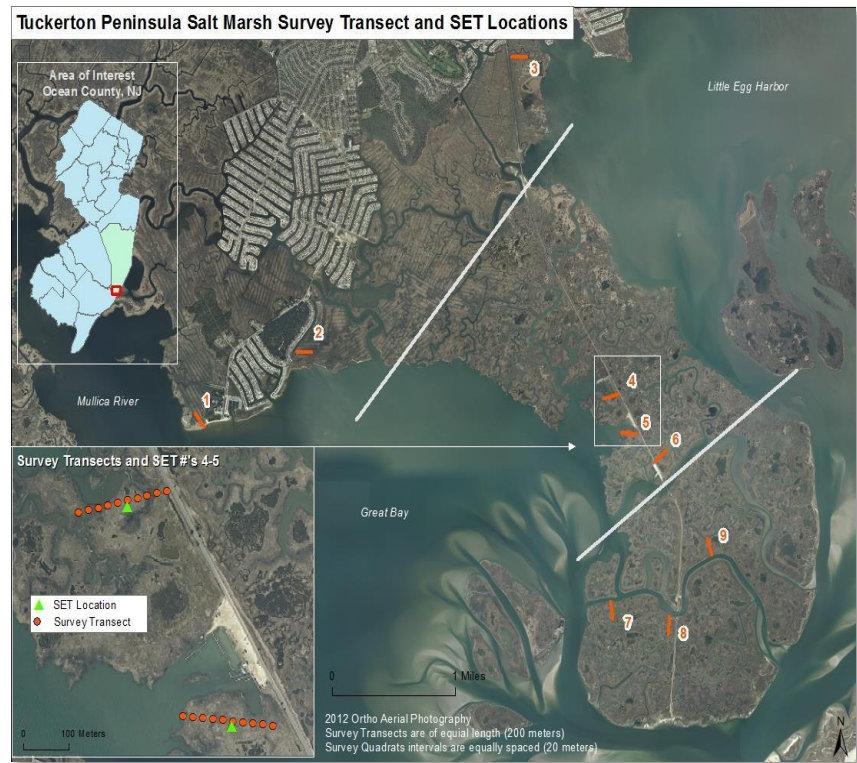
### **Vegetation Transects and Monitoring**

Comprehensive emergent vegetation monitoring of the Tuckerton Peninsula salt marsh system in the JC NERR was conducted in 2011 and 2013 (Kennish et al. 2012). Nine permanent transect lines have been established in three salt marsh segments (north, central, and south): Transects 1-3 (north segment),

Transects 4-6 (central segment), and Transects 7-9 (south segment). Monthly quadrat sampling during peak salt marsh biomass periods (June–September) were conducted at each of 90 plots along these 9 transects. This field sampling design will be used in all future emergent vegetation monitoring of the system that will be tied to the National Spatial Reference System (NSRS). Emergent vegetation monitoring will occur again in 2017.

### Surface Elevation Tables (SETs)

Nine surface elevation tables (SETs) have been installed on the Tuckerton Peninsula salt marsh to measure salt marsh elevation change relative to local sea level. They have been installed adjacent to nine vegetation monitoring transects where the composition and health of marsh plant communities will be examined periodically in response to climate change effects. The JC NERR plans to install nine additional SETs in the peninsula in 2017 (Figure 4). The installed sets were reviewed by National Environmental Policy Act (NEPA), and any future SET installations will be installed in a NEPA compliant manner.



**Figure 4.** Surface Elevation Table (SET) Distribution along the Tuckerton Peninsula

### Surface Elevation Models

Digital elevation models have been generated using Real Time Kinematic GPS (RTK) in the three salt marsh segments. These measurements will be repeated on a regular basis in future years to document broad surface elevation change over consistent temporal intervals and to augment fine-scale surface elevation change data obtained using SETs located adjacent to the nine transects in the north, central, and south segments of the marsh.

### Outreach

The RM staff has characterized the key environmental factors and processes that affect habitats as well as the species composition, diversity, and function of biotic communities in estuarine waters and watersheds of the JC NERR. SWMP monitoring has produced an immense database on water quality in the reserve. Information gathered by JC NERR research and monitoring activities, and the management implications of this information, are made available to decision-makers, stakeholders, and the public. JC NERR encourages the dissemination of research and monitoring results to these groups through:

- Journal articles and books in the peer-reviewed literature
- Research summaries and fact sheets
- Presentations at professional societies

- Special symposia arranged by NOAA or reserves, often in association with other meetings such as the biennial meetings of the Estuarine Research Federation or Coastal State Organization
- Annual reports to NOAA and the State of New Jersey
- Workshops, conferences, and roundtables offered through the Coastal Training, Education and Stewardship Programs
- Regular contact with representatives of other state and federal agencies, local government agencies, and planning boards

## **Literature and Publications**

In the past five years, contributions of local, regional, and national significance have been produced by the JC NERR RM staff. Of particular note are two books, a special issue of the journal *Estuaries and Coasts*, and an array of peer-reviewed publications authored, co-authored, or edited by the JC NERR Research Coordinator since the submission of the last Management Plan that deal with critical issues of estuarine and coastal marine science in NERRS, such as the sentinel site, climate change, and essential estuarine habitat (Fertig et al. 2013, 2014; Gandy et al. 2017; Kennish 2012, 2015a-f, 2017; Kennish and Elliott 2012; Kennish et al. 2014a-d; Kennish et al. 2016a, b; Lathrop et al. 2014). In addition, funding and facilitation by the JC NERR and its volunteer program - SWMP in particular - has led to numerous Peer-reviewed publications on marine animal migration and habitat use years (Turnure et al. 2015a, b, Grothues et al. 2012), recruitment cues and phenology (Able et al. 2013, Able et al. 2014a, Able et al. 2017), and fisheries interaction (Yergey et al. 2012) in the last 5 years. Development programs of the JC NERR and the access they provided to advanced technology also led directly to peer-reviewed publications on methodology (Biesinger et al. 2013, Grothues and Davis 2013, Eiler et al. 2014, Able et al. 2014b, Newhall et al. 2016, Grothues et al. 2017).

## **Program Delivery**

### Cooperative Ecosystem Studies Unit

The JC NERR, within the scope of its mission and structure, participates in the Cooperative Ecosystem Studies Unit (CESU). The CESU is a national consortium of federal agencies, tribes, academic institutions, state and local governments, nongovernmental conservation organizations, and other partners working together to support informed stewardship of public trust resources. These activities are conducted in close collaboration with the National Park Service and US Fish & Wildlife Service (USFWS), primarily using coastal topography monitoring protocols developed for the Northeast Coastal Barrier Network (NCBN) within the parks and refuges. Collaborative projects facilitated through the CESU support effective coastal resource management by informing decision-makers on sustainability and resilience of natural and built communities on environmental change effects and related coastal problems. Research also has focused on science-based management of marine protected areas. Of particular interest is the response of coastal habitats to storms, and the resilience of Marine Protected Areas (MPAs) to a changing environment. The JC NERR will also begin to explore MPA resilience in collaboration with international partners.

## **Needs and Opportunities**

### SETs and Water Quality

The JC NERR RM Program will install several surface elevation tables (SETs) in brackish and freshwater marsh areas of the Mullica River-Great Bay Estuary. These SETs will complement the nine already installed in the Tuckerton Peninsula salt marsh platform during 2015 and 2016. This installation will foster new funding opportunities for the JC NERR to assess climate change effects in upland areas of the JC NERR and increase the system connectivity. To enhance this work, a new SWMP water quality monitoring station will be sited in the Mullica River near the SETs installation. This new SWMP station

will increase water quality data compilation for connectivity purposes as well. Additional funding needs must be met to successfully complete expansion of SWMP in the Mullica River-Great Bay Estuary.

### Partnerships

Opportunities are greater than ever to engage partners in RM Program activities related to operation of the JC NERR sentinel site, assessment of ecosystem structure and function, land use and land cover change, climate change effects, coastal resilience, and other research areas. Expansion of research and monitoring initiatives will require pursuit of additional external sources of funding. The goal will be to expand production of the RM Program to generate more extensive databases in support of an array of user groups to achieve their goals and to meet the needs of coastal decision-makers. It will also help resource managers to protect, conserve, and restore natural coastal ecosystems in response to the growing risks from coastal hazards, such as hurricanes, sea-level rise, and an array of human activities.

### JC NERR Science Scholars

The JC NERR will establish a “JC NERR Science Scholars” program to help guide future research direction and investment, support a regular seminar series, and advance opportunities for graduate and undergraduate student training, field experiences, and communication skills. This program will be coordinated by the Special Projects Coordinator.

## **Continuing and Future Projects**

### JC NERR Sentinel Site: Goal and Operation

A Sentinel Site is a discrete location in coastal marine environments that has the operational capacity for intensive study and sustained observations to detect and understand physical and biological changes in the ecosystem it represents. The purpose of the sentinel site is to document changes in marsh accretion rates, marsh surface elevation, and intertidal/subtidal habitat of the Tuckerton Peninsula with ongoing climate change and land subsidence. To this end, biomonitoring surveys, marsh elevation and emergent vegetation mapping, and the acquisition of vegetation health metrics will be ongoing to characterize vital spatial-temporal changes in the marsh system. Together, current and future projects will leverage our understanding of climate change impacts on the peninsula and will help coastal managers plan effective adaptation strategies for future loss of this extensive marsh platform that currently buffers human settlement from extreme weather-related events, inundation, and flooding associated with rising sea level and coastal storm surge.

### Sentinel Site Operation

Studies are underway to determine the vulnerability of the Tuckerton Peninsula and how the loss of its salt marsh habitat will affect the resilience of coastal communities. The establishment of the JC NERR sentinel site as a long-term research and monitoring station will support NOAA’s mission of assessing coastal vulnerability to climate change and generating the monitoring and research data useful for forging climate adaptation and mitigation plans for coastal communities that will increase their resilience, particularly in the aftermath of coastal destruction from Superstorm Sandy. To establish an effectively operating sentinel site in the JC NERR, it is necessary to install the infrastructure for essential observational data acquisition, which includes a tidal station that has also been installed to make measurements of water level changes in the marsh habitat that can be related to local sea-level change. JC NERR staff will track changes in ecosystem processes to delineate the key natural and human-induced drivers of change that are affecting the system, and to develop remedial measures to mitigate impacted habitat for long-term sustainability.

The loss of marsh habitat area in the Tuckerton Peninsula has accelerated due to extreme weather

events, storm surge, perimeter shoreline erosion, sea-level rise, and submergence. Sentinel site infrastructure has been installed (i.e., surface elevation tables, tidal station, and benchmarks) to assess climate change effects. Projects document changes in accretion rates, marsh surface elevation, and conversion to intertidal/subtidal habitat with ongoing sea-level rise and coastal subsidence. In addition, biomonitoring surveys, marsh elevation and emergent vegetation mapping, and vegetation health metrics acquisitions characterize vital spatial-temporal changes in the system. Of note are innovative high-resolution remote sensing applications, habitat mapping, and system modeling. Together, current and future projects will leverage our understanding of climate change impacts on the peninsula and will help coastal managers plan effective adaptation strategies for future loss of this extensive marsh platform that currently buffers human settlement from extreme weather-related events and inundation associated with rising sea level and coastal storms.

### Nutrients and Eutrophication

Barnegat Bay-Little Egg Harbor is a highly eutrophic coastal lagoon affected by nutrient loading (nitrogen and phosphorus) from a rapidly developing watershed (Kennish et al. 2007, 2009, 2010, 2011, 2013; Kennish 2009, 2010; Kennish and de Jonge 2011). Excessive organic carbon production stimulated by elevated nutrient inputs from the surrounding watershed and the overlying airshed, together with restricted tidal exchange and limited flushing has led to adverse biotic responses (Fertig et al. 2014). The 2016 State-of-the-Bay Report by the Barnegat Bay Partnership specifies that eutrophication continues to be the most serious environmental problem impacting BB-LEH. The potential consequences of eutrophication in this valuable coastal water body are numerous and varied, including low dissolved oxygen, harmful algal blooms (HABs), loss of essential habitat (e.g., seagrass and shellfish beds), lower biodiversity, reduced harvestable fisheries, imbalanced trophic food webs, declining system stability and resilience, diminished ecosystem services, and impacted human use (Kennish et al. 2013; Fertig et al. 2014). Approximately one-third of BB-LEH is designated as impaired. Thus, nutrient levels will continue to be monitored in BB-LEH through JC NERR SWMP and other partner programs. In addition, biotic responses in the coastal lagoon will continue to be investigated as well, such as occurrence of algal blooms, abundance of submerged aquatic vegetation, and changes in shellfish and other resources. Reserve staff will work closely with partners (i.e., Barnegat Bay NEP and NJDEP) to identify management strategies to mitigate eutrophication in the BB-LEH estuary.

### Coastal Acidification

Increasing anthropogenic production of carbon dioxide (CO<sub>2</sub>) has resulted in the highest concentrations of atmospheric CO<sub>2</sub> (~403 ppm) in centuries. Since the Industrial Revolution, the pH of surface ocean waters has decreased by 0.1 units, and the mean pH may decline by 0.3 to 0.4 units by the end of this century. Ocean waters have absorbed ~25% of the CO<sub>2</sub> released by human activities since the Industrial Revolution. The effect is increasing acidification that directly impacts organisms with calcareous structures. Entire biotic communities can be altered by this process. Because of the increasing concern of coastal acidification, projects are being planned to monitor and assess its impact in the region. For example, the Barnegat Bay Partnership, a partner of the JC NERR, is deploying high-precision monitoring instrumentation to evaluate acidity and CO<sub>2</sub> levels in the Barnegat Bay-Little Egg Harbor Estuary because of the depleted state of natural shellfish populations, including hard clams, bay scallops, and oysters. Similar efforts are being projected for the Mullica River-Great Bay Estuary and coastal ocean waters of the JC NERR. Research staff will work with other observing system networks (MACAN, IOOS, NAML) to develop an integrated approach to track acidification levels in coastal and estuarine waters with standard sensors, and data collection and management standards.

### Establish a Living Laboratory to Enhance Resilience of Coastal Ecosystems and Communities

Major storms and other natural disasters occur on large scales, and efforts to protect or mitigate their impacts are needed on appropriate scales (e.g., the scale at which real waves and flow friction cause erosion, scales on which animals use or segregate habitat, scales on which plant communities are self-sustaining and successional because all necessary elements are within the space). The size and position of the JC NERR, with shorelines facing in many directions and adjacent to shallow, deep, estuarine, and coastal ocean areas, and with sand, salt marsh, forest, and mudflat environments, along with many miles of shoreline, provide opportunities for testing strategies such as living shorelines, thin-layer sediment deposition, ditching, sediment removal or replacement on real world scales. Reserve staff will work with partners (e.g., university investigators and NJDEP staff) to identify opportunities for pilot-scale demonstrations of novel strategies to enhance ecosystem and community resilience.

#### Ecosystem Assessment and Connectivity

The JC NERR encompasses a wide variety of natural and anthropogenically modified habitats, from freshwater creeks to the coastal ocean; natural, ditched, dredged, and artificially armored embayments; and connections or corridors between them for the flow of nutrients as well as the direct movement of large animals such as fish and marine mammals. The JC NERR has infrastructure and expertise for the study of the use and connections of these habitats, such as telemetry for monitoring the migration of anadromous fishes from freshwater creeks to the ocean (Grothues et al. 2005, Grothues et al. 2007, Ng et al. 2007, Sackett et al. 2007, 2008, Able et al. 2007, Grothues et al. 2009a, Able et al. 2012, Able et al. 2014), movements in rivers and ponds, and the establishment of easily monitored passage devices for catadromous eels. These studies are typically labor intensive and are supported by a strong volunteer/citizen science group in the JC NERR. JC NERR staff will provide precision mapping expertise as well as nascent remote sensing (drone) monitoring capability to support these efforts.

Assessment of seagrass habitats in BB-LEH has shown significant alteration by anthropogenic factors, such as eutrophication, prop scarring of boats, and shading by docks and other structures (Kennish et al. 2008, 2011; Kennish and Fertig 2012; Fertig et al. 2013; Kennish et al. 2013, 2016; Kennish and Fertig 2015). These problems are common in coastal lagoons bounded by highly developed watersheds (Kennish et al. 2014d). Restoration efforts have been undertaken to improve essential seagrass habitat in BB-LEH (Kennish 2012). Similar efforts will be extended to salt marsh systems in the Reserve that are being impacted by sea-level rise and shoreline erosion.

#### REMUS (Acoustic Tracking of Marine Organisms)

Measuring environmental conditions or animals in the ocean is often complex, dangerous, and tedious, making robotics a preferred choice to collect data. The JC NERR has a REMUS-100 autonomous underwater vehicle (AUV) which is a field workhorse both as an instrument test bed and as a tool for applied study (Grothues et al. 2009c, Grothues et al. and Dobarro 2010, Eiler et al. 2014, Biesinger et al. 2014, Newhall et al. 2014, Grothues et al. 2017). The capabilities of this AUV were recently further advanced by the implementation of a hardware/software stack that allows payload control, the interruption of planned routine and in-mission redirection decisions based on real-time information derived from its hosted sensors. A successfully tested program prompts the vehicle to leave its linear search path and execute complex maneuvers once it has detected acoustically tagged fish, maneuvers that generate greatly increased precision (m vs. km) in position estimates for those fish. REMUS will be available to support relevant studies on fish movement and habitat use, submerged habitat mapping, and water quality. That information will be available for educational programs including hands-on training for educators and students.

#### Integration of Long-Term Data Sets

Studies in the JC NERR are supported by data collections made in boundaries of the reserve that exceed its establishment by decades. For example, a program of weekly larval fish collections from inflowing water has been ongoing since 1989 along with temperature and salinity recordings that predate SWMP. Other oceanographic and biological studies pertain to environmental impact reports assessing a proposed offshore nuclear generating station (canceled) in the 1970s and the ongoing operation of a nuclear power plant (Oyster Creek Nuclear Generating Station) at Barnegat Bay. Efforts will continue to integrate these datasets to inform studies on long-term environmental change.

## **Research and Restoration Targets**

### Blue Crab

Blue crabs are the target of the most widely participated recreational fishery in New Jersey and possibly the entire Mid-Atlantic region. Research is ongoing to build and restore blue crab populations in less productive waters. This species also forms the basis of a thriving commercial fishery, with both a pot and winter dredge fishery operating within JC NERR estuarine waters (i.e., Great Bay and Little Egg Harbor). Paul Jivoff of Rider University has led much of the blue crab research in Great Bay, Little Egg Harbor, and Barnegat Bay over the past decade; the results of his work reveal relatively stable population abundance and commercial landings, although abundance dropped dramatically in 2014 possibly due to the impact of Superstorm Sandy in October 2012. We anticipate that Dr. Jivoff will continue his research on the temporal and spatial flux of blue crab abundance in estuarine waters of the JC NERR, sexual segregation as selector of harvest vulnerability and on bias in stock assessment, effects of male-biased harvest on crab reproductive capacity, effects of European green crab invasions on blue crab habitat use, and environmental effects on recruitment and year-class strength (among others).

### Horseshoe Crab

Horseshoe crabs are ancient animals that are of immense value to the pharmaceutical industry for a component of their blood. Their intertidal spawning habits are critically valuable to sustaining the trans-continental migration of seabirds. Historically, they have been harvested as bait for the eel pot fishery. Their numbers have fallen in recent decades, and the pharmaceutical industry now must release any horseshoe crabs from which they have harvested blood while maintaining strict mortality limits. However, recent research shows subtle effects such as lower reproductive output and crab numbers are recovering sufficiently to meet pharmaceutical demands. If extramural funding is available, the JC NERR will partner with the Rutgers Aquaculture Innovation Center to investigate the hidden life cycle and needs of the juveniles, while mitigating a survival bottleneck through intensive culture that could yield returns for people and migratory shorebirds.

### American Eel

American eel enjoy prized status as live bait for big game fishes and as a delicacy in ethnic food markets. The number of adults has declined drastically in recent decades, but research at Rutgers and the JC NERR shows no corresponding trend in larval supply (Sullivan et al. 2016). Instead, disruption to its life cycle, such as blocked passage to growth habitat above dams, is suspected. Research on American eel within the NERRS is examining the efficacy of dam bypass technologies and basic life history (including parasite epidemics) to help understand the decline and seek measures to restore the population. JC NERR staff will explore development of a citizen science program to help address these questions.

### River Herring

River herring are collectively American shad, blueback herring, and alewife, three members of the same genus (*Alosa*) that ascend into freshwater to spawn in spring. They have a wide distribution on the east coast, but numbers have plummeted from historical records. Two species, alewife and blueback herring,

are very valuable to sports fishers in the Mullica River as live bait for striped bass. Upstream movement into small creeks in the Pine Barrens is restricted at the Batsto Dam, where they can be scooped up by dip net and kept in small pools or pens at home. The decline is so severe that this practice is now illegal.

The decline is range-wide, but the cause is not clear. The species are taken as bycatch on offshore net fisheries for Atlantic herring and Atlantic mackerel because these species will mix in schools, although the decline may also be caused by the loss of access to upstream spawning habitat due to dams and improperly designed road crossings (culverts) that the fish cannot pass. Research on river herrings is ongoing in the JC NERR through video-supported studies of their behavior at dams. Multiple fish ladders have been placed in the reserve (including Batsto and Seaport), but passage has not been assessed, nor has recruitment in the waters above it. Tagging and telemetry are proposed for further understanding of river herring use of this watershed.

### Shellfish

Shellfish (hard clam and bay scallop) stock assessments in Barnegat Bay-Little Egg Harbor over the past decade indicate reduced abundance relative to earlier assessments. For example, hard clam abundance in the BB-LEH Estuary in recent years has decreased markedly compared with abundance in the mid-1980s. An estimated 64,803,910 hard clams were recorded in Little Egg Harbor in 2001 compared with an estimated 201,476,066 hard clams in 1986/87. An NJDEP hard clam stock assessment survey conducted in 2011, however, showed an increase in abundance to an estimated 85,745,065 hard clams, although this represents a decline in abundance of 57% compared with hard clam abundance in 1986/87. In addition, most of the increase in 2011 was ascribed only to a few sampling stations, with 25% of the total stock found at only five of 196 stations sampled. The median hard clam abundance decreased by 11% in 2011 compared with 2001. Furthermore, the commercial harvest of hard clams declined by more than 95% over the past 40 years. As for bay scallops, a significantly reduced population was evident in stock assessment surveys conducted more than a decade ago in BB-LEH relative to earlier abundance estimates.

Due to current shellfish resource problems in these coastal bays, studies are ongoing to revitalize shellfish populations. Bricelj et al. ("Status and Trends of Hard Clam, *Mercenaria mercenaria*, Shellfish Populations in Barnegat Bay, New Jersey") reviewed the historical and current status of hard clam populations in BB-LEH and evaluated their potential for rehabilitation under present environmental conditions. Bricelj et al. ("Characterization of phytoplankton functional taxonomic groups in relation to juvenile hard clam production in the Barnegat Bay-Little Egg Harbor Estuary (BB-LEH)") related phytoplankton functional groups to growth and survival of juvenile hard clams in the system. Munroe ("Restoration planning for hard clams in Barnegat Bay: Identifying population sources and sinks") is undertaking a project that will create a model of larval hard clam behavior with outcomes that include the creation of a larval connectivity map and observations of larval densities in real time for use in future shellfish restoration efforts. Regarding bay scallop studies, Gilbert ("Assessment of the population dynamics of bay scallops in a highly eutrophic estuary: Field and laboratory experimental approaches") is examining key habitat characteristics and locations within BB-LEH that may serve as sites for bay scallop source populations. The study is assessing population dynamics of an experimental population of bay scallops for development of potential restoration strategies.

Future projects on shellfish are focusing on identifying the best habitats for implementing restoration projects on viable shellfish populations. Targeted populations include hard clams, bay scallops, surf clams, ribbed mussels and American oysters. The focus will be to identify the best habitats in Barnegat Bay and Little Egg Harbor where these species are most likely to be restored.



### Salt Marsh Habitats

The JC NERR contains extensive salt marsh habitat, with ~20 km<sup>2</sup> occurring in the Tuckerton Peninsula, the sentinel site of the JC NERR. Extensive *Spartina* salt marshes border broad areas (~33.8 km<sup>2</sup>) of Little Egg Harbor to the north and the Mullica River-Great Bay Estuary to the south. The Tuckerton Peninsula salt marsh system has been the subject of considerable study during the past five years, notably characterizing emergent salt marsh vegetation communities via biomonitoring surveys. Ongoing research is examining the drivers of change that have rendered the salt marsh habitat in the peninsula vulnerable to perimeter shoreline erosion, coastal storm impacts, sea-level rise, and inundation (Kennish et al. 2014 a, b). Information derived from this research will inform coastal decision-makers about sustainability of the salt marsh system and the restoration programs needed to improve its condition.

Anthropogenic activities, such as parallel grid ditching and Open Marsh Water Management (OMWM) that alter hydrology, are also being investigated. Inundation and flooding of marsh habitat caused by storm surge during Superstorm Sandy demonstrate the serious impacts of coastal storms on wetlands habitat. Ongoing salt marsh research in the JC NERR is assessing the effectiveness of tidal salt marshes and maritime forests in buffering adjacent built communities from storm-related damage. Future studies will not only examine the vulnerability of the Tuckerton Peninsula, but also how the loss of its salt marsh habitat will affect the resilience of coastal communities. To this end, research and monitoring of the Tuckerton Peninsula focuses on the following objectives:

- Synthesizing existing SWMP water quality and meteorological databases to determine potential impacts of climate change
- Characterizing the temporal and spatial changes in the species composition, abundance, canopy height, and aerial cover of the emergent salt marsh plant communities
- Developing Marsh Futures maps to determine marsh sustainability
- Documenting changes in accretion rates, marsh surface elevation, and conversion to intertidal/subtidal habitat with ongoing forcing mechanisms
- Assessing key drivers of salt marsh habitat change in the system, notably storm activity, sea-level rise, erosion, coastal subsidence, parallel grid ditching, and OMWM

Results of these studies will inform coastal communities and end users (e.g., USFWS, NJ Division of Fish and Wildlife, NPS, Pinelands Commission, and Mid-Atlantic Coastal Wetlands Assessment Program) of the vital ecological services and economic benefits of this coastal wetland system and its importance to coastal resilience in New Jersey.

Various management approaches will promote the long-term sustainability of the coastal marsh habitat under rising sea level scenarios and attempt to restore damaged areas. Improved understanding of how salt marsh habitat structure might change in the long term under sea-level rise will inform marsh restoration decisions and long-term planning. Furthermore, it will provide coastal decision-makers with the information needed to make effective choices concerning the maintenance and/or restoration of salt marsh habitats as well as the use of green infrastructure within coastal communities. Green infrastructure strategies that may be pursued in future studies include the construction of living shorelines, the application of thin-layer deposition on salt marsh surfaces, and the alteration of habitat to increase tidal flow in the salt marshes.

### Biofouling

Investigations of biofouling communities are ongoing to assess the structure of macrofouling communities in estuarine waters of the JC NERR and to determine the spatial and temporal variation of

the macrofouling taxa both seasonally and annually. Using artificial substrates made of PVC, data are being compiled on macrofouling settlement and recruitment, as well as the spatial distribution, seasonal flux, and dominance of the macrofaunal taxa. Macrofouling settlement is also providing information on macrofouling species diversity in the system. The distribution of macrofouling species in Great Bay and Barnegat Bay-Little Egg Harbor, their reproductive strategies, larval and spore responses to physical and chemical conditions, and variations in recruitment are all important in determining the composition and variation of the macrofouling assemblages. These investigations are yielding important data for understanding fouling of SWMP dataloggers in the JC NERR and other NERRS sites.

### SWMP Water Quality Monitoring

Water quality and meteorological monitoring within the SWMP is vital to JC NERR operations. High standards of water-quality monitoring will be maintained in SWMP, and biomonitoring will continue as well. Monitoring data collected as part of SWMP will establish data trends for the Mullica River-Great Bay estuary and support research in the sentinel site and estuarine waters of the JC NERR. SWMP operations are centered at RUMFS. An array of physical and chemical water quality parameters are monitored.

#### Physical Parameters

Water quality data are collected at 15-minute intervals at four sampling stations (Lower Bank, Chestnut Neck, Buoy 139, and Buoy 126) along the Mullica River-Great Bay estuarine gradient using moored YSI 6-series and Exo2 datasondes (Figure 5). These monitoring sites extend from the freshwater/saltwater interface at Lower Bank, approximately 25 km up the Mullica River from the point where it joins Great Bay to the mouth of Great Bay, a distance of 8 km. Thus, the datasondes cover a total of 33 km in this estuarine system.

Two of these stations (Chestnut Neck and Buoy 126) are equipped with telemetry equipment that broadcasts water quality data to a GOES satellite, which is then posted to the internet. The suite of environmental parameters monitored at 15-minute intervals at these stations include

temperature, specific conductance, salinity, DO concentration, DO percent saturation, pH, turbidity, and depth. In addition, a monthly grab sample will be taken in Little Egg Harbor at Buoy 115 for SWMP data collection. Grab sampling is also performed throughout the remaining SWMP sites.

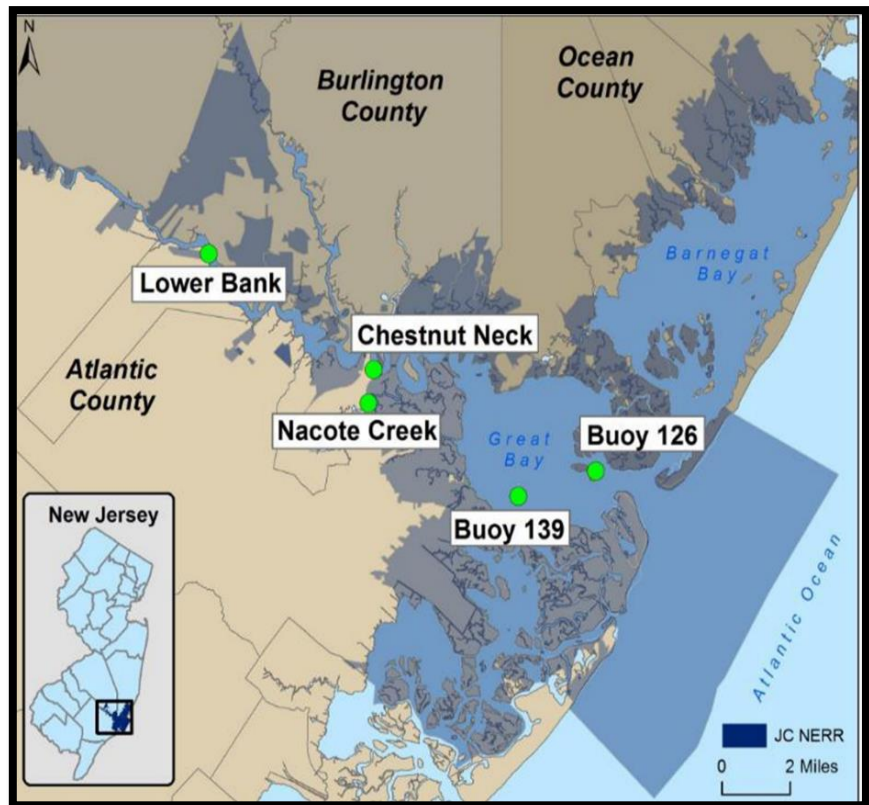


Figure 5. System-Wide Monitoring Sampling Sites of the JC NERR.

temperature, specific conductance, salinity, DO concentration, DO percent saturation, pH, turbidity, and depth. In addition, a monthly grab sample will be taken in Little Egg Harbor at Buoy 115 for SWMP data collection. Grab sampling is also performed throughout the remaining SWMP sites.

A major objective of SWMP monitoring is to characterize physical-chemical parameters in reserve estuarine waters.

A Campbell weather station located at the Stockton University Marine Field Station on Nacote Creek will continuously record air temperature, wind speed and direction, solar radiation, barometric pressure, humidity, and precipitation. Water quality and weather data collected in SWMP will also be useful for analysis and assessment of habitat conditions and habitat utilization by commercially, recreationally, and ecologically significant fish species and other organisms in the estuarine system.

### Nutrients

In addition to the previously mentioned water quality data acquisition, nutrient chemistry (i.e., nitrite + nitrate, ammonium, dissolved inorganic nitrogen, orthophosphate, and chlorophyll *a*) will also be monitored monthly at each of the five SWMP monitoring stations (Lower Bank, Chestnut Neck, Buoy 139, and Buoy 126) and at Buoy 115 using grab sampling. Once a month, these nutrients will be measured every two hours over a 24:45-hour period at Buoy 126 using an automated ISCO sampler, yielding a more complete array of measurements. The water quality of the Mullica River-Great Bay system has traditionally been relatively clean and free of excessive nutrient loading from anthropogenic sources. This is because there is very little development or industry within the drainage basin of the Mullica River and its tributaries.

The collected water quality and weather station data will help address short-term and long-term episodic events in the estuary, including patterns of circulation, effects of upwelling events from the continental shelf, and extreme climatic events (e.g., hurricanes). These data will also be valuable in research conducted on the species abundance and distribution of organisms in estuarine waters of the JC NERR.

### Education and Outreach

The RM staff will collaborate with Coastal Training and Education staff to relay SWMP data to target audiences. For example, TOTE is an appropriate vehicle to make SWMP data available to teachers and the public. Additionally, through NERRS PAC FY'17 funds, JC NERR was awarded funding to produce a new video for the Life on the Edge exhibit, utilizing data collected via SWMP abiotic monitoring, emergent vegetation monitoring, and sentinel site research. Visitors will be front and center as they journey in the field and connect to the JC NERR as a living laboratory where good scientific data resides.

# COASTAL TRAINING PROGRAM PLAN



## Introduction

The Coastal Training Program (CTP) provides new and emerging scientific information and skill-building opportunities to coastal decision-makers who make decisions that affect coastal resources. Additionally, the CTP provides a critical feedback loop to ensure that professional audiences inform local and regional science and research priorities. Programs include seminars, hands-on skill training, workshops, technology demonstrations, and technical assistance. Participants can share experiences and network in a multidisciplinary setting. Technical assistance, often directed at individual communities or audiences on specific topics, is becoming a staple of the JC NERR CTP.

Partnerships are important to the success of the CTP program. Reserves work closely with federal partners, state coastal programs, protected area networks, and local partners to determine key coastal resource issues and target audiences. The CTP requires a systematic program development process, involving periodic review of the Reserve niche in the training provider market, audience assessments, development of a five-year program strategy, a marketing plan, and establishing an advisory group for guidance, program review, and perspective in program development. The CTP implements a performance monitoring system where staff report data in operations progress reports according to a suite of performance indicators, outcomes, and success stories related to increases in participant understanding and application of learning.

## Reserve System CTP Goals as Defined in Regulations (15 C.F.R. Part 921(b))

The CTP seeks to provide up-to-date scientific information and skill-building opportunities for coastal decision-makers. Through this program, NERRS ensures coastal decision-makers have the knowledge and tools needed to address critical resource management issues of concern to local communities.

CTPs offered by Reserves relate to current and future risk and vulnerability, coastal resilience, water quality, and sustainable resource management activities. Programs target a range of audiences, such as municipal and county elected officials and staff, state and federal regulators, land managers, and environmental non-profits. These training programs provide opportunities for professionals to network across disciplines and develop new collaborative relationships to solve complex environmental problems. Programs are developed in a variety of formats ranging from seminars, hands-on skill training, workshops, technology demonstrations, and technical assistance. Participants benefit from opportunities to share experiences and network in a multidisciplinary setting, often with a Reserve-based field activity.

The CTP requires a systematic program development process, involving periodic review of the Reserve niche in the training provider market, audience assessments, development of a five-year program strategy, a marketing plan and the establishment of an advisory group for guidance, program review and perspective in program development. The CTP implements a performance monitoring system, wherein staff report data in operations progress reports according to a suite of performance indicators related to increases in participant understanding, applications of learning and enhanced networking with peers and experts to inform programs. Program success and outcomes are also reported.

#### How JC NERR Will Meet Program Demand

The CTP seeks to provide decision support tools and to build capacity among coastal managers in New Jersey. Two full-time Community Resilience Specialists have been employed to meet increasing demand for the Getting to Resilience (GTR) one-on-one municipal-level Technical Assistance Program. Community Resilience Specialists have been and will be employed on an as needed basis to meet the demand for the Getting to Resilience technical assistance.

#### **Goals, Objectives, and Actions**

**Goal:** To provide science-based information for decision-makers to inform management of coastal ecosystems and communities.

#### **Objectives**

- Coastal decision-makers will recognize the CTP as a resource for scientific information relevant to coastal ecosystems and community management issues
- Coastal decision-makers will use decision support tools and reserve products to address local and regional needs
- Coastal decision-makers will increasingly implement science-based decision-making
- The Coastal Training Program will continue to work with partners to promote best practices, delivery of science-based information, and relevant training opportunities

#### **Actions**

- Develop and utilize decision support tools to inform coastal decision-makers
- Conduct coastal training workshops and technical assistance opportunities in response to local and regional information needs
- Coordinate programs and activities through a variety of topically relevant partners
- Implement performance measures and program evaluations to guide and improve JC NERR products, programs, and services

**Program Evaluation and Design**

All JC NERR CTP events, products, tools, and resources are evaluated for effectiveness and usefulness. The JC NERR utilizes the national performance monitoring system as a first level evaluation for training programs, conferences, and webinars. Program delivery, structure, and content are adjusted based on this feedback. More in-depth evaluations are performed with larger scale projects. These evaluations have included focus groups, evaluation surveys, website evaluations, and interviews with past CTP participants.

The JC NERR CTP follows the Instruction System Design (ISD) for program development. ISD is commonly used for the development of programs and products (Gagne 1987) and employs a “systems approach” that matches the products and programs to users’ needs to ensure that program/product development is effective and efficient. The ISD model steps are depicted in Table 1.

Analyze Audience	Design Product	Develop Product	Launch Product	Evaluate Product & Process
Front-end Evaluation <i>(assess users’ needs &amp; desires for improved decision making)</i>	Formative Evaluation <i>(get feedback on design criteria, storyboards, prototypes, beta products, etc., as often as possible &amp; is needed)</i>			Summative Evaluation <i>(assess if products work &amp; are useful)</i>

JC NERR will broaden the use of science-based information, products, and decision support tools within the coastal community. The CTP will offer workshops and training opportunities in conjunction with reserve partners such as the NJDEP, Rutgers University,

*Table 1. ADDIE Model. The type of ISD model the CTP follows is the ADDIE (Assessment and Analysis, Design, Development, Implementation and Evaluation) model. ADDIE is a well-known, iterative process where the results of one phase become the starting products for the next phase. The results of the formative evaluation of each step may lead the project designer back to any previous step for a refined design.*

Center for Remote Sensing and Spacing Analysis (CRSSA), and BBP. This professional training program and the tools and resources provided by the JC NERR CTP will support science based decision- making. Through the Rutgers CRSSA and Bloustein School partnership, the CTP will broaden the online spatial information available to coastal decision-makers. Finally, the CTP will continue to assess audience needs and respond with appropriate information, tools, resources, and opportunities.

**Program Capacity**

Staff

Coastal Training Program Coordinator  
Community Resilience Specialist  
Community Resilience Specialist

**Key Partners**

The JC NERR CTP operates through a vast network of partners who assist with providing advice and guidance, marketing and providing financial support for the CTP. Rutgers University, the managing partner for the JC NERR, provides a variety of resources that benefit the CTP program. These include direct access to state of the art scientific and technical information, direct access to scientists and



educators, and match funding for CTP grants. As resiliency challenges continue to grow in need and importance along the shore, a network of partnerships made up of these groups and the others described above will be critical.

Many of the members of the JC NERR Advisory committee frequently act as resources for CTP programs. These partners help deliver programs, act as resources for scientific and management information, help with funding needs, assist in advertising programs, and serve as sponsors. Key partners include the CRSSA, Richard Stockton College of New Jersey, USFWS, NJ Division of Parks and Forestry, Ocean County government, the NJDEP, Pinelands Commission, and the BBP.

#### Federal Partners

The JC NERR partners with FEMA to distribute coastal risk and flooding information. Federal level agencies like the Army Corps of Engineers and the NOAA's National Ocean Service will be partners that will continue serve as good references and provide resources to the program. Federal natural resource managers within the Reserve such as the Edwin B Forsythe National Wildlife Refuge serve as audiences for training programs and as possible pilot site locations for coastal resilience enhancement project.

#### NJDEP

On the state level, the CTP works closely with divisions in the NJDEP including the Coastal Management Program, Land Use Regulatory Program, and the Bureau of Dam Safety and Flood Control.

#### Rutgers

The JC NERR partnership with a variety of entities at Rutgers University continues to grow, thus expanding the depth and reach of the CTP. A long-standing partnership with Rutgers' CRSSA helps to provide the geospatial needs of our audiences. The Rutgers Bloustein School of Public Policy and Planning, the Rutgers Climate Institute, and the Rutgers-led Climate Adaptation Alliance have become, and will continue to be, strong partners for content and additional resources and expertise.

#### Local Partners

Another major partner is the Barnegat Bay Partnership (BBP). Through co-sponsored programs and grant opportunities, the BBP supports the outreach of the CTP. They have been funded by the Environmental Protection Agency (EPA) for a Climate Ready Estuary project, and the BBP has been working closely with the CTP to implement that project. Another primary focus of the BBP is the effects of climate change on the resilience of the natural and built communities within Barnegat Bay. As this is one of the priority topics for the JC NERR CTP, we will continue to offer combined programming and complementary trainings.

The JC NERR partners with various county agencies including the Ocean and Monmouth County Planning Departments, Ocean County Soil Conservation District and the Ocean and Monmouth County Emergency Management Agencies. Together, we address green infrastructure, resilience, and hazard mitigation. Nonprofit agencies are important New Jersey resilience partners in the post-Sandy recovery process. Agencies include: NJ Future, the Nature Conservancy, the American Littoral Society, NJ Sea Grant, Nurture Nature Center, the New Jersey Association of Floodplain Managers, and Sustainable Jersey.

#### Other Academic Institutions

Monmouth University, Stevens Institute of Technology, and The College of New Jersey (through the Sustainable Jersey program) are ongoing partners to the CTP. They provide additional science-based content, training co-hosting opportunities and the ability to expand the reach of the CTP to other parts



of coastal New Jersey.

### Volunteers

JC NERR Volunteers assist the Coastal Training Program Coordinator and Community Resilience Specialist staff with program logistics including materials preparation and organization, food set-up, service, and clean-up for coastal training programs and workshops hosted at the JC NERR Education Center and at off-site locations.

### **Program Delivery**

The CTP will continue tailoring programs and outreach opportunities to meet the needs of coastal decision-makers. CTP staff will develop and maintain a strong rapport with land use decision-makers at the local level. Through targeted educational programs, websites, and one-on-one interactions, the JC NERR plans to serve this audience by providing information resources, best available knowledge, management practices, and technologies such as GIS and web-based tools to meet the needs of coastal decision-makers. In addition, the JC NERR will collaborate with partners to identify opportunities for training and outreach collaborations.

CTP participants will evaluate each CTP in accordance with the CTP performance measures adopted by the Reserve system. The results of these evaluations will guide JC NERR programs, products, and services.

### Workshops and Conferences

Delivery of CTP information is tailored to specific audiences. For coastal decision-makers, information may be presented in the form of services such as coastal decision-maker workshops, technical training, or products such as web-based mapping platforms and decision support tools.

### Technical Assistance

One-on-one technical assistance is emerging as a desired service through the CTP. This type of delivery can be nimble and specific based on the targeted audience need and request. The level of technical assistance can develop overtime as the need and education of the audience matures with ongoing technical assistance. These one on one assistance opportunities allow for more refined outcomes and successful implementation and adaption of science based information due to the ongoing and specific nature of the assistance. Unlike trainings where larger numbers of decision-makers are trained, technical assistance has a narrow focus but a deep impact.

### Web-Based Tools and Resources

The JC NERR Coastal Training Program has been directly involved in the development of numerous web-based tools and resources, some of which form the backbone of our training opportunities and technical assistance. All web-based tools and resources are developed with the end user in mind throughout the development. Many of the tools have iterative assessments throughout their development and deployment to ensure the content and usability continues to meet the needs of the intended audiences.

One of the cornerstone web-based tools is “Getting to Resilience.” This tool is an online self-assessment developed to assist communities in reducing vulnerability and increase preparedness by linking planning, mitigation, and adaptation. Through this interactive, facilitated process communities learn how their preparedness can yield valuable points through voluntary programs like FEMA’s Community Rating System and Sustainable Jersey. The assessment process will also increase the community’s understanding of where future vulnerabilities should be addressed through hazard mitigation planning.

Developed to be used in association with [NJFloodMapper.org](http://NJFloodMapper.org) and [NJAdapt.org](http://NJAdapt.org), Getting to Resilience is the next step in communities planning for the risks associated with climate change and sea level rise. Together, these websites will help communities visualize their future risk and plan for that risk using their existing municipal planning tools.

These websites have been developed and continue to be maintained and improved through partnership with Rutgers CRSSA, Bloustein School, and the Climate Institute. Other partners have included the Barnegat Bay Partnership, the NJ Department of Environmental Protection's Coastal Management Office, Sustainable Jersey, and the Environmental Protection Agency's Climate Ready Estuary Program.

## **Needs and Opportunities**

### Reduce Impacts

Development and associated human activities along New Jersey's coastline affects water and habitat quality throughout the state. Coastal communities and habitats face resilience challenges exacerbated further by environmental change and sea level rise. As a result, many management issues relate to community preparedness and risk reduction. These are:

- Coastal/beach erosion
- Sea level rise
- Beach maintenance and replenishment
- Nuisance and back bay flooding and floodplain area management

### Engage Local Entities

As a "Home Rule" state, local municipalities possess decision-making authority for zoning, land use planning and ordinances. The JC NERR CTP will continue to consider municipal elected and appointed officials and staff as a priority target audience. These representatives include mayors, land use planners, zoning officials, environmental commissioners, planning board members, township administrators, construction code officials, engineers, stormwater coordinators, public works employees, and emergency management officials.

### Secure and Retain Funding

The CTP has been very successful at garnering outside funding support to supplement the NERRS operations grant. Funders to date have included the NERRS Science Collaborative, NOAA's National Ocean Service, FEMA, the State Coastal Management Office, and NJ Sea Grant. These outside resources have helped supplement a portion of the CTP Coordinator's salary, additional training opportunities and needs assessments and programmatic evaluations. Often these external grants are written with two to three partners, resulting in larger scale projects. Post-Sandy funding and ongoing resilience support has allowed for two full-time Community Resilience Specialists to be added to the JC NERR CTP team. Grant writing and the identification of external funding streams are necessary to maintain the current level of CTP staff, reach, and depth of service.

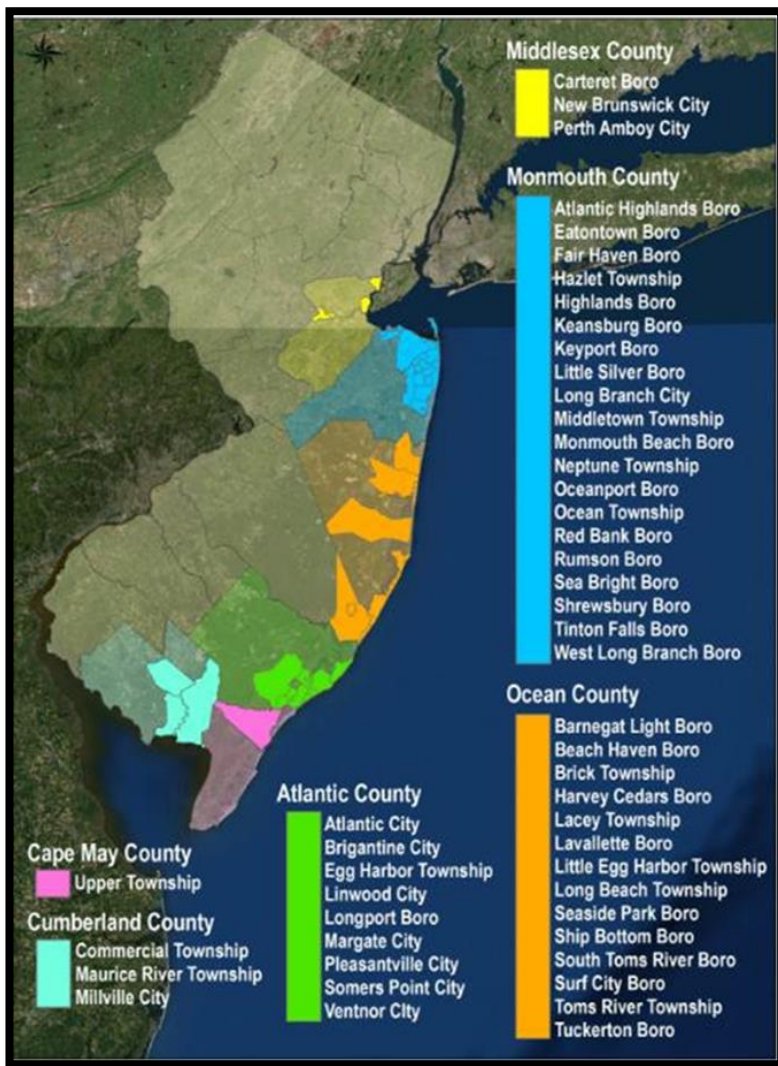
## **Continuing Projects**

### Resilience and Community Preparedness

In the wake of Superstorm Sandy, there has been an overwhelming call for the need to increase the resiliency of coastal human communities and natural ecosystems. Whereas sea level rise is a global phenomenon, adapting to its impacts is a local decision-making challenge. Through land use planning,

development, and coastal management decisions, local decision-makers play a key role in influencing the resilience of coastal communities to climate-change related sea level rise and storm surge.

Coastal managers need timely access to site-specific information to aid both strategic and tactical decision-making. Emergency managers especially need “locational” awareness of where flooding may take place as well as real-time information on the location of critical infrastructure and vulnerable populations. Starting in 2010, JC NERR teamed up with Rutgers CRSSA and NOAA’s Coastal Services Center to develop [NJFloodMapper](#). As our target audiences of coastal emergency management personnel are often non-expert GIS users without ready access to GIS software and data, we opted for a web-based GIS or WebGIS approach. Based on the software template originally developed for NOAA’s Digital Coast initiative, the NJFloodMapper tool leverages this national-scale effort with enhanced



**Figure 6.** *Getting to Resilience Town Map*

adaptation. Additionally, this community-based technical assistance involves face-to-face review and discussion of risks as illustrated by FEMA flood maps, the NJFloodMapper, and NJAdapt. Coastal resilience outreach to coastal municipalities remains a priority of the JC NERR. The Reserve has undertaken the GTR municipal planning evaluation process with about 40 NJ coastal municipalities. *Figure 6* shows the participating

functionality and locally-refined geospatial data and visualization examples that illustrate the location of flood exposed natural assets, property, and infrastructure.

It became clear through our experience working with coastal decision-makers that additional decision support tools and local-level training were needed to help coastal decision-makers translate the place-based information into concrete action plans. With additional support of NOAA’s CINAR program, we integrated the NJFloodMapper tool with the web-based Getting to Resilience municipal-based [planning evaluation tool](#) to provide fuller decision support capability. An important component of this work is a one-on-one facilitated GTR process with New Jersey municipalities to identify current and future hazards and vulnerabilities. As such, JC NERR Community Resilience Specialists work alongside communities to increase their preparedness by linking planning, mitigation, and

communities.

Finally, as the CTP municipal resilience work advances, the natural progression with individual municipalities will be to provide assistance and recommendations ways to engage their residents on the topics of resilience to coastal hazards and community preparedness. The GTR process, with ties to FEMA's CRS, incentivizes community engagement as a direct part of the resilience building continuum. At the JC NERR, the CTP Resilience staff has started working collaboratively with the Education staff to find opportunities to help communities that have already participated in the GTR process enhance their community outreach on coastal hazards and associated mitigation and preparedness opportunities. This integrated approach capitalizes on the assets of both the CTP and the Education programs at the JC NERR while advancing the resilience of local municipalities.

#### Nationally Funded Resilience Projects

Along with the NJDEP's CMP, Louis Berger Group, and the Two Rivers Council of Mayors (Monmouth County, NJ), the JC NERR, Rutgers Bloustein School, and the Rutgers Climate Institute are University partners on a three-year NOAA Regional Resilience grant. Known as the "New Jersey Fostering Regional Adaptation through Municipal Economic Scenarios" (NJ FRAMES) project, the 15 communities that make up the Two Rivers Council of Mayors in Monmouth County will work alongside project partners to perform a stakeholder-led scenario planning process, deploy new and enhanced decision-making tools, and develop consistent state- and community-level policy and practices that support resilience and adaptation actions.

Additionally, the JC NERR is co-Principal Investigator on a five-year, National Science Foundation funded project. Known as the Coastal Climate Risk & Resilience (C2R2) traineeship, JC NERR will be working directly with research-based master's and Ph.D. Rutgers University students in the Earth system sciences, social sciences, and engineering. Students will learn to conduct research that integrates natural, socio-economic, and engineered elements of coastal systems and communicate effectively with coastal stakeholders in defining research problems, conducting research, and applying research to address real-world resilience challenges. The C2R2 is housed at the Rutgers Institute of Earth, Ocean, and Atmospheric Sciences. It is a collaboration between the School of Arts & Sciences, the School of Environmental & Biological Sciences, the School of Engineering, and the Bloustein School of Planning & Public Policy.

In January 2016, JC NERR partners at the NJDEP CMP received \$15,000,000 in National Disaster Resilience Competition funding to support the creation of a Regional Resiliency Planning Grant Program, which will help regions and communities that experience significant flooding undergo a comprehensive planning process to identify and address vulnerabilities due to increased flooding risk. Through this award, the CMP will work with university partners to develop a toolkit of best practices for communities to assess their flooding risks and develop resilience building codes and plans. Their project mirrors the regional and economic cost-benefit approach undertaken in FRAMES, the current NJ-based NOAA regional resilience grant. This project could significantly involve the JC NERR CTP staff and partners in its implementation.

#### Digital Coast

NOAA's Digital Coast web platform is highly visible, has utility for the target national audience, and has become one of the most used resources in the coastal management community. The website provides coastal data and the tools, training, and information needed to make these data truly useful. Content comes from many sources, all of which are vetted by NOAA. The Digital Coast Act of 2016 authorizes that

“communities will continue to have the data to make smart choices for economic development, shoreline management, and coastal restoration” and “increases access to uniform, up-to-date data to help communities get the information they need to respond to emergencies, plan for long-term coastal resilience, and manage their water resources.”

The JC NERR will continue to provide content, case studies, and stories to complement the Digital Coast website. Additionally, the CTP will encourage our audiences to take advantage of the tools, training and online resources that are available.

## **Future Projects**

### Coastal Risk Communication

Following Superstorm Sandy, New Jersey’s municipal decision-makers faced challenges of immediate short-term recovery and eventually, longer-term municipal resilience planning. Technical assistance to these municipal leaders focused on risk and exposure awareness, resilience incorporation into overall municipal planning and implementation of suggested actions to improve resilience. Many of these suggested actions included educating municipal residents about current and future coastal hazards. A more informed municipal citizenry will improve resilience, education and outreach involving floodplain hazards and risks, and help participating municipalities earn points through the Community Rating System (CRS). While Sandy opened the local conversation regarding the presence and power of coastal hazards, communicating those risks in a way that triggered local actions was a skill set many municipal decision-makers lacked. Recognizing this risk communication knowledge gap, the JC NERR Coastal Training Program worked with NOAA’s Office for Coastal Management (OCM) and a risk communication expert (S. Watson) to develop risk communication outreach materials, a hands-on training activity, and a new addition to their social science publication series focused on risk communication. These materials were developed collaboratively with the goal to increase understanding and practical application of risk communication skills among coastal decision-makers and outreach professionals. These materials now form the basis of a Risk Communication field-deployed one-day training that will be offered by OCM, with a pilot that was offered at the JC NERR in spring 2017.

### Infrastructure Preparedness

Infrastructure preparedness is another natural tie to the ongoing municipal resilience assistance. Pairing the concepts of resilience, hazard mitigation and infrastructure preparedness (natural and built) represents a strategic, programmatic direction to steer future resilience opportunities. This approach also allows a scalar opportunity to work at the state, county and municipal level on built and natural infrastructure resilience preparedness.

### JC NERR CTP Transfer to Other Partners

The approach to resilience technical assistance post-Sandy has been a model that other reserves have emulated. The GTR process and associated online flood exposure awareness tools have been transferred via grant opportunities to two other reserves in New England. Additionally, numerous informal transfer opportunities have taken place via webinar, phone calls and conference presentations. As the JC NERR CTP continues to improve and refine tools and delivery methods, opportunities for additional transfer grants and mechanisms will be pursued to share successes and contribute to national models of science-based coastal management information transfer.

## EDUCATION AND OUTREACH PLAN



### Introduction

The Reserve system increases understanding and awareness of estuarine systems and improves decision-making among key audiences to promote stewardship of the nation's coastal resources. Education and interpretation in the Reserves uses programs and methodologies, tailored to key audiences, conveying priority coastal resource issues and incorporating scientific content. Reserve staff members work with local communities and regional groups to address coastal resource management issues such as nonpoint source pollution, habitat restoration, and invasive species. Through integrated research and education programs, the Reserves help communities develop strategies to deal successfully with these coastal resource issues.

Formal and informal education and training programs in the NERRS target K-12 students, teachers, university and college students and faculty, as well as coastal decision-maker audiences such as environmental groups, professionals involved in coastal resource management, municipal and county zoning boards, planners, elected officials, landscapers, eco-tour operators, and professional associations.

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 activity. Reserve education activities are guided by national plans that identify goals, priorities, and implementation strategies for these programs as well as the JC NERR's 2011 K-12 Estuarine Education Program's (KEEP) Market and Needs Assessment. Education and training programs, interpretive exhibits and community outreach programs integrate elements of NERRS science, research, and monitoring activities and ensure a systematic, multi-faceted, and locally focused approach to fostering stewardship.

## **Reserve System Goals Defined in Regulations**

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 2018-2022 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
- 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, students, environmental professionals, resource users and the 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 various resources to increase the estuary literacy of students, teachers, and the public. These tools can help 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 Teachers on the Estuary workshop and the Estuaries 101 curriculum. The System-Wide Monitoring Program database is another teaching tool aiming to strengthen data literacy. Conservation Action Education is another priority for the Reserve System. Conservation Action 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.

### How JC NERR Will Meet These Goals

The JC NERR education and training program aims to increase environmental literacy and build public capacity to make science-based decisions related to estuaries and coastal watersheds. Programs provide onsite and off-site educational opportunities for community members, teachers, and other targeted audiences, and focus on NERRS priorities, JC NERR research focus areas, and general information about the Reserve including its ecological, economical and historical values, and how research relates to



natural resource protection and management issues.

Formal education programs target elementary and secondary school teachers and informal educators, enhancing their ability to present Science, Technology, Engineering, and Math (STEM) education in innovative ways. Hands-on field enrichment opportunities include real-time scientific research conducted in and around the Reserve, NERRs, and with Reserve partners.

Habitats within the Reserve serve as a living classroom for public education, as does our LOE exhibit at the Tuckerton Seaport and public programs offered on and off-site. These activities explore ongoing research in and around the Reserve along with cultural, historical, and economic issues. The Education and Public Outreach program connects scientists and researchers directly with teachers and community members through seminars and presentations to relate studies to the community. Coordination with our land management partners provides an additional off-site programming opportunity within the JC NERR's varied habitats in the watershed and surrounding areas.

### **Goals, Objectives, and Actions**

**Goal:** To empower K-16 and community members to make informed decisions and take responsible actions to promote stewardship of coastal ecosystems.

#### **Objectives**

- Increase awareness, understanding and knowledge leading to wise-use of estuaries, coastal watersheds and marine ecosystems
- Establish formal and informal education programs for K-16 audiences
- Provide teacher training workshops and programs for the public

Our vision is that of an informed citizenry which includes community members, at all levels, who are ocean, climate and science literate and engage in responsible stewardship of our coastal resources.

#### **Strategies**

The JC NERR's Education and Public Outreach program strives to increase awareness, understanding, and knowledge leading to wise-use of estuaries, coastal watersheds, and marine ecosystems by:

- Providing hands-on classroom and field enrichment experiences, curriculum and information materials tailored to the needs of a wide range of audiences with an emphasis on estuarine, coastal watersheds, marine ecosystems and JC NERR research focus areas
- Addressing local, regional and national coastal issues that emphasize the interrelationships of coastal habitats and human activities while promoting individual responsibility
- Link on-site and off-site programs to the JC NERR's and NERRs research, environmental monitoring and stewardship programs
- Increase understanding and appreciation for the JC NERR and NERRS by participating in outreach events, communication and marketing activities
- Promote awareness of the value of estuaries through diverse media including public exhibits, Reserve website, newsletter, local newspapers, brochures and social media
- Develop partnerships with land management partners and other local, regional and national partners that enhance education opportunities

## **Program Context**

### Value of Education

Without education, it is nearly impossible for one to appreciate, change, or be proactive in our ever-changing world: *"In the end we will conserve only what we love; we will love only what we understand; and we will understand only what we are taught."* (Baba Dioum, 1968).

### Place-Based Education

Place-based educational experiences are one of the most impactful and memorable forms of learning for students, teachers, and community members. This hands-on experience, virtually impossible to replicate in the classroom, lasts a lifetime. Through JC NERR and our land management partners, visitors form an understanding and appreciation for local environment, history, and culture. The JC NERR is an essential location for place-based learning that includes exposure to numerous environments such as estuaries, the Pine Barrens, barrier islands, the ocean, and freshwater wetlands. Place-based education at the JC NERR exposes educators and students to a variety of habitats and the real-world research and monitoring focused on issues facing our world today. Our homeschool programs and the Pinelands World Water Monitoring Day are our two best educational experiences that integrate place-based learning.

### Ocean Science and Climate Literacy

It is important to the JC NERR that the community understands the impact they have on their environment and how the environment impacts them. Therefore, we promote education on ocean, science, and climate literacy and its value to the community. The JC NERR offers many programs to the public and to professionals on wise use of natural resources, leading to informed decision making while promoting stewardship within their community. An informed and literate community is a resilient community that can empower action and change. This change can help create a better world for future generations.

### Changes and Evolution of the JC NERR Education Program

While our mission remains the same, our education programming must change to reflect our changing world. Our forms of communication, interests, resources, and environment continually fluctuate. Therefore, we must adapt to these changing conditions to promote our mission and meet our goals.

### *Market Analysis and Needs Assessment*

Results of the JC NERR's Needs Assessment and Market Analysis (MA/NA), completed in 2011, drives the development of field and classroom educational opportunities. MA/NA results led to the expansion of our classroom technology including the addition of a SMARTboard and iPads that allow us to connect with researchers in the field and around the world. Additional professional development workshops will be designed and/or offered in alignment with results of our needs assessment.

### *Digital Learning*

The JC NERR plans to explore and expand virtual educational programming over the next few years. We live in a world where digital devices are one of the major sources of information and entertainment. Having this technology accessible and available for learning purposes can help teachers, students, and the public better understand coastal and estuarine concepts, data literacy, and more. The JC NERR also purchased an iPad and hotspot to bring technology to more remote areas in the field. Tablets and monitors at the Life of the Edge Exhibit are also very helpful in engaging students and families.

### *Online Learning*

Our online learning program includes webinars and access to more information and resources than in print. Through our website and social media, the JC NERR can make more information available to the public, students, and K-12 educators. The development of the Estuaries 101 curriculum has increased our web-based learning by offering resources such as educational videos and using SWMP in the lessons. The E101 curriculum is available on the newly updated NERRS Estuary Education website, which is now easier to navigate and more user friendly. At the JC NERR the installation of the Smart Board has expanded online learning by making it more easily accessible during presentations and trainings. Articulate Software will help begin development of online courses that can enhance TOTE and other professional development workshops offered by the JC NERR.

### *Accomplishments and Achievements*

There have been numerous accomplishments and achievements within the education sector of the JC NERR. The JC NERR and education coordinators from the other reserve systems developed the online teaching resource: Estuaries 101 Curriculum (E101). E101 consists of lesson plans and activities for teachers of grades K-12 as well as educational videos, and access to the SWMP data which is incorporated into many of the lessons. The Teachers on the Estuary (TOTE) training program was also developed by the education coordinators from the NERRS. The JC NERR research and education staff joined forces to make SWMP more available to teachers and public by creating “SWMP stories,” which explain why certain data readings are occurring during different climates or weather events. The NOAA Marine Debris WeCrab project took place from 2015-2017, in partnership with Stockton University, as part of a Conservation Action Education program in which recreational crabbers are educated and given materials to reduce the loss of crab pots and therefore reduce the amount of marine debris in our surrounding estuaries. Teachers were also given training on marine debris lessons and activities they can use in the classroom.

Through a grant from the National Science Foundation, The JC NERR and the New Jersey Sea Grant Consortium partnered to offer more programs involving marine science and underwater technology. The JC NERR has offered educational programs to both teachers and students on Remotely Operated Vehicles and Autonomous Underwater Vehicles (ROV/AUV). These ROV and AUV programs involve incorporating STEM content through building and constructing small-scale underwater robots. JC NERR has also been incorporating STEM principles in a new homeschool spring series, with plans to continue to expand this programming in the future.

The education staff from the JC NERR and other reserves around the country collectively applied for, and received, a NERRS Transfer Grant. The project is titled “Method for TOTE: Update Science Collaborative Projects” to have an associated educational component. The purpose of the project was for education coordinators to gain a better understanding of the Science Collaborative projects going on within the Reserve system. Knowledge gained will help Education coordinators build upon the Estuaries 101 Curriculum and STEM content during TOTE trainings. The result was a website with E101 extension activities that focus on topics that were of most interest within Science Collaborative projects: climate change, ecosystem services, and water quality.

An educational component was collaboratively written into a grant led by Kenneth Able titled “Implementing American Eel Passage on Existing Dams.” The education component included making the data available and interpreted for a wide range of audiences. Information gained from the research was

used for the public and used in teacher trainings. This topic is also one that the Education Coordinator and the Volunteer Coordinator hope will engage citizen scientists locally. Other accomplishments include incorporating education on climate and ocean literacy, contributions to the planning and design of the Life on the Edge exhibit at the Tuckerton Seaport, and working to develop and implement the Barnegat Bay Curriculum for teachers.

New partnerships were developed as well such as Ocean County parks, the Pinelands Preservation Alliance and Pinelands Adventures, Barnegat Bay Partnership, Ocean County Soil Conservation District, and the New Jersey Conserve Wildlife Foundation, among others. Relationships with other NERRS sites have also strengthened, especially within the Mid-Atlantic region.

## **Program Capacity**

### Staff

*Education Coordinator*

*Part-time Seasonal Educator*

*Part-time Interpretation/Exhibit Coordinator*

## **Volunteers**

JC NERR volunteers provide support for various public education and outreach programs including Creature Feature, Summer Fun, Ecological Evening, and RUMFS Open House. Volunteers assist our Education and Volunteer Coordinators, as well as ancillary staff (teachers, interns, etc.), with preparing and organizing education materials, helping with execution of educational programs, and subsequent clean-up/follow-up from programs.

Volunteers accompany JC NERR staff to environmental festivals where they interact with the public and promote JC NERR's mission, research, and goals. Volunteers also assist JC NERR's Education Coordinator with professional development program logistics, such as for Teachers on the Estuary and Project WET and WOW!, including preparation and organization of program materials, classroom and program set-up, and food set-up and service.

Volunteers represent the JC NERR at the Life on the Edge exhibit located at the Tuckerton Seaport. The exhibit communicates research occurring throughout the Mullica River-Great Bay Estuary, educates visitors about the stewardship of our coastal/estuarine resources, and encourages environmental awareness and informed decision making about resource protection. JC NERR volunteers interact with exhibit visitors by discussing and answering questions about the exhibit and the Reserve, and guide visitors through the exhibit to ensure that they have a positive experience. Volunteers also provide integral support to the Interpretive Coordinator by assisting with presentations to school and senior citizen groups that visit the exhibit, as well as supporting on-site educational programs.

Volunteers are encouraged to attend professional development or educational programs hosted by the JC NERR. If volunteers are interested in learning more about coastal and estuarine environments and issues, or would like to delve deeper into learning about a specific resource to enhance their volunteering experience, they are welcome to attend trainings and programs pertaining to their interests.

Based on funding, JC NERR will continue to offer the opportunity for up to three volunteers, based on interest and prior volunteer experience and hours, to attend local Master Naturalist, Environmental

Steward, or other external professional development courses to further volunteers' environmental education, enjoyment, and involvement in volunteering at the Reserve.

JC NERR will continue to expand its volunteer program by providing additional opportunities including the development of volunteers into leadership roles and additional field-based Citizen Science projects. The JC NERR will explore these opportunities, both on and off-site, and offer them where appropriate.

## **Key Partners**

### The Tuckerton Seaport

Colloquially known as The Tuckerton Seaport and Baymen's Museum, a 501(c)(3) educational institution, dedicated to the mission of preserving, presenting, and interpreting the rich maritime heritage, artistry, and environment of the Jersey shore and the unique contributions of its inhabitants. The Tuckerton Seaport houses our Life on the Edge exhibit and is where we have our Lunch n' Learn programs.

### Land Management Partners

Community outreach programs will continue to be developed and enhanced by working with our land management partners. The JC NERR land management partners include Wharton State Forest, Bass River State Park, Port Republic Wildlife Management Area, Swan Bay Wildlife Management Area, Great Bay Blvd. Wildlife Management Area, Absecon Wildlife Management Area, Edwin B. Forsythe National Wildlife Refuge, and New Jersey Conservation Foundation (NJCF).

### Stockton University

Located in Galloway, NJ, Stockton University is one of the leading institutions in the country for undergraduate studies in marine and coastal sciences. Stockton also has been a leader in marine debris research, particularly derelict crab pots. With the help from Stockton University professors, their field station staff, and students, we have been able to grow our marine debris action efforts and education programs over the last four years. We are looking forward in continuing to strengthen our partnership with Stockton University.

### National Marine Educators Association (NMEA)

An international member-based organization of classroom teachers, informal educators, university professors, scientists, and more from around the world working together to advance the understanding and protection of our freshwater and marine ecosystems. The JC NERR has been a member of NMEA for many years, attending the annual conference, meetings, and board calls as Chapter Representative. The Chapter Rep acts as a liaison between NMEA and the chapter region of New Jersey and Eastern Pennsylvania (PA).

### The New Jersey Marine Education Association (NJMEA)

NJMEA is a NMEA regional chapter that includes New Jersey and Eastern PA. This organization is made up of teachers, students, marine scientists, and lay persons united in a common interest: "To promote marine and aquatic sciences throughout all disciplines and all levels of the education process." NJMEA offers educational materials, workshops, seminars, guest speakers, and our official publication, the *Sea Horse*. The JC NERR has been involved with NJMEA for many years, serving on the board and electoral staff.

### Alliance of New Jersey Environmental Educators (ANJEE)

An organization that supports and advances environmental education efforts in New Jersey for people of all ages to cultivate and environmentally literate population. The JC NERR has been involved in ANJEE for

many years, attending the annual conference as both an exhibitor and presenter.

## Facilities

### Classroom at the JC NERR

The JC NERR classroom supports public programs such as Family Fun Nights and Ecological Evenings. It is also center stage for our Summer Creature Feature Classes for students in grades 1-5. The classroom also is the main area for conducting professional development classes and workshops on Marine Debris, TOTE, Project WET and WOW!, and many more. Other organizations have also used this space to conduct classes and workshops.

### Life on the Edge Interpretive Trail at the Grassle Marsh



**Figure 7.** JC NERR LOE at the Grassle Marsh Trail.

(deadfall and/or removed vegetation (*Figure 7*). At the beginning of the trail, a Welcome Kiosk along with benches, bike racks. Interpretive signage is placed at various locations along the trail. A 6' x 130' raised boardwalk out to a 14' x 10' observation deck built using non-polluting materials is a signature feature (*Figure 8*).

The LOE Interpretive Trail is used to engage both casual visitors and participants of formal education programs conducted by JC NERR staff. The trail will enhance a variety of public programs offered by the Reserve as well as teacher professional development, including the system-wide program Teachers on the Estuary. TOTE is a highly visible NERRS education program that offers hands-on, field based, professional teacher development opportunities by NERRS sites across the nation. Currently, to get program participants into the field, they must

As local community anchor, the JC NERR and the Tuckerton Seaport have developed shared life-long learning opportunities to a diverse audience, showcasing how local environment and culture have been intertwined over time. The Tuckerton Seaport also maintains an existing and newly updated Maritime Forest Trail. The LOE Interpretive Trail at the JC NERR Coastal Center complements the LOE exhibit by providing a nearby, additional outdoor experience for local residents and visitors to learn about tidal wetland habitats, the importance of the natural resources located within the transition zone between forests and wetlands and the natural benefits that these systems provide. The tidal wetland viewshed offered through the LOE Interpretive Trail allows an opportunity for visitors to immerse themselves within a critical local resource. The LOE Interpretive Trail is a natural earth path walkway with trail at-grade and minimum trimming of vegetation, outlined with trunks

travel by vehicle to other locations within the Reserve. For many public programs, which are often only 60-120 min., this has limited our ability to get participants out into the field for hands-on experiences. With the addition of the LOE Interpretive Trail and the proposed raised boardwalk and observation deck, participants of our public programs will not only learn about the marsh ecosystem but will be able to experience them first hand using all their senses. For example, they will have the ability to see and touch the variety of plants found in the Grassle Marsh, and to see and hear the osprey they just learned about in the classroom.



**Figure 8.** Boardwalk and observation platform along the LOE at the Grassle Marsh Trail

For teachers, the addition of the observation deck will provide an additional venue for monitoring and conducting place-based research. Due to the proximity of the trail, monitoring equipment can be placed and checked throughout the day (over several tidal cycles) and on multiple days of an extended training such as TOTE, making us less dependent on availability of vans and even weather due to increased flexibility. The addition of easily accessible research equipment will reduce the impact to the marsh by participants. The observation platform will also serve as an example of how to develop a study site and what types of research and monitoring can be done. Ideally, this will inspire teachers to use study sites at or near their schools while providing opportunities to compare multiple sites.

Partners on the Grassle Marsh Acquisition and the LOE Interpretive Trail project include the Ocean County Natural Lands Trust and Little Egg Harbor Township (co-owners of the Grassle Marsh), the Tuckerton Seaport with an adjacent Maritime Forest Trail, (in addition to the LOE exhibit), and Rutgers University Marine Field Station, which has a great interest in accessing the trail for environmental monitoring of the marsh. The Tuckerton and Little Egg Harbor Environmental Commissions also have great interest in being partners on the LOE Interpretive Trail, as it provides a local outdoor experience to connect with the environment and learn about the local ecosystem resources.

#### Life at the Edge at the Tuckerton Seaport

Organized in 1989, the Tuckerton Seaport arose from the grassroots efforts of the local community who saw a need to champion the quickly disappearing traditions of the Jersey shore. The Life on the Edge exhibit, on the upper level of Tuckerton Seaport's visitor center, opened to the public in July 2002.

The Tuckerton Seaport/LOE is open 362 days a year with about 50,000 attendees annually. Of the visitors, 66% are from New Jersey; 33% from other states; and 1% are international. Over 6,000 students participate in the Seaport's on-site educational programs annually. Currently, the demographics of the Seaport reflect the community of the region: 70% Euro-American, 13% African American, 11 % Hispanic or Latino, and 5% Asian. Families, residents, and tourists account for the largest audience.

Trending among museums and nature centers, including the Seaport, is to attract millennials. Courting



millennials to JC NERR programs, presently an underserved demographic, taps into their potential powerhouse as catalysts for change and commitment to environmental issues.

The LOE exhibit (pictured to the right), located on the top floor of the Tuckerton Seaport, is the gateway to the Reserve by introducing how its habitats are connected by river, forest, bay marsh, and ocean. The interpretive exhibit serves as a lens through which research, coastal training, recreation access, education and outreach programs can become better known to the public. The exhibit offers various perspectives



from scientists and people who use the estuary, and it is prime opportunity for the JC NERR to reach the public. Housing our exhibit in a living history maritime museum allows the JC NERR to interpret how the estuarine environment has affected communities over time and in turn how community development reshapes the natural environment. Our audiences are tourists, lifelong residents, newcomers, boaters, local business, children, recreational boaters, and fishers.

The exhibit highlights ways that our estuary is a special place, constantly changing in response to humans and natural causes. After watching the 5-minute introductory video in the theater, visitors engage with hands-on activities throughout the redesigned 2,400 sq. ft. exhibit space. There are many innovative interactive experiences such as examining the depths of a water droplet, immersing oneself into a marsh while discovering its hidden richness, a 'match the critters' puzzle, and watching coastal changes through an oversized view master.

Visitors learn how humans affect the estuary in small and large ways and how everyone can manage their impact. Many voices reflect on how estuaries are remarkable and productive; playing the role of nurseries, buffers, filters, sponges and home or temporary refuge for many animals. Images evoke the daily and seasonal rhythms of the estuary. Scientific research and how it can inform our decisions to best protect the value and beauty of the estuary is discovered throughout the exhibit. Appreciation of how our lives are intertwined with the benefits of and threats to the estuary can be a catalyst for change and guide visitors take responsibility actions that support local and global environmental and sustainable practices.

#### *Hands-on Interpretive Interaction*

Interactions with nature on the LOE Interpretive Trail on the Grassle Marsh will complete an interconnected loop between the maritime heritage at the Tuckerton Seaport, the Life on the Edge exhibit and facilitated education programs at the Cousteau Coastal Center. Together they provide a meaningful learning experience with multiple levels of content and points of entry.

The addition of a mobile education cart to the LOE exhibit provides for informal guided learning opportunities to enhance topics and content of the exhibit. This mobile cart is used by exhibit educators to bring the estuary inside the exhibit and outside on the Seaport boardwalk on festival days. The cart provides for hands-on learning

opportunities to discover the research and biological life within the Reserve and allow for informal interpretation of the estuary. The JC NERR Education, Interpretation Coordinator, and JC NERR volunteer educators are responsible for engaging visitors with direct observation of the natural world. Specific TOTE activities can be offered on the cart.

Volunteers will be trained to work closely with scientists and educators exploring scientific content while learning valuable skills for working with and teaching learners of all ages.

### RUMFS

The Rutgers University Marine Field Station (RUMFS) is used for educational purposes such as professional development workshops and field trips, and special events such as our Annual Open House.

## **Program Delivery**

### Professional Development

To increase awareness and understanding of ecosystems such as an estuary, resources must be provided to the educators. The JC NERR education program will focus on elementary and secondary school teachers, enhancing their ability to present science in innovative ways to stimulate student interest.

### *Teachers on the Estuary (TOTE)*

Teachers on the Estuary (TOTE) is a NERRS education program that offers hands-on, field based, professional teacher development opportunities at NERRS sites across the nation. TOTE trainings are promoted on a national and local level. Teachers across the United States can apply to participate. The TOTE program, developed by NERRS Education Coordinators, began in 2004. NERRS TOTE workshops began in 2010 and the JC NERR offered its first in 2013. Reserves create their own course theme to utilize unique local research, habitats, professional knowledge, and existing infrastructure. However, sites are required to incorporate certain elements, including: a minimum of 15 contact hours, alignment to state and national curriculum frameworks, a NOAA/NERRS overview including resources, and an evaluation plan. Through TOTE the JC NERR translates results of NERRS research and SWMP information along with NOAA resources into educational products that will strengthen educator capacity in the scientific process, introduce advanced technologies, and boost estuarine and climate literacy. Evaluation results from TOTE offered to date show TOTE trainings enhance content knowledge, teacher competence, and confidence in facilitating science learning.

### *NJDEP: Project WET and WOW! Wonders of Wetlands*

As stated in the NERRS Strategic Plan, “each reserve serves as a place-based living laboratory and classroom.” Habitat workshops developed for formal and informal educators specifically focus on the “living classroom” of the Reserve’s land as well as the research and monitoring done in and around the Reserve. One and two-day workshops build content knowledge and provide materials for the classroom that emphasize reserve habitats, water quality, and technology subject areas. That is why we plan on continuing to offer professional development workshops with NJDEP. Professional development workshops through NJDEP include curriculums such as Project WET and WOW!, Wild, Aquatic and Project Learning Tree.

### *ROV/AUV Repository and Training*

Through grant opportunities such as a National Science Foundation grant and a grant through the National Park Service, the JC NERR began serving as an advanced technology training center focusing on Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUVs). In partnership with Rutgers University, New Jersey Sea Grant, and Stockton College, the JC NERR provides professional development workshops focused on advanced technologies. Primarily grant funded, these trainings also provide access to equipment such as Aqua Botz kits (used to build ROVs) that trained teachers can then “check out” for use in their classroom or request

classroom assistance and resources from JC NERR staff to bring advanced technologies into their classrooms.

#### *National Network for Ocean and Climate Change Interpretation*

Through the National Network for Ocean and Climate Change Interpretation, also known as NOCCI, the JC NERR will continue to facilitate NOCCI workshops. NOCCI workshops and trainings help educators (formal and informal) overcome the challenges and barriers of educating the public on climate change. The JC NERR plans on continuing offering workshops through NOCCI while staying informed on the latest research and educational tools aiding in proper climate change interpretation.

#### *Marine Debris Workshops “Talking Trash”*

Through the WeCrab Marine Debris project, The JC NERR offered and will likely continue to offer teacher professional development training focusing on the issue of marine debris. Formal and informal educators will learn about the crab pot removal projects happening regionally and will receive training and materials so they can use NAMEPA’s An Educator’s Guide to Marine Debris Curriculum and NOAA’s Turning the Tide on Trash: A Learning Guide on Marine Debris in their classroom.

#### *STEM and Advanced Technologies*

Many studies have shown that conventional approaches to teaching science are not effectively communicating science basics to students across the nation. Students begin to lose interest in science in elementary school, and this trend continues through high school. Only a small percentage of students graduate high school with the knowledge and motivation necessary to pursue science-related careers.

Through environmental education, young people can be encouraged to explore their ability to develop theories, analyze evidence, and make a difference in their environment. The key to a change from conventional methods to an inquiry-based approach is a well-trained, motivated educator. One means to achieve this is to provide educators with access to new technologies and research relevant to estuarine ecosystems. Hands-on field enrichment opportunities will be promoted, and educators will be immersed in real-time scientific research being conducted in the Reserve. In addition to field experiences, educators will work with the Education Coordinator to develop practical applications that bring their experiences into the classroom.

One way the JC NERR will accomplish this is through K-12 Estuarine Education Program (KEEP), which increases the ocean literacy of students and teachers to promote responsible stewardship of our coastal resources now and into the future. The goals of KEEP are to:

- Raise the ocean literacy of K-12 students and teachers regarding coastal and estuarine ecosystems
- Increase the number of teachers trained to teach students about estuaries and coastal ecosystems
- Encourage responsible stewardship of estuarine, natural, and cultural resources, especially of research reserves
- Promote understanding of the NERRS

KEEP focuses on place-based education. We provide opportunities for teachers and students to explore the JC NERR’s unique habitats as a living laboratory and become immersed in real world research. Along with opportunities for field-based studies, teachers and students are introduced to classroom activities and curriculum that focuses on locally relevant topics and Reserve research themes. The JC NERR also uses and promotes the on-line, inquiry-based Estuaries 101 Curriculum, correlated to national and state standards, which promotes estuarine science activities to excite teachers and students about coastal and estuarine concepts.

## **Student Programs**

### The “Life on the Edge” Exhibit at the Tuckerton Seaport

The Interpreter works with the Tuckerton Seaport educational staff to deliver a seamless field trip experience that connects the cultural heritage and natural resources of Mullica River/Great Bay and Barnegat Bay to an average of 6,000 children per year. The children learn what an estuary is, how it functions, and recognize that it is a special place worth protecting and preserving.

The interpreter and docents develop ideas for conducting tours and extending the reach of the exhibit by designing and implementing a suite of indoor and outdoor experiences. All tour programs promote a cohesive field trip experience and fulfill NJ core curriculum standards. There is a targeted effort to provide underserved districts through free bus grants. The Seaport is a favored destination for schools serving special needs children.

### Creature Features

Our premier summer program is Creature Features. This camp runs during the summer months and focuses on students in 1<sup>st</sup> - 5<sup>th</sup> grade. The program celebrates the creatures of the estuary and ocean with hand-on activities, games, crafts, and special guests. Topics focus on addressing estuary and ocean literacy principles.

### World Water Monitoring Day

Development and delivery of educational opportunities geared for the K-16 audience continue to be a priority. The JC NERR will continue to work with local, regional, and national partners to provide unique education opportunities. World Water Monitoring Day occurs in October each year. The Reserve partners with the NJDEP and the State of New Jersey Pinelands Commission to offer the Pinelands/World Water Monitoring Challenge at Wharton State Forest for middle and high school students.

### Homeschool

The JC NERR is exploring ways to reach out to and work more collaboratively with local and regional homeschool groups providing extended science-based learning opportunities. A partnership with the "Macaroni Kids" and the "World Explorers", both local homeschool resource groups, will serve as a pilot in developing and evaluating home school educational opportunities.

## **Public Programs**

### Community Focused Education

Public education programs and outreach events are planned based on NERRS priorities, current Reserve research and audience surveys. The overall focus for these activities will be familiarizing the community with the variety of habitats within the Reserve, and ways in which the public can be informed stewards of these habitats.

### Behavioral Change Education

Over the last few years there has been an increased emphasis among the JC NERR, NERRS education coordinators, and NOAA in focusing on environmental education and ways to foster behavioral change to promote resource conservation and to support the mission of the Reserve. Behavioral Education (currently referred to in the NERRS as "Conservation Action Education") focuses on audiences whose choices impact the integrity of our estuaries and their associated watersheds. The JC NERR strives to turn participant intentions into actions. Much of our development focuses on community-based education models such as Community-Based Social Marketing (CBSM) to move community members along the behavioral change spectrum. The JC NERR has been actively engaged in conversation about behavior change education on the local and national level.

In 2012, the JC NERR started a new series (Build a Better Backyard) focused on participants building the skills and confidence and providing participants with the tools and supplies to practice personal stewardship within their homes, yards and neighborhoods. Future improvements to this program include the expansion of program

offerings as well as alignment to NOAA's Stewardship Performance Measure that is currently in development.

Another example of Behavior Change Education at the JC NERR has been through The WeCrab Marine Debris Project (MDP), which uses Community-Based Social Marketing to encourage changes in behavior to prevent derelict fishing gear and other debris (land and sea based) from ending up in our marine and coastal waters. The WeCrab MDP consists of three main objectives: Prevention, Education and Active Participation in small scale removal. The education sector looks to continue to offer Behavior Change Education programs surrounding the topics of marine debris and beyond.

#### Lunch n' Learn and Ecological Evenings

The Lunch n' Learn and Ecological Evening program series are a collection of presentations by scientists and professionals to inform the public of current coastal issues, science research, cultural and historical importance, and to inspire appreciation for the natural world. The programs address estuary and ocean literacy principles, along with science and climate literacy. These programs are geared towards adult audiences, allowing interactions between community members, researchers, and topic experts. Sessions include questions and thought-provoking discussions. Lunch n' Learn has been done in partnership with the Tuckerton Seaport since 2004. It remains one of our most attended programs, generally drawing 40-60 people each month. After Hurricane Irene and Superstorm Sandy, the topic of resiliency has become a popular topic that is included in each season's offerings. The overwhelming success of this series has led limiting participants due to fire codes that limit the number of occupants to 65.

#### Marine Field Station Open House

Coinciding with National Estuaries Month, the JC NERR and the RUMFS host an annual Open House at the Tuckerton-based field station. This annual event draws 500-700 people from the Northeast who want to learn more about the research projects occurring at the Field Station. Visitors tour the field station and interact with scientists as they discuss research projects conducted by technicians and research staff from throughout IMCS. This annual event is one of the most anticipated in the area.

#### Recreational Education

The JC NERR offers outdoor recreational programs such as hiking, kayaking, and birding through our "Out and About the Reserve" programs. These programs will provide the community with hands-on experiences and a greater appreciation and understanding of New Jersey's unique habitats. During our Out and About programs, participants learn new skills, about the partnerships that make up the lands of the Reserve, how we work together to manage the Reserve, and why protection of these lands is important. These programs are developed in cooperation with Ocean County Parks, a partner generally recognized in the region for quality educational and recreational programs, and other land management partners. The addition of the Life on the Edge Grassle Marsh Trail at the JC NERR offers another opportunity to expand outdoor recreational programs, such as hiking, to the public. The LOE map table is a useful way to explore the Reserve system for places to partake in outdoor recreational activities. Expansion and continued development of this program is prioritized as we increase the participation of families in our outdoor recreation programs.

#### Festivals and Events

Many people who live and work within the boundaries of the JC NERR are unaware of the tremendous natural resource value of the Reserve. The JC NERR serves as the educational link between the community and the scientific research being conducted throughout the Reserve. Offsite community outreach programs consist of off-site presentations, festivals, and fairs. Community Outreach programs are designed to raise public awareness about watershed and coastal ecosystems, current research and ocean and climate literacy. Outreach programs take various forms based on audience needs. They may be focused on the JC NERR's role as a research reserve or

be topic oriented. These programs are offered free of charge to community organizations and nonprofit groups. The JC NERR also engages the community through our attendance at a variety of local events such as fairs and festivals. The spring and summer provide numerous opportunities for staff and volunteers to man booths that introduce the JC NERR, current research projects and increase awareness of coastal ecosystems. The JC NERR will put an increased emphasis on the development of new interactive activities for these events and the training of volunteers to help staff the table and run the activities.

### **Outreach via Technology**

In addition to offering programs locally, it is essential for us to reach communities beyond the borders of the Reserve. We have been achieving this digitally through social media, our website, and the JC NERR email list serve. Outreach education programs, special events, workshops, and conferences also broaden our reach and allow us to network and create new partnerships. This will help the Reserve to motivate individuals to take informed action on environmental issues within their community. The JC NERR will seek funding for projects and programs that incorporate storytelling and visualization techniques, commonly known as augmented reality, a digital experience that reflects 21<sup>st</sup> century learning expectations of participatory engagement. Cutting-edge digital reality through augmented spaces extends the boundaries of storytelling and education by placing community members at the center of an experience. We plan to incorporate augmented reality to create multiple entry points to a particular subject such as SLR, resilience, environmental change, and design of carbon reducing products/processes. Digital strategies for experiential storytelling will be used to integrate resources of JC NERR research, CTP, education and outreach programs, while leveraging collaborative cooperation across disciplines and departments at Rutgers University. The outcome will help to create a catalyst for community driven change and commitment to environmental issues.

### **Program Evaluation**

Evaluation is a key element of all JC NERR education and outreach programs. Front-end evaluations guide initial program development. Formative assessments provide adaptive program feedback, which shapes ongoing programs and informs the development of future programs. Summative evaluations provide results, which feed into new educational programs and opportunities. Evaluations and results of the JC NERR Market Analysis and Needs Assessment Survey, conducted in 2011, help develop and improve the JC NERR education and outreach programs.

### **Needs and Opportunities**

#### Identify Areas Where More Education is Needed

##### *Underserved Populations*

Through tracking of visitors to our LOE, we have seen an increase in visitation by certain demographics, including Haredim families, and the Millennial Generation (ages 18-34 as of 2015). We will look closely at possibilities to develop programs that will raise estuarine and coastal awareness among these audiences.

##### *Homeschool and Remote Learning*

Through our market analysis and needs assessment conducted in 2011, we learned that homeschool groups and distance learning opportunities were two areas that may represent opportunities for program expansion.



## STEWARDSHIP PLAN



### Introduction

Stewardship within NERRS is implemented differently by each Reserve based on its structure and land management responsibilities. At the JC NERR, science-based stewardship is a principal goal integrated throughout the research, education, and coastal training program. The JC NERR does not own or directly manage large tracts of land and therefore does not conduct “on the ground” physical forms of stewardship. Rather, the JC NERR defines stewardship in the broader sense of providing relevant information, education, and training to achieve our mission. This stewardship role has been broken down into different themes, each corresponding to a different spatial area of our estuarine and watershed system. These themes present the JC NERR with a variety of training opportunities based on land management, human use, and unique ecological conditions. The JC NERR also views our engagement and nurturing of volunteers as a core opportunity to meet our stewardship objectives.

### Goals, Objectives, and Actions

**Goal:** To provide information, services, and infrastructure for research, education, and outreach in support of sustainable natural resources and communities.



## **Objectives:**

- Resource managers will increasingly use scientifically collected data to support coastal management decisions
- Partners will recognize the ecological, economic, historical, and cultural importance and value of research in estuaries
- Land stewards will utilize the JC NERR monitoring and research data and management best practices to protect, conserve, and restore estuarine habitat and water quality

## **Actions:**

- Identify the best available information, tools and technology for environmental decision-making
- Train resource managers in the use of GIS and GPS technologies
- Track land use/land cover change in the Mullica River-Great Bay estuary and surrounding watershed
- Establish JC NERR as a sentinel site for demonstrating approaches to respond to effects of climate change and sea level rise

## **Program Context**

### Steward Tools, Data and Information

#### *Habitat Mapping and Change*

The JC NERR will be updating the 2007 Habitat Map using new 2015 Aerial Imagery (*Figure 9*). The map will be developed in a GIS environment using protocols and a classification scheme that has been standardized across the NERR system. The JC NERR habitat map will be used to characterize both short term and long-term trends of change in the reserve habitats, as well as identify habitats that are vulnerable to the impacts of climate change and sea level rise.

### Disaster Response Planning

JC NERR's Disaster Response Plan is a comprehensive emergency management plan for the Reserve. It addresses the full range of emergencies and disasters that may affect the safety of reserve staff and the reserve's ecological integrity. The plan addresses three critical factors:

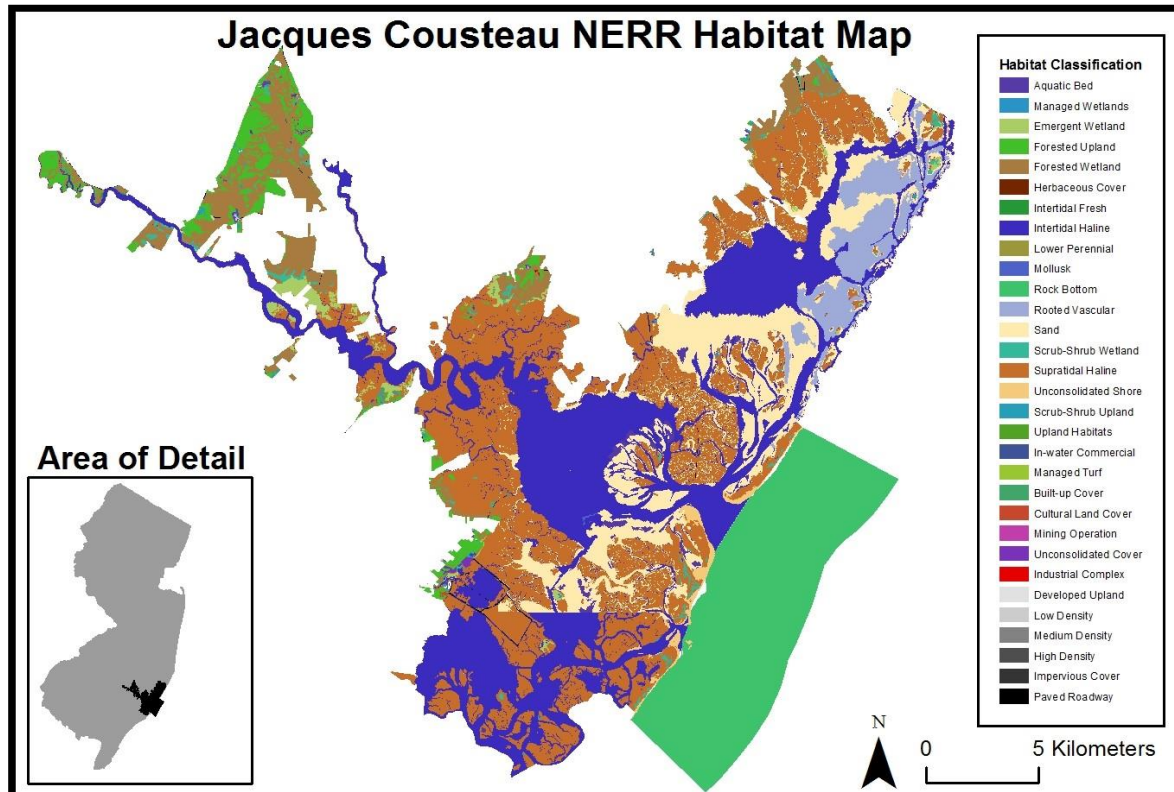
- People, infrastructure, and physical and biological resources (along with their vulnerabilities) are identified to protect them from disasters
- Hazards that may affect Reserve resources were analyzed to anticipate and mitigate expected impacts
- Emergency capabilities identified to support disaster response. The plan addresses activities that may be implemented before, during and after an emergency or disaster. It also provides a framework for cooperation and coordination among local, state, federal, private and nongovernmental organizations for emergency response

### *Vertical Control Infrastructure*

JC NERR staff completed an inventory of vertical control infrastructure at the Tuckerton Peninsula as part of the development of the Sentinel Site Plan for JC NERR. The key elements identified for a local control network were:

- Tide stations
- Vertical and horizontally accurate geodetic benchmarks

- Locations for SET



**Figure 9. JC NERR Habitat Map.**

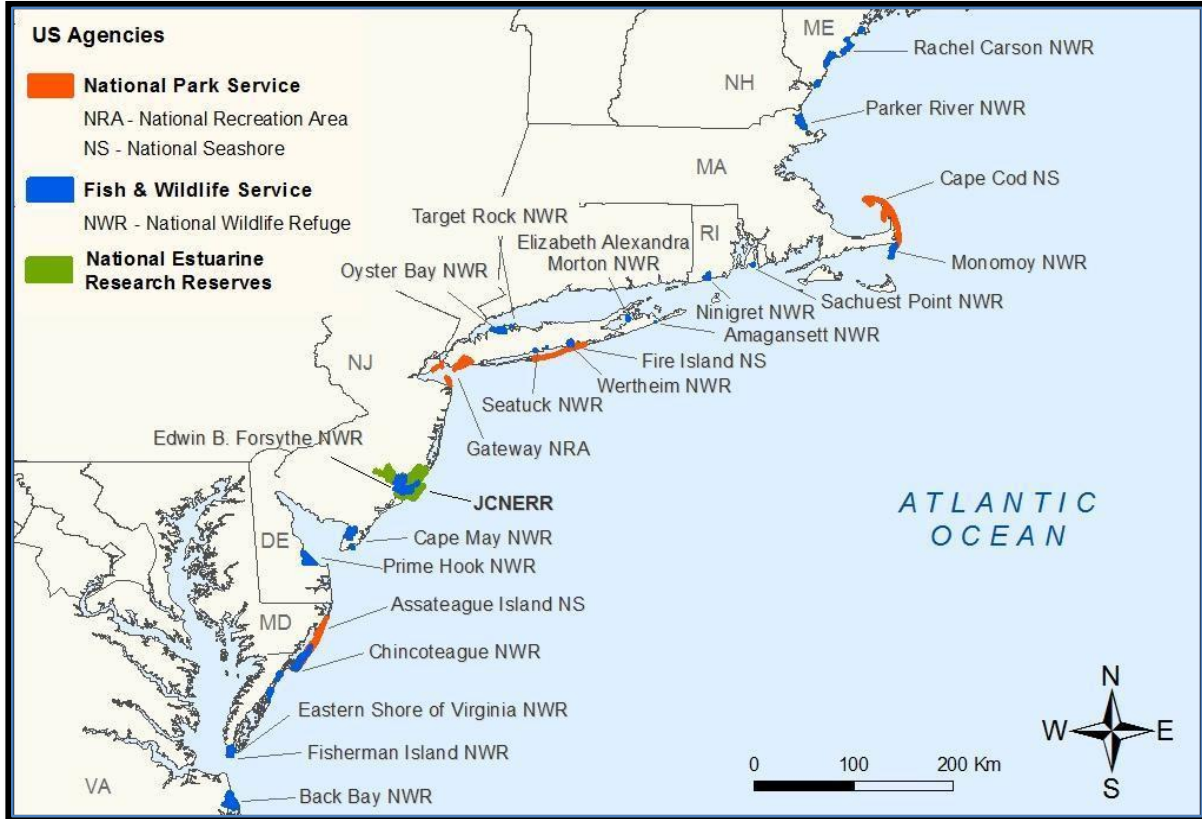
Following NOAA's recommendations of the plan, JC NERR has just installed a temporary tide gauge at the Cape Horn Marina in the Great Bay Boulevard Wildlife Management Area. Three benchmarks (one installed by JC NERR) were used to ensure the vertical accuracy of the tidal data being generated. The JC NERR will continue the buildout of vertical control infrastructure in 2017 in the JC NERR Sentinel Site. The buildout will primarily include the installation of vertically and horizontally accurate benchmarks that will be used by the JC NERR and reserve partners to tie monitoring equipment to National Spatial Reference System.

#### *Coastal Topography Monitoring*

JC NERR Staff, the National Park Service, and the US Fish and Wildlife Service have developed a rigorous long-term program of monitoring coastal topographical change in the parks of the Northeast Coastal and Barrier Network, the coastal refuges in Region 5 of the Fish and Wildlife Service, and coastal portions of the JC NERR. This effort is conducted through the Coastal Ecosystems Studies Unit agreement between Rutgers University and the federal agencies. Under this agreement, we have written the protocols for shoreline position monitoring (Psuty et al. 2010) and generating beach-dune profiles (Psuty et al. 2012). As part of this cooperative CESU effort, development of the protocol for intensive collection of topographical data in areas of special concern is currently under review (Psuty et al. 2017).

Shoreline change and coastal topography protocols have been developed to identify the seasonal, annual, and long-term trends and variability as part of the basis for understanding the coastal geomorphological system. The products of the monitoring program provide data sets that define sediment budget variations in a geotemporal matrix. The program uses sub-meter accuracy GPS equipment to track a feature-based, one-dimensional (1D) shoreline position along the park's ocean

shoreline. Additionally, topographical data sets are produced with geodetic RTK GPS equipment to collect 2-cm accuracy two-dimensional (2D) dune-beach profiles throughout the parks tied to an array of benchmarks. In areas of special concern, the GPS equipment is used to collect high-resolution three-dimensional (3D) topographical surveys to create Digital Elevation Models and calculate volumes and sediment budgets in cross and alongshore components. The resulting data are stored, according to the



**Figure 10.** National Park Service sites and US Fish and Wildlife sites involved with some of the monitoring protocols produced by members of the JC NERR team.

protocols, in a publicly available geodatabase.

Originally developed to monitor four coastal National Parks in the northeastern US, in 2011, the application of the 1D and 2D protocols was extended to the coastal refuges in Region 5 of the US Fish and Wildlife Service. Workshops and demonstrations were held to instruct the staff on the methodology and instrumentation for conducting the surveys in 12 coastal refuges (see Figure 10). The expansion of the protocols to FWS has created a seamless and replicable means of data gathering in the northeast. The monitoring program provides critical information on the spatial and temporal morphodynamical evolution of the Park and Refuge coastal system. Analysis of the collected data, using USGS’s Digital Shoreline Analysis System and other GIS platforms, provides timely and scientific information to managers on the 1-D, 2-D, and 3-D dynamic nature of coastlines. JC NERR staff conduct webinars and on-site training to assist local staff in data collection.

**Program Capacity**

Staff

Stewardship and GIS Coordinator

*Coastal Geomorphologist  
GeoScientist Interns*

Volunteers

Through JC NERR's research, education, and coastal training programs Reserve volunteers interact with people of all ages and encourage stewardship of our coastal and estuarine environments. The volunteer program supports the Research, Education, and Coastal Training sectors and the Reserve administration, with a volunteer base of well-trained individuals, and generates public involvement in the stewardship of our estuaries and coasts. The Volunteer Coordinator oversees the implementation and operation of the program. Recruitment of volunteers is conducted in a variety of ways, including the JC NERR website, outreach at public programs and festivals, staff/faculty interaction with college/university students, and through other volunteers' outreach efforts.

JC NERR volunteers come from all walks of life, but to date, volunteers have consisted of two predominant demographic groups – retirees and undergraduate/graduate university students. With the prevalence of large retirement communities in Ocean and Atlantic counties, retirees make up a large portion of our volunteer base and bring a broad range of previous professional experience and a keen existing and new-found interest in our coastal and estuarine resources. Given JC NERR's partnership with Rutgers University and close geographical proximity to Stockton University and other NJ colleges/universities, students in the marine and environmental sciences also make up a principal part of our volunteer base. Students bring an enthusiasm and passion for their chosen field of study and obtain valuable hands-on experience working on research as well as marine/estuarine education.

With the inception of the Interpretive Nature Trail on the Grassle Marsh, JC NERR volunteers have become involved with trail maintenance and clean up. Volunteers participated in the NJDEP statewide 'Trails Day' in 2016, for which JC NERR hosted a maintenance and clean-up project. As the Grassle Marsh Trail project continues to progress, we will continue to engage volunteers to become active stewards of the trail and encourage participation in ongoing efforts of maintenance, upkeep and monitoring of the trail, for education and outreach programs at the Reserve as well as for the public.

Volunteer Rewards and Recognition Program

The annual Volunteer Recognition program will continue to honor volunteers for their contributions to the JC NERR. The Volunteer Coordinator tabulates volunteer hours for volunteer recognition which includes - an annual Volunteer Recognition Dinner for those with 10 or more service hours, a gift to each volunteer who has 25 or more hours of service in a given year, and recognition of a nominated 'Volunteer of the Year.' Volunteers who have reached 500, 1000, and 2500 hours, respectively, in their term of service with the JC NERR will be honored on an annual basis at the Recognition Dinner. JC NERR also hosts an end-of-year social held at the JC NERR Education Center for all volunteers who gave their time to support the Reserve during the year.

Key Partners

Major federal partners are the National Park Service, US Geological Survey, and USFWS. Staff also regularly interacts with partner government agencies (municipal, county, state, and federal agencies), National Estuary Programs (e.g., Barnegat Bay Partnership and Partnership of the Delaware Estuary) and academic institutions (e.g., Rutgers, Stockton). Much of this collaboration involves projects on wetlands habitat, natural buffer, shoreline erosion and protection, climate change effects, bayshore flooding, and sentinel site sustainability.

### Facilities

The JC NERR GIS and Stewardship program is managed from two locations: the JC NERR Coastal Education Center in Tuckerton, NJ and Sandy Hook Cooperative Research Program Office at the James J. Howard NOAA Laboratory in Highlands, NJ.

### **Program Delivery**

#### Stewardship for Partner Managed Lands, Private Lands, and Unique Habitats

The upland areas of the JC NERR are owned and managed by Reserve partners and include a National Wildlife Refuge, state forests, wildlife management areas, state natural areas, and state natural land trusts. Each of these designations has different management approaches with unique goals relating to human use and natural habitat function. The JC NERR provides a range of stewardship programs and services in collaboration with reserve partners.

#### Relevant Management Information

The JC NERR staff will conduct research on land use, land cover change, and habitat classification for the entire Reserve watershed including areas owned by land management partners. Analyses will be conducted using remote sensing technologies (aerial and satellite photography) and quantified within a Geographic Information System. This data is presented as a technical report and available to reserve partners.

#### Capacity Building for Partners

JC NERR staff will provide partner organizations with opportunities to diversify skill sets and use of Reserve data layers. Examples of planned programs include the use of GIS and remote sensing technologies, the practical use of LiDAR data including data acquisition, storage, and processing, and skill-based training for staff and managers of land management agencies.

#### Scientific Data

Science information collected on upland habitats provides partners with data on habitat, human land use, and future land use changes. These projects are supported with remote sensing technologies and geographic information systems. For example, the JC NERR staff plans to update maps of land use/land cover/habitat type over a variety of temporal and spatial scales using satellite imagery and aerial photography.

#### Priority Land Acquisitions

JC NERR works alongside land management partners to acquire priority lands for our core boundaries. The JC NERR competes for land acquisition funding by applying for Coastal and Estuarine Land Conservation Program and NERRS-specific land acquisition funds. The JC NERR engages in priority land acquisition partnerships through the Mullica River Land Conservation Initiative (See Section VI).

#### Needs and Opportunities

##### Collection of Remote Sensing Data

JC NERR GIS program has provided ongoing support to the Rutgers University Marine Field Station, NJDEP, Army Corps, FEMA, NJ County Offices, USGS, and other reserve partners. The support includes providing GIS data, raster data, surveying, and technical support. To provide the geospatial support, it is important to keep an updated database of LiDAR, aerial imagery, bathymetric data, and additional remote sensing information. JC NERR currently receives data from other agencies' periodically planned collection, and will therefore look for opportunities with partners and funding sources to collect more high-resolution data.

## Partnerships

A major effort at the JC NERR is to interact more closely with land management partners. One specific way is through the Seamless Network Initiative with Gateway National Recreation Area and the NOAA National Marine Fisheries Howard Lab at Sandy Hook. Coastal geomorphological data gathering in the form of structured field surveys have been implemented throughout Gateway. JC NERR is involved with conducting the surveys as well as providing on-site training and webinars in data collection and data processing throughout the region. Staff distributes information on the survey protocols and the outcomes of the surveys through a variety of local and professional venues. Building on the knowledge and expertise of the work being done in Gateway NRA, a strong emphasis has developed stressing coastal geomorphological evolution (incorporating resilience and restoration) and impacts of sea-level rise. The application of this expertise extends from outreach to local communities, through regional sites, and to professional publications emphasizing the local data being collected.

## **Future Projects**

### Development of Unmanned Aerial System Capacity

The JC NERR is working with NOAA on a project to evaluate the effectiveness of UAS platforms to produce multiple mapping data and products in marsh and dune systems. In addition to this product, the JC NERR will be exploring opportunities to partner with the Rutgers University UAS department to collect high resolution aerial imagery and elevation data within the JC NERR. The high-resolution data will aid in habitat classification and change monitoring, resulting in a useful management product for the JC NERR partner.

## ADMINISTRATION PLAN



### **Lead State Agency Role/Responsibility**

The JC NERR serves as the umbrella for an integrated approach to managing the Mullica River-Great Bay watershed among Reserve landholders. The lands that comprise the JC NERR are managed as a partnership of state and federal landholders, with Rutgers University, NJ Agricultural Experiment Station (NJAES) as the managing state partner. Each landholder has provided Rutgers with a written commitment to the Reserve program through a Memorandum of Understanding (MOU) (Appendix B-3). Rutgers, NJAES receives the federal financial assistance and has overall responsibility for Reserve management. Primary staff members employed by Rutgers, NJAES include a Manager, Assistant Manager/CTP Coordinator, Program Coordinator, Education Coordinator, Research Coordinator, Field Researcher/SWMP Technician, Stewardship/GIS Coordinator, Volunteer Coordinator, Interpretation Coordinator, and Special projects staff.

### **Federal Agencies**

#### US Department of Interior, US Fish & Wildlife Service

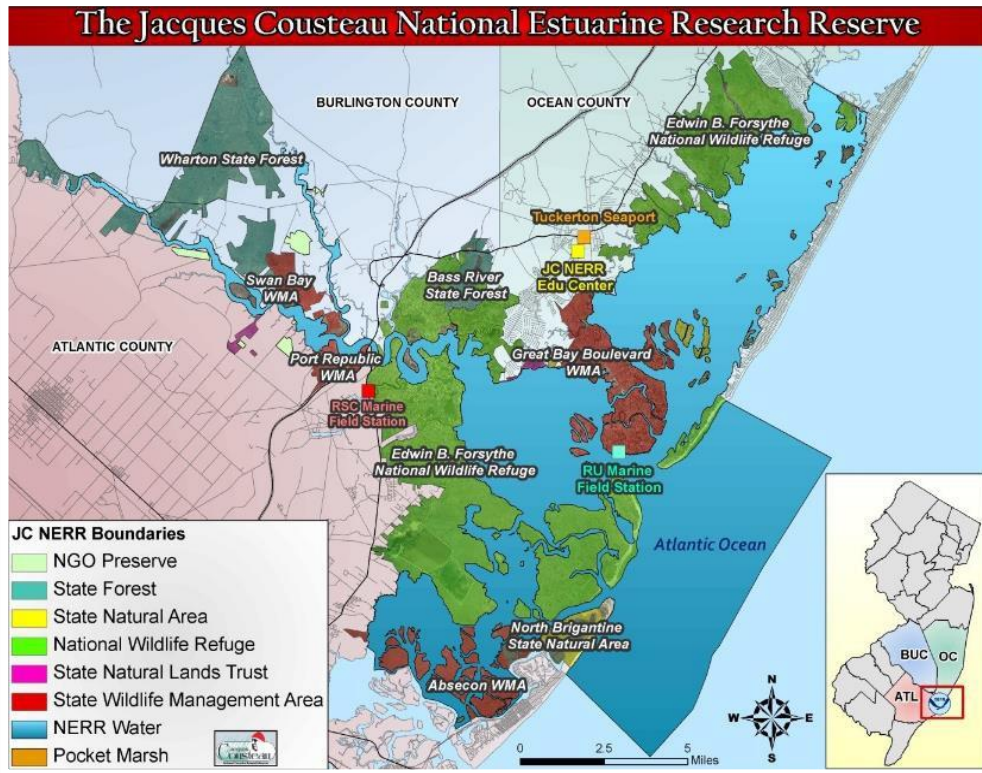
The US Fish and Wildlife Service manages the Edwin B. Forsythe National Wildlife Refuge. The Barnegat component of the Forsythe Refuge lies within the boundary of the JC NERR, an area that is managed in support of migratory waterfowl and includes environmental manipulations to provide habitat and food for this natural resource. The Forsythe Refuge maintains a field office, impoundments, nature trails, and a Coastal Center. The Refuge Manager sits on the JC NERR advisory board.

### **State Agencies**

#### N.J. Department of Environmental Protection

The NJDEP is the designated state agency to administer programs under the CZMA. The NJDEP implements state coastal programs and enforces regulations. The NJDEP collaborates on CTP and





**Figure 11.** JC NERR Boundaries.

outreach programs with the JC NERR, and coordinates management of state lands associated with the Reserve (eg. state run natural land trusts and natural areas) (Figure 11). Rutgers, NJAES together with the NJDEP and the USFWS have signed a memorandum of understanding (see Appendix B-3) to advance the long-term management goals and objectives of the

Reserve. NJDEP program offices jointly coordinate and collaborate on research initiatives and education programs within the Reserve, targeting those coastal and management issues of importance to coastal decision-makers. This partnership network promotes exchange of research findings and training and educational programs, and helps to integrate delivery of NJDEP and JC NERR.

### Pinelands Commission

The mission of the Pinelands Commission is to preserve, protect, and enhance the natural and cultural resources of the Pinelands National Reserve, and to encourage compatible economic and other human activities consistent with that purpose.

The Pinelands is a unique ecosystem of historic villages and berry farms amid a vast oak forest, extensive wetlands, and diverse species of plants and animals. It is protected by state and federal legislation through management by local, state, and federal governments and the private sector. The reserve contains Wharton State Forest and Bass River State Forest, which provide public recreation facilities.

The Pinelands Commission has pioneered many smart growth planning concepts, such as watershed management, transfer of development rights, timed growth, and conservation planning. The JC NERR collaborates primarily on education and outreach programs with the Pinelands Commission.

### **Local Agencies**

#### Barnegat Bay Partnership (BBP)

The JC NERR features overlapping boundaries with the Barnegat Bay Partnership (BBP), the NEP located in southern NJ. JC NERR Reserve staff was very involved in designation of this program and remain

involved in the implementation phase of the BBP. The Reserve Assistant Manager is a member of the BBP Advisory Committee. The JC NERR Fields Researcher Coordinator and Education Coordinator also participate on BBP committees. The BBP supports Reserve programs by increasing awareness of related local and adjoining watershed management issues and by providing opportunities for county, municipal, and state governments to conserve resources in Barnegat Bay and the adjacent JC NERR and by providing funding opportunities for research within the Reserve.

#### Tuckerton Seaport

Tuckerton Seaport oversees 40 acres of coastal lands within the JC NERR. The Borough of Tuckerton, Little Egg Harbor Township, and Ocean County jointly acquired the land through the state's Green Acres Program (N.J.S.A. 13:8A-13(a)). The Green Acres legislation requires that land be used for recreational or conservation purposes and specifies that changes in the designated use of the lands must be approved by the Commissioner of the NJDEP and the State House Commission of the State of New Jersey. The Tuckerton Seaport was also required to pay an amount equal to 50 percent of the current value of the land, as determined by the commission. The mission of the Seaport, to support public education on Bay culture and human interaction with the natural environment, complements JC NERR programs and services. The Life on the Edge exhibit, designed for the public, is located at the Seaport.

#### New Jersey Conservation Foundation

The mission of NJCF is to preserve New Jersey's land and natural resources for the benefit of all. They are a private, not-for-profit organization that relies on philanthropic support and grants from a variety of public and private organizations and individual donors. Through acquisition and stewardship NJCF protects strategic lands, promotes strong land use policies, and forges partnerships to achieve conservation goals. Since 1960, NJCF has protected over 100,000 acres of natural areas and farmland in New Jersey – from the Highlands to the Pine Barrens to the Delaware Bay, and from farms to forests to urban and suburban parks. NJCF is JC NERR's newest land management partner. In 2009 NJCF partnered with the reserve to acquire the Lee property in Burlington County.

#### **Universities**

##### Rutgers University, NJAES

In 2014, Rutgers University restructured the Institute of Marine and Coastal Sciences, the administrative home for the JC NERR, into several existing entities and one new one. Coastal programs, including the JC NERR, were transferred to the Office of Research at the New Jersey Agricultural Experiment Station. This office oversees most of the Rutgers field research programs and facilities. This new reporting relationship has not altered JC NERR, programs or staff, and in fact presents excellent opportunities to integrate reserve programs into the Rutgers Cooperative Extension program, a network of science and education programs with offices throughout New Jersey.

##### Stockton University

The Stockton University Field Station maintains and operates a research and education facility within the Reserve at Nacote Creek. The facility houses computer and environmental science labs and a fleet of small boats. RSC assists in preserving the research, education, and stewardship goals and objectives of the NERRS program through its undergraduate education program (conducted at the Nacote Creek Field Station) and research program. They also maintain the Reserve's weather station, which provides real-time information to the JC NERR System-Wide Monitoring Program.

##### New Jersey Sea Grant

The New Jersey Sea Grant College Program is administered by a private, nonprofit group, the New Jersey

Marine Sciences Consortium located at Sandy Hook. The JC NERR Manager is a member of the governing board of the NJ Marine Sciences Consortium. Efforts to collaborate have focused primarily on public events such as Coast Day and Coastal Training, and K-12 education. Future efforts will be aimed at promoting collaboration on coastal training opportunities.

### Staffing Roles and Responsibilities

Support for core staff is essential for meeting the mission, goals, and objectives of the JC NERR. The core staff consists of a Manager, Assistant Manager/CTP Coordinator, and Education, Research, and Stewardship/GIS Coordinators who manage the education, coastal training, stewardship, and research programs on behalf of the Reserve. Rutgers, NJAES has the lead responsibility for administering these core positions.

Reserve staff members are employees of Rutgers, NJAES (*Figure 12*). Because of limited NERRS funding, some of the Reserve staff positions are partially or fully supported by outside funding sources. The Manager, Research Coordinator and Program Director have offices at the main campus of Rutgers in New Brunswick and at the Coastal Center at Tuckerton. The Assistant Manager/CTP Coordinator, Volunteer Coordinator, Interpretive Coordinator, Stewardship Coordinator, Education Coordinator, and Field Researcher/SWMP Technician are stationed at the JC NERR Coastal Center. The commute time

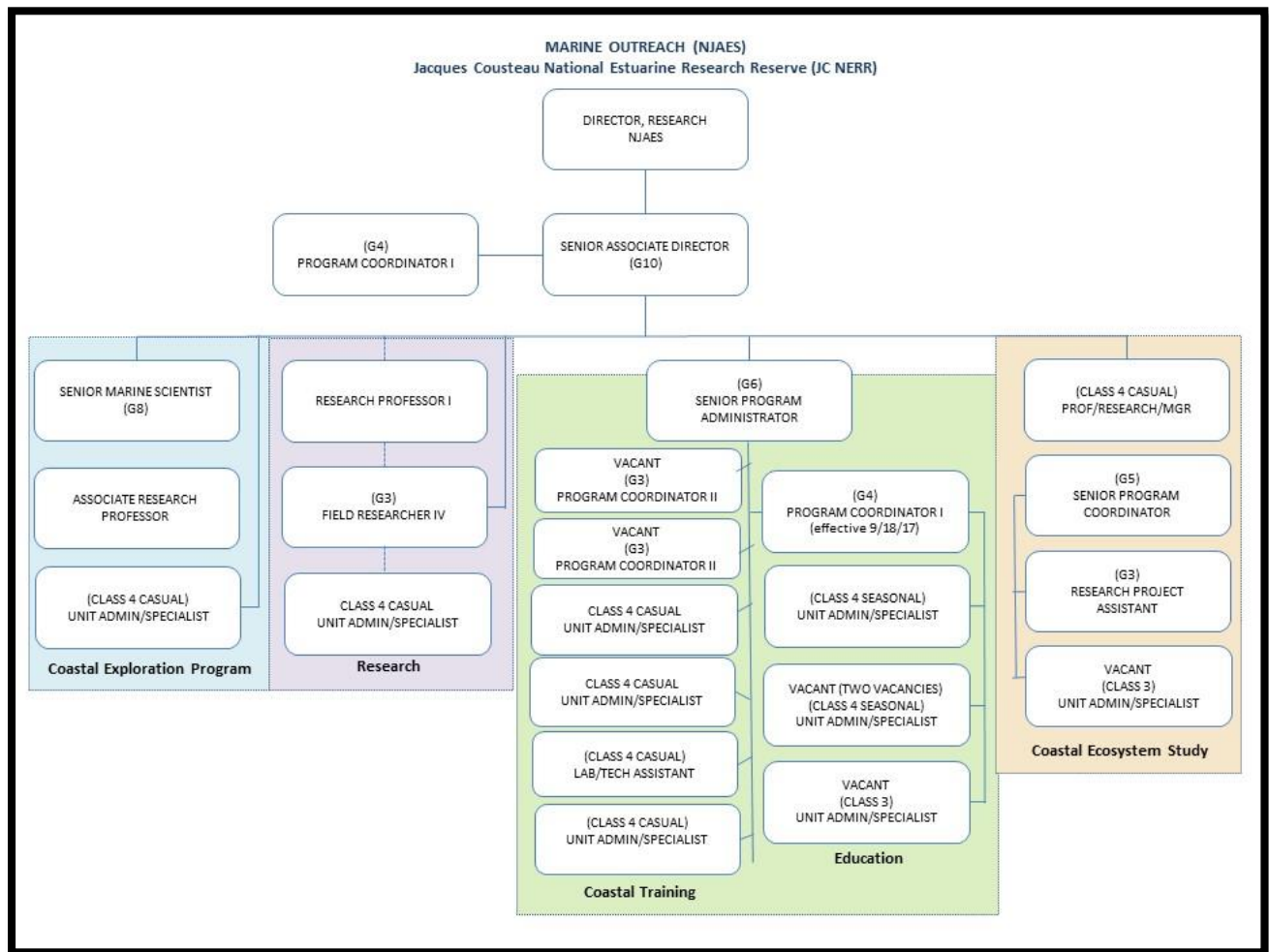


Figure 12. JC NERR Organization Chart.

between the Tuckerton facility and the office in New Brunswick is approximately 75 minutes.

#### Manager

The Reserve Manager is the principal administrator of the Reserve and is responsible for ensuring all policies, regulations, and program activities are conducted in accordance with the Reserve Management Plan. The Reserve Manager is employed and supervised by the Research Director of the New Jersey Agricultural Experiment Station. Specific duties of the Manager are to:

- Manage daily Reserve operations, prepare state and federal grant applications, proposals, budgets, reports, and maintain necessary records
- Represent the Reserve and its policies at public meetings and hearings
- Advise and coordinate government agencies on issues, questions, or projects, and their effects on our relationship to the Reserve
- Oversee all special studies and research activities in or related to the Reserve to interpret and apply research results to produce benefits
- Oversee the research and education programs for the Reserve
- Coordinate with other program Managers on Reserve activities
- Monitor day-to-day operation of the Reserve and progress of research and education plans
- Direct and coordinate with NOAA any changes in the management plan
- Supervise Reserve staff members
- Oversee facilities development, site selection, and changes in the Reserve boundaries with consent from NOAA
- Prepare required reports and work plans for NOAA and other funding agencies

#### Assistant Manager

The JC NERR Assistant Manager helps with management and coordination of major programs of the Jacques Cousteau National Estuarine Research Reserve including proposal and budget preparation, grant management, report writing, general administration and supervision, presentations to stakeholders, and represents the Manager as needed.

#### Coastal Training Coordinator

The CTP Coordinator works closely with Reserve partners and target audiences. Responsibilities include management of the CTP, land acquisition, and outreach activities. Specific duties are:

- Design and conduct training programs and seminars, provide technical assistance and workshops on environmental issues of importance to coastal stakeholders, and manage the Coastal Training and coastal resilience portfolios for the JC NERR
- Develop science-based management programs and initiatives in coordination with Reserve partners, stakeholders and the resource management community including the Programs and Centers at Rutgers, NJDEP, and County governments, Tuckerton Seaport, Pinelands Commission, NOAA and EPA
- Enhance funding and support for the JC NERR

#### Community Resilience Specialist

Two full-time Specialists in Tuckerton provide technical assistance to local communities on coastal resilience issues. They work one-on-one with New Jersey municipalities to identify current and future hazards and vulnerabilities. They also work alongside communities to increase their preparedness by linking planning, mitigation, and adaptation. This community-based technical assistance involves face-to-face review and discussion of risks. The individual assistance provided by the Community Resilience Specialists results in increased comprehension of the GTR planning evaluation process and enhanced

implementation of adaptive actions designed to decrease vulnerability and increase resilience. Key duties include:

- Community-based technical assistance for municipalities utilizing the Getting to Resilience community evaluation process
- Review and discussion of risks as illustrated by FEMA flood maps, the NJFloodMapper, NJAdapt, and the state's Community Vulnerability Index (CVI)
- Assist municipalities with implementation of adaptation actions designed to decrease vulnerability and increase resilience

#### Research Coordinator

Implements and oversees all research and monitoring activities for the Reserve. The Research Coordinator maintains regular and direct communication with the research community and executes research activities in the Reserve. The Research Coordinator reports to the Reserve Manager and is located at IMCS Rutgers, the JC NERR Coastal Center, or Rutgers Marine Field Station in Tuckerton, depending on assignments and projects. The Research Coordinator's responsibilities are to:

- Provide staff support for research and monitoring initiatives in the JC NERR
- Coordinate all special studies and research activities within or related to the Reserve
- Assist the Reserve Manager and participating agencies in preparing and updating a list of priorities for research and monitoring at the JC NERR
- Implement the research program for the Reserve
- Interpret and apply research results
- Recommend locations for research and monitoring stations within the Reserve and provide technical advice and assistance to scientists in conducting research and monitoring as available
- Serve as the Reserve's liaison with the scientific community, promote data utilization, and act as primary contact for scientists performing research within the Reserve
- Represent the Reserve at public and scientific meetings
- Create a site profile
- Implement the National NERRS Research (Fellowship) program at the Reserve

#### Education Coordinator

Implements and coordinates education and interpretation elements of the management plan. The Education Coordinator oversees all educational programming within the JC NERR Education Center. Specific duties include:

- Plan education programs both on and off-site
- Prepare grant proposals for educational program funding
- Conduct and offer professional development courses to teachers
- Develop and continue key partnerships with other environmental organizations and the community
- Represent the JC NERR during state and federal workshops and conferences
- Interpreting real science and making it available to the public

#### Seasonal Educator

The Seasonal Educator works under the supervision of the Education Coordinator. This position:

- Develops and conducts our Summer Creature Feature programs to children grades 1-5. Creature Feature programs are offered at the JC NERR Education center only

### Field Researcher/SWMP Technician

This position is the lead technical coordinator of SWMP water quality monitoring, telemetry, and IOOS applications at the JC NERR. This staff person oversees all field and laboratory aspects of the program including calibration, deployment, retrieval, and maintenance of dataloggers, sampling, and analysis of nutrients and other water quality parameters, and the preparation of SWMP water quality reports for the NERRS program. Field Researcher/SWMP Technician also:

- Maintains comprehensive and accurate SWMP records
- Maintains telemetered water quality stations and instrumentation
- Updates and maintains internal database
- Prepares metadata reports for submission
- Provides support for JC NERR Education programs
- Collaborates with the JC NERR Research Coordinator to prepare technical reports and manuscripts for publication in peer-reviewed journals and other media

### Stewardship/GIS Coordinator

The Stewardship/GIS Coordinator assists the Research Coordinator. This individual monitors changing land use patterns within the JC NERR boundaries. Tasks include:

- Design and completion of research projects
- Create cartographic products
- Collaborate with the Watershed Coordinator on CTP outreach efforts
- Conduct ecological investigations, including biomonitoring projects and other estuarine research efforts to characterize the Reserve
- Implement the JC NERR Sentinel Site Initiative

### Program Coordinator

The Program Coordinator assists with grant preparation and management, budget development for proposals, and provides general program assistance for the Manager and Assistant Manager.

- Organizes, administers and coordinates multiple facets of major science-based programs and projects on behalf of the JC NERR
- Organizes, administers and coordinates financial management of major grant programs
- Organizes, administers and coordinates operations of the JC NERR

### Volunteer Coordinator

This person (part-time hourly) trains and organizes volunteers and docents to support JC NERR programs including public programs and festivals, field and research programs, administrative assistance, data entry, library work, and outreach at the Life on the Edge exhibit. The Volunteer Coordinator:

- Prepares and plans volunteer programs in coordination with the Reserve staff
- Recruits, trains, and supervises volunteers
- Evaluates volunteer programs
- Develops an incentive/reward program for volunteers
- Develops and maintains a Volunteer Guidebook that includes an overview of JC NERR and RUMFS, and describes the relationship between the two organizations and their programs, people, and audiences. The guidebook outlines ongoing volunteer opportunities including the LOE exhibit,

volunteer etiquette, and the volunteer rewards program

#### Interpretive Exhibit Coordinator

This role (part-time hourly) contributes to audience understanding of the LOE exhibit. The docent's responsibility is to increase awareness of research and education programs conducted at the Reserve and to act as a spokesperson on coastal decision-making issues and inform the public of recreational access to MR-GB. Assigned duties:

- Promote the LOE at Tuckerton Seaport
- Foster audience understanding to why they should learn about the estuary and connects its meaning to their personal lives
- Provide context that relates LOE as a gateway to the JC NERR
- Increase understanding of the benefits and threats to the estuary promotes stewardship of our shared coastal community to over 40,000 visitors per year
- Train volunteer docents/educators in interpretation techniques and conducts exhibit-related programs and tours during the 362 days annually that Tuckerton Seaport is open
- Monitor/implement upkeep and maintenance of the exhibit space and audio/visual components
- Prepare grant proposals for exhibit repurposing and acts as liaison between selected design studios and fabricators

#### Field Researcher/Special Projects Coordinator

Works with the JC NERR Manager, Assistant Manager, and Reserve Staff on program development projects and special projects as needed. Oversees the operation and management of the JC NERR research vessel, R/V Resilience, and specialized technology such as the REMUS vehicle.

#### **JC NERR Advisory Committee**

The JC NERR Advisory Committee (*Table 2*) provides senior level advice and guidance on Reserve priorities to the Reserve Manager and staff. The committee meets twice annually to help develop opportunities for collaboration among Reserve partners, define key areas for future investment, and to provide advice on programs, products and services. Committee members are specifically charged with helping to advance the Reserve mission of science-based management through partnerships, leveraging resources, and providing guidance on emerging trends in coastal management protected area networks.

JC NERR staff will communicate regularly with committee members, especially to exchange information on results of reserve programs. Reserve staff may establish informal ad hoc committees to help guide their respective core area efforts as necessary.

<b>Committee Members</b>	<b>Affiliation</b>
Director	New Jersey Department of Environmental Protection, Coastal Management Program
Refuge Manager	Edwin B. Forsythe National Wildlife Refuge
Director	Center for Remote Sensing and Spatial Analysis, Rutgers University
Executive Director	Pinelands Commission



Planning Director	Ocean County Planning
Director	Ocean County Department of Parks and Recreation
Executive Director	Pinelands Preservation Alliance
Program Director	Barnegat Bay Partnership
Director	New Jersey Sea Grant

*Table 2. JC NERR Advisory Committee*

**Memoranda of Understanding and Other Inter-Agency Arrangements**

Memoranda of Understanding (MOU) have been developed with key Reserve partners to define roles and responsibilities for Reserve programs, products, and services. Agreements exist with NOAA, the NJDEP, USFWS, New Jersey Pinelands Commission, NJCF, Rutgers University, and the Tuckerton Seaport. These agreements were initially developed when the Reserve was designated in 1997. They have been updated and revised and are included in Appendix B-3.

**Coastal Zone Management Program Consistency Certification**

While the JC NERR has not received formal consistency certification from the NJDEP, other methods insure this management plan is consistent with the NJ CZMA. Several senior level NJDEP employees on the JC NERR Advisory Committee help to advance the Reserve mission of science-based management and comply with the CZMA. Each Advisory Committee member has copies of the management plan to review. They have provided advice and guidance on Reserve priorities to establish CZMA consistency. The Federal Consistency Review is documented in Appendix C.

## COLLABORATION PLAN



### National Program

The JC NERR has devoted a great deal of time to advance and participate in collaborative initiatives that engage the entire NERR system. This includes participation on a variety of NERR committees and work groups such as the Strategic Committee, Growth Strategy Workgroup on System Expansion, NERRS Biomonitoring Workgroup, CTP Meeting Planning Committee, CTP National Project Committee, NERRS-IOOS workgroup, Conservation Action Education Workgroup, Oversight Committee, SWMP Technician Training Workshop Planning Committee, and the SWMP Solutions and Innovations Manual Committee.

JC NERR staff also have led regional and national efforts to compete for funding to enhance science education, coastal resilience, integration of SWMP with other observing system networks, and system-wide monitoring initiatives (real-time telemetry). JC NERR staff actively participate in leadership positions with national organizations such as the National Association of Marine Laboratories, National Marine Educators Association, Association of Floodplain Managers, National Estuarine Research Reserve Association, and American Planning Association. Past national-scale efforts have also focused on integration of the sentinel site initiative with other protected area networks. JC NERR staff will be encouraged to continue participation in these national-scale collaborations and will also seek opportunities to work internationally with MPA networks to share best practices and lessons learned.

JC NERR staff will be encouraged to continue participating in system-wide projects and leadership service in national organizations.

JC NERR staff will continue to seek opportunities to collaborate with NOAA and other national partners on areas of emerging coastal management priorities. These include the effects of environmental change on coastal ecosystems and communities, integration of resilient design strategies into efforts to upgrade the national infrastructure, and workforce training programs to provide the skilled workers needed to ensure sustainability of coastal ecosystems and the economic benefits that rely on water and habitat quality.

#### Framework for Collaboration at the JC NERR

The JC NERR has a long history and track record with development of integrated projects that engage many core sectors on a common project. A few recent examples include efforts to characterize marsh response to sea level rise, incorporation of SWMP data into education, stewardship and coastal training programs, management strategies to reduce marine debris, and identification of management information needs that benefit from sentinel site data. These and other efforts require the research, education, coastal training and stewardship sectors to design and deliver programs that capitalize on the diverse expertise of staff and use of the logic model to help develop expected outcomes and desired deliverables. Collaborative and integrated JC NERR programs are typically developed with external support funds. Although the staff is relatively small, they communicate regularly through monthly staff meetings and informal meetings. They are encouraged to work across discipline and sector.

In addition, all research proposals include an education or outreach component requiring integration. The Manager typically serves as the PI or Project Coordinator on these grants to ensure integration across sectors. More recently, the Assistant Manager has also assumed this role. This approach will continue to be used for major investment areas and program priorities where appropriate.

Two additional mechanisms will be established to support integrated efforts. These are a Science Scholars Group and a Science to Management Seminar series. The Science Scholars Group will be comprised of regional researchers who have worked extensively in the JC NERR system, and who represent a variety of scientific organizations and institutions. The seminar series will be conducted on current and emerging coastal management issues, led by a staff member with advice and guidance from the Science Scholars and JC NERR Advisory Committee.

In the next five years, key management issues that will benefit from sector integration and collaboration with partners are:

- Resilience of coastal ecosystems and communities to anthropogenic and natural drivers of environmental change
- Response of coastal ecosystems to habitat change and alteration
- Processes governing connectivity of habitats and communities from watershed to ocean

#### JC NERR and the Integrated Ocean Observing System

The NERRs and the IOOS program have been working together to find collaborative opportunities. Through a series of NERRS/IOOS integrated workshops in 2015-2016, it was agreed that both IOOS and NERRS programs robustly sample the coastal ocean and estuarine systems. It was decided that a draft collaborative framework for the NERRS/IOOS partnership would include examples of monitoring successes from both programs and a discussion of which successes might be worth expanding into the future. Topics that formed the examples included Ocean and Coastal Acidification (OCA) as an impact on shellfish growers, and water inundation and salinity signals.

The JC NERR will continue to play a role in the NERRS/IOOS Collaboration Framework moving forward, including participation in a demonstration project to recreate a similar analysis that JC NERR undertook utilizing SWMP data collected during Hurricane Sandy with water level and salinity data that was collected in Delaware during Hermine. This type of demonstration project, and applied uses for its results, could be effective models for future collaborations with the NERRS and the IOOS community. Additionally, as data from JC NERR SWMP meets QA/QC standards for integration with other regional observation networks and can fill critical spatial gaps for the development of understanding, forecasting, and modeling of ocean weather and climate, there exists other potential collaborations with groups like the National Association of Marine Labs.

## BOUNDARY AND ACQUISITION PLAN



### Introduction

The JC NERR boundary incorporates the Mullica River upriver to the head of tidal influence and down river, including the entire Great Bay. It extends north to include the adjacent waters and marshes of Little Egg Harbor to include submerged aquatic vegetation habitats (i.e., extensive beds of eelgrass, *Zostera marina*) that are largely absent from Great Bay proper. The boundary extends south to the important migratory waterfowl habitats contained in the Brigantine portion of the Forsythe National Wildlife Refuge and adjacent State Fish & Game Management lands. The tributaries of the Mullica River, including Bull Creek, Wading River, Bass River, Landing Creek, and the Nacote Creek are included to the limit of tidal influence. More than 99% (114,955 acres) of the JC NERR is composed of state and federal public lands.

The boundaries for the JC NERR comprise a natural ecological unit to the greatest extent possible. They encompass a core area of contiguous wetlands, riparian habitats, and portions of open water in the Great Bay. The total acreage for the JC NERR has been updated to match the 2008 geospatial data that was submitted to NOAA. The original acreage was reported using data with a lower resolution than what is now available. The Reserve's increased acreage was not due to boundary acquisition.

The JC NERR's boundaries support diverse activities including recreation (fishing and boating) and research studies by Rutgers, Stockton University, the Pinelands Commission, and other institutions. Because estuaries receive inputs from the adjacent oceanic margin, the boundaries of the JC NERR extend seaward into the Atlantic Ocean approximately 3 miles to include the LEO-15 observatory on the inner continental shelf. One reason for considering this oceanic area is the importance of organic and inorganic exchanges within the water column and at the sediment interface, and opportunities to evaluate the significance of the oceanic contributions to the maintenance of the estuarine system. The LEO-15 site is designated as a 2.79 km offshore research area and is listed on all navigation charts and notices to mariners. In Great Bay proper, except for small communities (i.e., small population size) of

Mystic Island and Tuckerton extending less than 3,000 m. along the margin of the Bay, the aquatic boundary is in a near pristine state. A handful of marinas occur outside of Mystic Island, but their spatial impact is small within the overall scale of the JC NERR. This characteristic is particularly beneficial to compare the long-term processes related to estuarine quality in other nearby locations. For example, the adjacent waters and shoreline of Little Egg Harbor have experienced greater human pressure with the lagoonal development of Beach Haven West and the developed portions of Long Beach Island. Thus, the MR-GB estuary can provide baseline data for evaluating modification and recovery programs at other sites.

#### Core Areas

The core area totals 78,531 acres. It extends from the head of saltwater influence in the Mullica River downstream to include the entire Great Bay and adjacent inlet areas, and continental shelf waters to the LEO-15 site. In addition to the above water bodies, the core area includes the emergent wetlands and contiguous forested wetlands of adjacent estuaries. It is composed of three distinct areas:

1. Great Bay Blvd. Wildlife Management Area, a state owned and managed salt marsh area (4,670 acres) at the end of a peninsula extending south from Little Egg Harbor which forms the northern and eastern shore of Great Bay
2. A federally-owned complex of salt marsh and undeveloped barrier islands (40,000 acres) forming the southern boundary of Great Bay with eastern frontage on Beach Haven Inlet and the Atlantic Ocean
3. A coastal ocean area offshore at the mouth of Beach Haven Inlet

These areas, along with the barrier islands, have unique beaches, dune features, overwash fans, abandoned inlets, and extensive back marsh virtually unknown throughout most of the East Coast. Certain heavily populated areas were specifically excluded to minimize conflicts with existing incompatible uses (e.g., Mystic Isles Development to the south).

#### Buffer Areas

The buffer areas comprise approximately 37,585 acres of public lands. Upland forest areas in the buffer area capture the full ecological gradient from uplands to wetlands (e.g., soil catena) and serve as a protective buffer. Adjacent areas include missing coastal habitats and/or allow greater comparative analysis of adjacent habitats. The JC NERR boundary covers the adjacent waters and marshes of Little Egg Harbor, which includes submerged aquatic vegetation habitats (i.e., extensive beds of eelgrass, *Zostera marina*) that are absent from Great Bay proper. The proposed boundary extends south to include the important migratory waterfowl habitats contained in the Brigantine portion of the Forsythe National Wildlife Refuge and adjacent State Fish & Game Management lands.

#### Boundary Control and Regulation

The core region contains four major state and federal facilities including RUMFS, the Stockton University Field Station (at Nacote Creek), the NJDEP Fisheries Laboratory at Nacote Creek, and the Edwin B. Forsythe Visitor Center. All state regulatory agencies with jurisdiction in the proposed Reserve boundary have committed to enforcing the level of state regulation necessary to uphold the long-term resource protection objectives of the NERRs program. Existing regulatory agencies including the Pinelands Commission, USFWS, and NJDEP (under the CZMA) are empowered to manage the public lands comprising the proposed Reserve and are committed to upholding the resource protection goals of the NERRS program under the MOU between all parties (see Appendix B-3).



## Management

A total of 40 acres of the JC NERR are overseen by the Tuckerton Seaport, a local non-profit organization dedicated to the preservation and interpretation of the history of the New Jersey Baymen culture. The towns of Tuckerton, Little Egg Harbor Township, and Ocean County jointly acquired the land through NJ Program (N.J.S.A. 13:8A-13(a)). Green Acres legislation requires that the land be used for recreational or conservation purposes and specifies that changes in the designated use of the lands must be approved by the Commissioner of the NJDEP and the State House Commission of the State of New Jersey following a public hearing. As per N.J.S.A. 54:4-3.63 et seq. P.L. 1974, Chapter 167, the Legislature hereby finds and declares that natural open space areas for public recreation and conservation purposes are rapidly diminishing; that public funds for the acquisition and maintenance of public open space should be supplemented by private individuals and conservation organizations. Therefore, it is in the public interest to encourage the dedication of privately owned open space to public use and enjoyment and provided for in this act. Historically, private landowners adjacent to the public land holdings of the Reserve have practiced good stewardship and have maintained a strong conservation ethic in management of these properties. Public education and awareness will be used to foster continued stewardship of properties neighboring (i.e., buffering) the Reserve. Public participation in the Reserve has and will continue to promote compatible uses of lands within the Reserve region.

## **Past Land Acquisitions**

### Pocket Marsh (15.29 acres) a.k.a. Grassle Marsh

Acquisition of the Pocket Marsh (*Figure 13*) was ranked as top priority by the JC NERR in the 2009-2014 Management Plan. In April 2012, JC NERR received a \$100,000 award from NOAA to purchase the 15.29 acres of Tucker's Creek Pocket Marsh. Match funding of \$95,000 was provided by the Ocean County Natural Lands Trust. Little Egg Harbor Township contributed \$45,000. Official financial partners in the acquisition were the JC NERR, Ocean County Natural Lands Trust, and the Little Egg Harbor Open Space Program.

Ocean County and the JC NERR co-hosted a Pocket Marsh Dedication ceremony on October 11, 2012. This ceremony was attended by representatives from Ocean County Freeholders, County Planning, Ocean County Natural Lands Trust, Little Egg Harbor Township Open Space Committee, NOAA, the JC NERR, Rutgers University, and the Tuckerton Seaport. Members of the local press were also present. A boundary expansion action will be required for inclusion of the Grassle Marsh into the NERR boundary. This is a high priority, future action for the NERR.



**Figure 13.** JC NERR Pocket Marsh, a priority parcel acquired in 2012.



Turtle Creek Preserve (259 Acres)

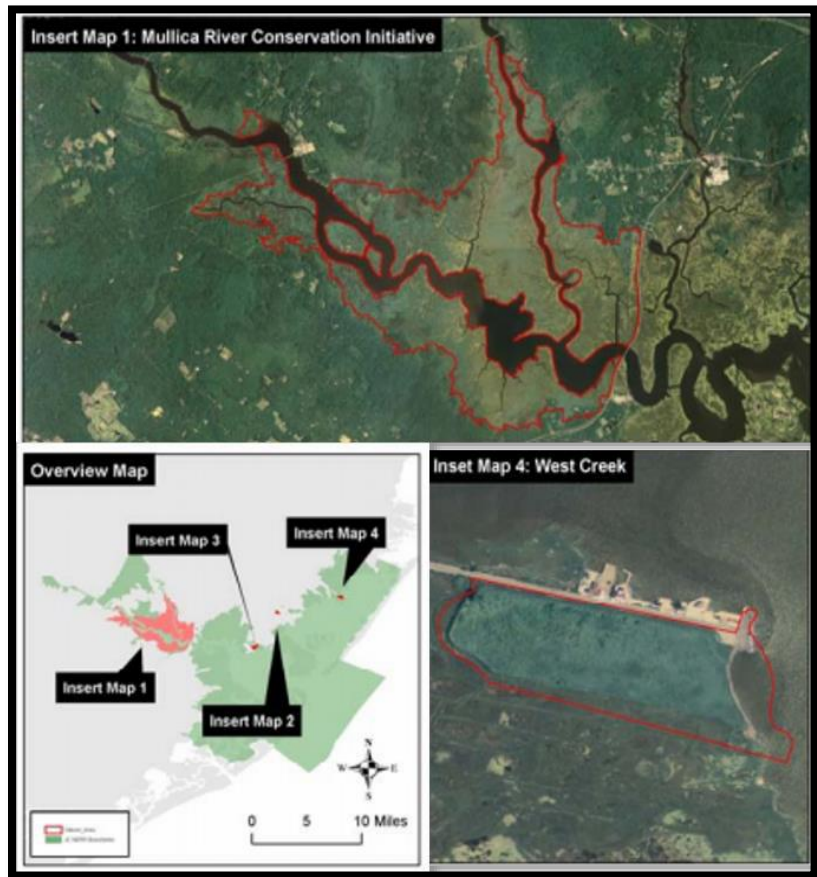
In July of 2009, the JC NERR partnered with the New Jersey Conservation Foundation to acquire Turtle Creek Preserve. The property hosts the beginning of a small Mullica River tributary. Turtle Creek was transferred to NJCF for wetland and wildlife habitat mitigation related to construction on the Garden State Parkway. Located off Turtle Creek Road, the land borders the state's Swan Bay Wildlife Management Area and is open to the public for hiking and nature observation. JC NERR assisted in the preservation by reimbursing NJCF for its costs. The Turtle Creek Preserve is near the 20-acre Lee property in Galloway Township, Atlantic County, which was preserved this spring of 2009 through a partnership of NJCF, JC NERR and the New Jersey Pinelands Commission.

The property has a phenomenal stand of huge Atlantic white cedar, and a trail leads out to the edge of the salt marsh where you can sit in an old duck blind and watch eagles, osprey and various waterfowl traverse the Wading River.

The Turtle Creek Preserve is another high priority for inclusion in the JC NERR boundary, and will be the subject of a future boundary expansion action.

**Proposed Priority Acquisitions**

Although the JC NERR is comprised primarily of public lands, we recognized the importance of long range planning for the acquisition of unique lands that possess critical habitat within the Mullica River-Great Bay watershed, and areas that will be suitable for marsh migration. Reserve staff will continue to work with USFWS and non-profit organizations such as the Trust for Public Land and the New Jersey Conservation Foundation to identify suitable conservation and public access sites. In collaboration with these partners, the following is a list of priority acquisitions sought during the next five years provided there is available funding and willing sellers. The JC NERR recognizes that any future land acquisition will require an Environmental Assessment. We will be certain to follow this required process.



**Figure 14.** Map of JC NERR priority land acquisitions.

West Creek Dock Road Property (26 acres)

This property is a 26-acre parcel of wetland/marshland at West Creek Dock Road, a rural, residential area in West Creek, New Jersey (*Figure 14*). This parcel is surrounded by JC NERR property that is managed in partnership with the Edwin B. Forsythe National Wildlife Refuge. This land was previously a dredge spoil site and has the potential to be used by the JC NERR for restoration science efforts, education, and stewardship programs. It is the only point of access for local hunters accessing the designated hunting grounds of Edwin B. Forsythe Refuge. It has historically been privately owned and does not currently fall within the boundaries of the JC NERR. However, it does fall within the buffer area.

The property encompasses a full ecological gradient including wetlands and uplands, and provides a protective barrier to human disturbance, and restoration activities would be planned and approved by NOAA to ensure that the area would improve the character and integrity of the Reserve. Recently the New Jersey Department of Transportation (DOT) purchased the land to use as a dredged materials disposal site, which has met local opposition. JC NERR is currently working with NJ DOT and the refuge to acquire the land. The Forsythe Wildlife Refuge has land adjacent to this parcel and may be interested in acquiring it. The Trust for Public Land has also expressed interest. The Green Acres Program, the Ocean County Natural Lands Trust, and the NJCF are additional agencies the JC NERR can partner with to acquire this land.

#### Wading River and Mullica River Wetland (4,192 Acres)

The JC NERR looks to acquire the tidal lands along the Wading and the Mullica rivers. This parcel is pristine waterfowl and duck habitat due to the extensive wild rice stand, which represents the last major stand in New Jersey. The rice stand extends beyond the Wading River Bridge into the freshwater stream of the Bass River State Forest in small patches. This extension is a relatively new growth. Wild rice grows in patches above the Green Bank Bridge. These wetlands habitats are partially protected by state and federal forests, but public ownership would ensure the preservation of this wetland habitat.

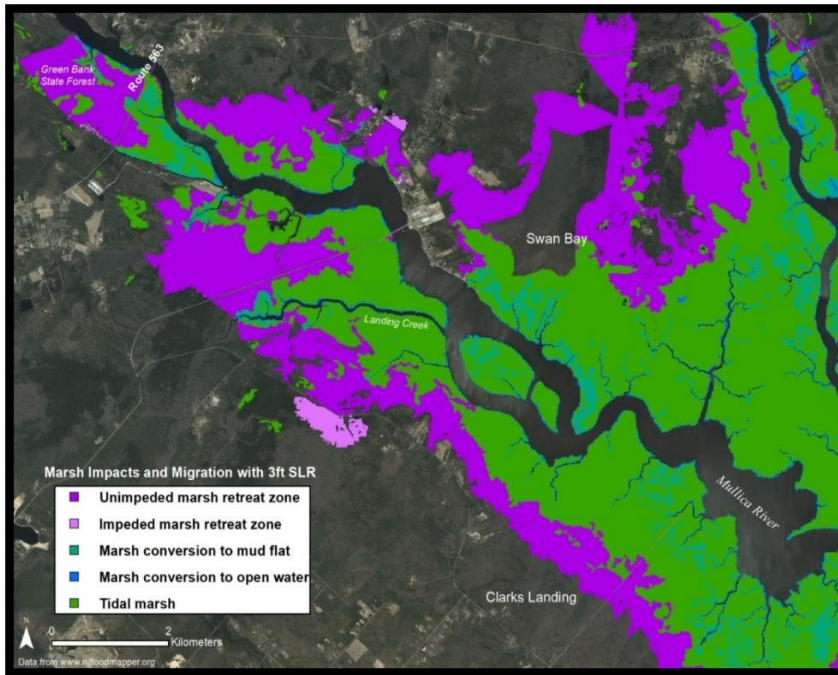
The current Mullica River Conservation Initiative boundary line only includes tidally flowed lands. Many of these properties are already afforded protection through tidelands and coastal wetlands regulations. To include properties that may have more imminent development pressure, the Mullica River Conservation Initiative partners are considering expanding the current conservation boundary line to include upland properties. This boundary expansion could potentially include a much broader area and consider lands adjacent to the Mullica and Wading River headwaters, including their respective sub-watersheds. The JC NERR will partner with NJCF to acquire individual land parcels that make up the Mullica River Conservation Initiative either through purchase or donation. Currently, the NJCF owns numerous properties within this area. The going rate for coastal wetlands is approximately \$1000 per acre. Due to the abundant number of parcels within this area that are owned by many different private landowners, property in this area will take years to acquire.

### **Needs and Opportunities**

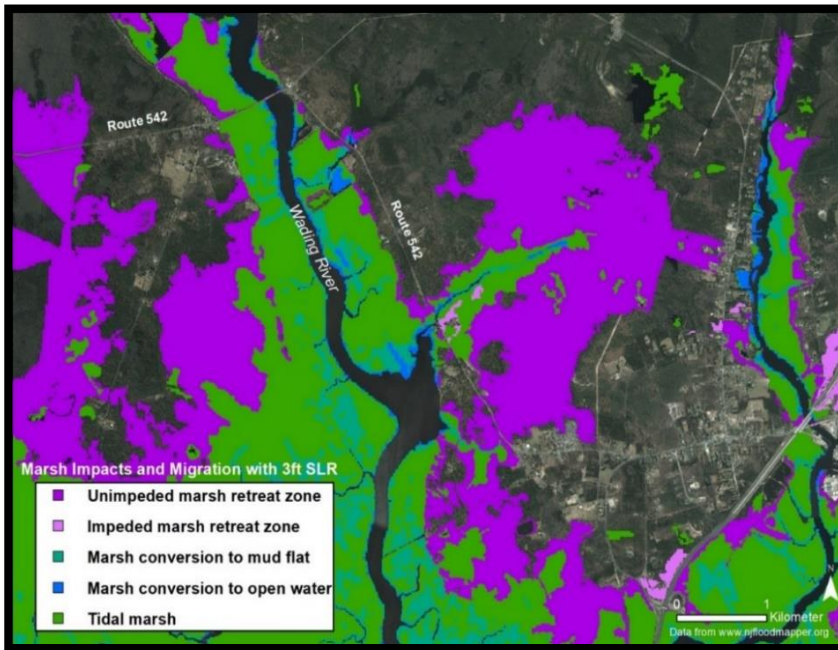
#### Sea Level Rise, Marsh Migration and Land Acquisition

Rising sea levels are expected to impact coastal ecosystems within the reserve. Salt marshes can raise elevation through the capture of suspended sediments. This has historically allowed salt marshes to keep up with the rate of sea level rise to a certain degree, though many marshes have shown degradation over time, likely due to insufficient sediment budgets. As rates of sea level rise increase,

areas of salt marsh will increasingly struggle to keep pace, likely leading to conversion of low marsh to sand and mud flats or open water. Meanwhile, the border of the landward edge of the marsh against the connected uplands may migrate inland, converting uplands areas to wetlands.



**Figure 15.** Marsh Impacts /Migration



**Figure 15.2** Marsh Impacts/ Migration II

Wading River, particularly in the Merrygold Branch region, contain vast marshlands and marsh retreat areas (Figure 15). According to the SLAMM model, current marsh areas along the Wading River show higher vulnerability to sea level rise than other portions of the JC NERR reserve and contain large areas of marsh that may convert to mud or sand flats or even open water over time.

The Sea Level Affecting Marsh Migration model (SLAMM) indicates that the Reserve has large areas of uplands that could convert to wetlands over time. According to the model, at all but the highest possible rates of sea level rise over the next 30 years, the acreage of salt marsh within the Reserve could be maintained through the conversion process. However, this would result in a net loss of uplands area within the Reserve. The impact of sea level rise on habitat loss and conversion should be taken into account when considering potential opportunities for Reserve land acquisition. For example, the southern bank of the Mullica River (not including Bear Creek Preserve) between the Clarks Landing State Natural Trust and Green Bank State Forest at Rt. 563 contains significant wetlands as well as large areas of potential marsh retreat zones.

Additionally, areas along the

Another way to accommodate for sea level rise impacts to marshes through land acquisition would be to preserve any upland areas adjoining current Reserve areas (*Figure 15.2*). As marshes extend landward as sea levels rise, many upland areas of the reserve will be converted to marshland. This process may help offset the loss of low elevation wetlands that will convert to sand and mud flats or open water, maintaining ecosystem services within the reserve. Whereas this does preserve the marsh habitat, it points to the ongoing dynamic nature of the natural “boundaries” and ecosystems. Preserving larger areas of upland would help to protect uplands habitat that borders marshes.

### **Methods/Strategies for Acquisition**

To acquire these lands, the JC NERR will seek direct grant support from land management partners, and the NERR Construction and Land Acquisition Program. These opportunities will be pursued via established competitive grant applications, local land trusts, county and state-based green acres or open space funds. The JC NERR seeks priority status for land acquisitions on the state priority list, being developed by the JCNERR in partnership with the NJDEP. Any lands acquired by the JC NERR will ultimately be transferred to appropriate land management agencies for long-term stewardship and management. The JC NERR will work with its land management and conservation partners to develop acquisition criteria that improve resiliency of coastal communities, with an emphasis on identifying properties that can help mitigate effects of climate change.

#### Acquisition Policy

Acquisition policy of the JC NERR states that lands may be added by:

- Continuing efforts by the federal government to acquire land for the Forsythe Refuge;
- State efforts to increase its holdings of natural areas;
- Private donations; and/or
- Acquisitions made through the Coastal and Estuarine Land Conservation Program and the NERRS Construction/Acquisition program.

### **Exploring Future Boundary Expansion: The Barnegat Bay Watershed**

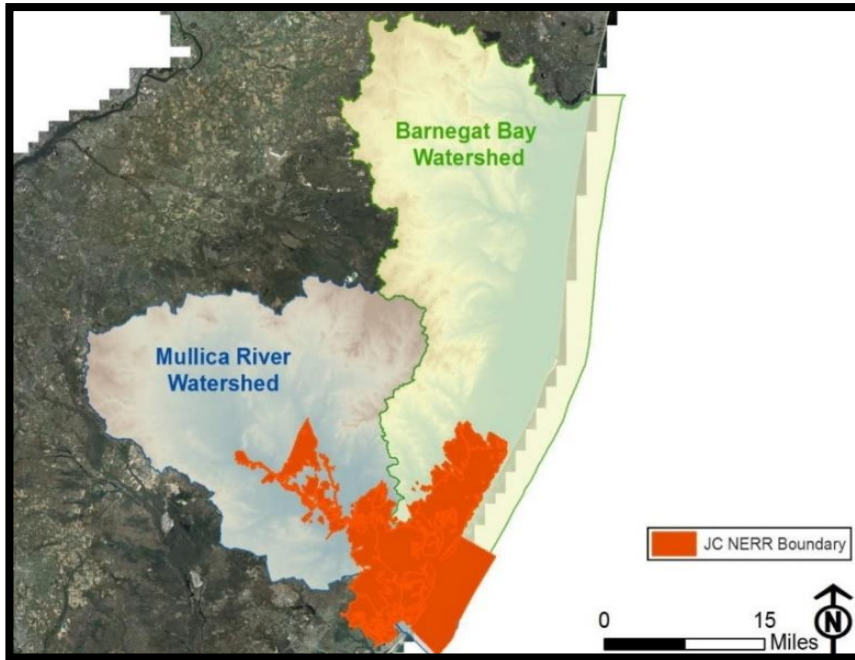
#### Ecological, Ecosystem and Biogeographical Representation

The JC NERR currently overlaps with two watersheds: the far northern extent of the Reserve falls within the Barnegat Bay watershed while the remainder of the Reserve falls within the Mullica River watershed. The Barnegat Bay watershed portion of the Reserve is characterized as a “shallow lagoonal estuary,” while the Mullica River/Great Bay Watershed portion of the JC NERR is geologically considered a “drowned river estuary.” The two watersheds of the Reserve share common form, geology, and habitat types: a general North-South orientation, marshland (both undeveloped and highly developed) to the West, barrier islands (both undeveloped and highly-developed) to the east, deeper waters and organic bottom sediment in their western halves, shallower shoals of sandy sediments in their eastern halves, and some (but limited) freshwater input maintaining weak, tidally-dominated salinity gradients. Notably, both regions host seagrass and macroalgae beds that serve as critical nursery habitat for a myriad of ecologically and commercially important species.

The recent determination that a majority of the water in the northern headwaters of Barnegat Bay are sourced from Little Egg Inlet (the other half being sourced from Barnegat Inlet and Manasquan Inlet via the Point Pleasant Canal) adds to the rationale for considering expansion northward into and encompassing greater extent of Barnegat Bay (Defne and Ganju 2015). This phenomenon suggests the JC NERR, as defined by its current borders including Little Egg Inlet and the waters of Little Egg Harbor up to the Route 72 bridge, shares water volume and chemistry (both physical characteristics as well as



nutrient constituents) with the remainder of Barnegat Bay (in this document, “North Barnegat Bay”); it is possible, at the population-level of many species, the two bodies of water are highly connected and function as a single contiguous habitat and/or range.



**Figure 16.** *Mullica River and Barnegat Bay Watershed*

#### Naturalness

Since the Barnegat Bay Watershed is significantly more developed than the Mullica River Watershed, and it does not fit the defined criteria of “naturalness” for the Reserve boundaries, it would be beneficial to focus on the research potential of expanding the JC NERR Boundaries into the Barnegat Bay instead of on land use (Figure 16). Due to the impacted nature of the Barnegat Bay Watershed, the JC NERR would work closely with the BBP to ensure that any research focused on science-based

restoration priorities of the reserve, the BBP, and other Watershed partners.

#### Research Potential

Both bodies of water in the northern portion of the JC NERR and the remainder of Barnegat Bay have significant differences, particularly greater anthropogenic impact via development, use of impervious surfaces (such as roadways and sidewalks), hardened shorelines, and increased runoff and nutrient input in Northern Barnegat Bay. The expansion of the JC NERR to include the remainder of Barnegat Bay would provide ample opportunity to monitor, assess, and model the effects of these variables, utilizing far less impacted waters of the JC NERR as a baseline to which data collected in Barnegat Bay could be compared.

The shared source of oceanic water (from Little Egg Inlet) suggests the probability of a strong linkage between populations of organisms, including but not limited to, fish, shellfish, plankton (micro-, meso-, and megaplankton), algae, and seagrasses between the current waters of the JC NERR and waters of northern Barnegat Bay. JC NERR could lend its expertise and experience in monitoring water, weather, nutrient, and vegetation, as per the mandates of the NERRS SWMP, and follow suit to establish and provide the baseline physical data critical for the analysis and interpretation of such biological and population data.

#### Educational Opportunities

Current JC NERR Coastal Training Programs, Community Education Programs, and Teacher Professional Development Programs already focus a great deal on the Barnegat Bay Watershed and its Ocean County municipalities, residents, teachers, and visitors. Numerous of public access points/opportunities and existing interpretative programs within the Barnegat Bay Watershed complement existing JC NERR

programs and allows for additional programming and exploration of new estuarine educational opportunities through enhanced partnerships. Additionally, the comparisons between the highly developed Barnegat Bay Watershed and the lesser developed Mullica River Watershed provide many opportunities to compare impacts, resiliency, build out, and coastal indicators.

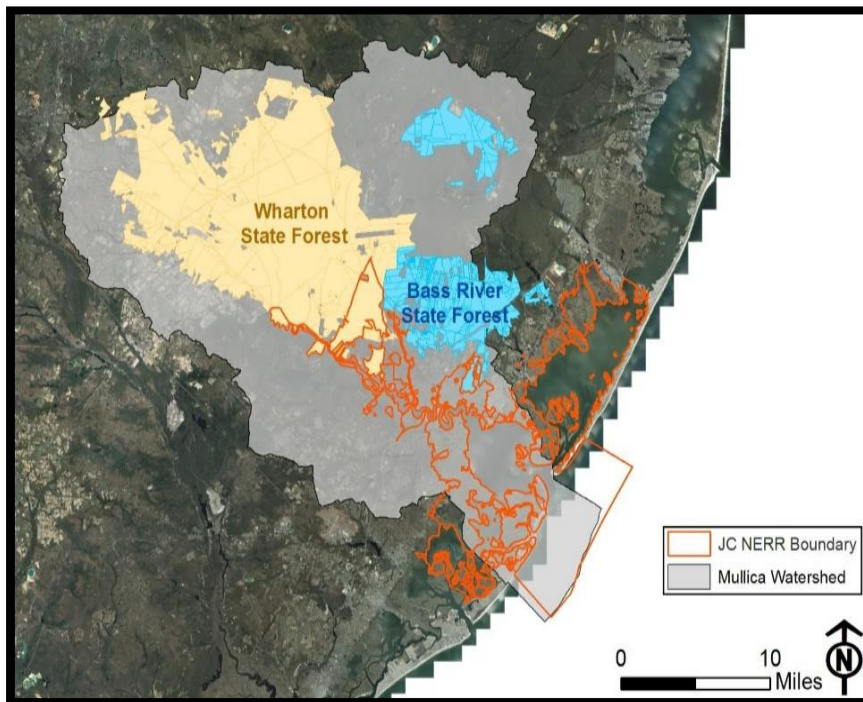
### Management Considerations

The Barnegat Bay Partnership is another federally funded National Estuary Program located within and focused around issues in the Barnegat Bay Watershed. Through a formal Memorandum of Agreement/Understanding, the NERRS System and the National Estuary Program have formally agreed to work more closely together to enhance the protection, monitoring and education opportunities within overlapping NERRS/NEP jurisdictions. An expanded JC NERR boundary allows for additional synergy between the two programs and enhances the opportunities for collaboration, expanded education and training program delivery, increased estuarine monitoring and restoration, and a broad and powerful network of combined partners. The Barnegat Bay and Mullica River Watersheds provide two large watersheds and many sub-watersheds in which the JC NERR and the Barnegat Bay Partnership could establish combined research, monitoring, stewardship, education, and training programs.

The expansion of the JC NERR's borders to include northern Barnegat Bay is not without challenges. Monitoring and surveying this territory would require increased funding, logistics, and effort.

### **Exploring Future Boundary Expansion: Wharton and Bass River State Forests**

The JC NERR boundary currently incorporates portions of both Wharton State Forest and Bass River State Forest (*Figure 17*). Extending the JC NERR to include more of the Wharton and Bass River State Forests would move the JC NERR boundary beyond the head of saltwater influence in the Mullica River



**Figure 17.** Wharton and Bass River State Forests within the JC NERR boundary.

and incorporate a significant amount of the Mullica River Watershed into the JC NERR. Addition of these properties will enhance the interaction and partnership between the JC NERR and NJ Division of Parks and Forestry.

#### Wharton State Forest

##### *Ecological, Ecosystem and Biogeographical Representation*

Throughout Wharton are rivers and streams for canoeing, hiking trails (including a major section of the Batona Trail), miles of unpaved roads for mountain biking and horseback riding and numerous lakes, ponds, and fields ideal for wildlife

observation. Bald eagles, red-tailed hawks, marsh hawks, ospreys, great blue herons, swans, screech owls, great-horned owls, bluebirds, hummingbirds, purple martins, goldfinch, turkeys, beavers, river otters, fox, and deer are only some of the wildlife visitors can see.

Natural areas within Wharton State Forest include Batsto Natural Area (9,449 acres) which is composed of two sections bordering the Batsto and Mullica rivers, and several forest communities that are representative of New Jersey Pine Barrens. Additionally, there is the Oswego River Natural Area (1,927 acres) which is an extensive white cedar and pitch pine forests bordering the Oswego River. This freshwater wetland corridor is home to the rare bog asphodel, Pine Barren boneset, curly grass fern and Pine Barrens tree frog.

#### *Cultural Considerations*

Wharton also offers cultural and educational experiences such as a visit to Batsto Village, the site of a former bog iron and glass making industrial center (1766-1867). The village, part of Wharton State Forest, currently reflects the agricultural and commercial enterprises that existed here during the late 19<sup>th</sup> century. Batsto consists of thirty-three historic buildings and structures including the Batsto Mansion, gristmill, sawmill, general store, workers' homes, and post office.

#### *Educational Considerations*

Educational opportunities such as [Batsto Through the Years: A Teaching Resource](#) was recently developed to help educators explain the importance of the New Jersey Pinelands and the lifestyles of the people who lived and worked there. Topics range from the environment and early Pinelands industry to daily life in the village. In conjunction with the manual, Batsto Village offers seasonal educational programs and interpreter-led tours. Age appropriate presentations and a “hands on” museum greet Batsto’s visitors.

#### Bass River State Forest

##### *Ecological, Ecosystem and Biogeographical Representation*

Bass River State Forest was the first forest acquired by the state of New Jersey in 1905 for public recreation, water conservation, and wildlife and timber management. Lake Absegami, a 67-acre lake created in the 1930s, is the center of the forest's recreational activities. It provides an area for swimming and a serene setting for boating and canoeing. A trail through the Absegami Natural Area (128 acres) wanders through a pine/oak woods and a small Atlantic white cedar bog that shares the canopy with red maple and magnolia. The Pinelands white cedar swamp and surrounding oak-pine forest community make up the Absegami Natural Area. The West Pine Plains Natural Area (3,830 acres) is made up of a unique stunted forest ecosystem, known locally as the Pygmy Forest. This ecosystem is globally rare and supports an extensive forest of pine and oak trees that may obtain a canopy height of only four feet at maturity. New Jersey contains the largest acreage of this forest community type worldwide. The area also supports an endangered plant species (the broom crowberry) and numerous rare species of moths.



## **PUBLIC ACCESS PLAN**



### **Introduction**

Waterfront property and public open space is at a premium in New Jersey and access to it is highly desirable. The potential for conflict among users and resource protection is great, but proper management can minimize conflict. The success of well-managed waterfront and public open space lie in approaches that combine long-term flexible public use with resource protection. The JC NERR relies on public access plans enacted by the public agencies that manage the federal and state lands and waters comprising the Reserve. These plans maintain the integrity of the land for research, long-term resource protection, and education while permitting traditional uses that do not conflict with Reserve goals. The plans foster strategic access to public lands and waters for municipal and recreational uses in a manner that mitigates broad human disturbance.

### Existing Access Points

The JC NERR currently maintains the public access policies enacted by the Reserve land management agencies. Public access to state waters for traditional uses such as boating, hunting, and fishing are maintained under these policies. A new interactive map table at the Life on the Edge Interpretive Center has one of eight maps dedicated to the various recreational opportunities available throughout the Reserve boundary.

Continued and improved access is encouraged to the extent that Reserve resources are not adversely affected. Current statutes that exist for the land Managers in the Reserve continue to govern access within the Reserve. No new regulations will be developed regarding access. The Forsythe Refuge provides access for more than 200,000 visitors annually through an 8-mile Wildlife Drive and foot trails.

To ensure that the Refuge remains protected from human impact, visitors are asked to comply with

simple guidelines and regulations. Access to the 6,000 acres of designated wilderness area, including Holgate and Little Beach (undeveloped barrier islands), is managed by the USFWS, which restricts access through state and federal programs. The Reserve does not impose any additional limitations on lands within the Reserve boundary.

### Traditional Uses

Traditionally, the JC NERR has been used for hunting many game species. Recreational fishing in the rivers and creeks, and commercial fishing and shell fishing in the estuary and bay, also are recognized traditional uses. Each of these activities is subject to state regulation through required licenses, permits, and other laws. The Reserve does not possess authority to enforce or implement existing laws and regulations concerning these or any other traditional uses of the JC NERR. These activities are permitted up to levels indicated by local and state laws unless they interfere with research, educational activity, or conflict with traditional uses.

### Needs and Opportunities

#### *Ongoing and Future Projects*

With the acquisition of the Pocket Marsh (now called the Grassle Marsh) in April 2012, the JC NERR has been planning public access on the Rutgers managed lands by providing the Life on the Edge at the Grassle Marsh Interpretive trail. In 2016, the JC NERR received two grants: one from New Jersey Department of Environmental Protection Green Acres Program Trails Grant and one from the NOAA PAC competition. These two grants complement each other in the purchase of trail maintenance supplies, benches, signage, two trail kiosks, and the construction of a raised boardwalk and overlook for the Life on the Edge (LOE) Interpretive Trail at the Grassle Marsh. It was the intent of these grants to have the JC NERR Life on the Edge public exhibit at the Tuckerton Seaport and the Life on the Edge Interpretive Trail at the Grassle Marsh complete an interconnected JC NERR public, interpretive experience.

### Challenges

The JC NERR Coastal Center property has never been a place where visitors, other than program participants, would come and explore. The LOE Interpretive Center always filled that need for the reserve. With the construction of the LOE at the Grassle Marsh Interpretive Trail, the reserve staff onsite at the Coastal Center may have a greater need to interact with the public coming to walk on the trail, explore the area, and obtain additional information about the Reserve. This is a potential challenge for an already limited staff, but one that we are excited to confront, as we really open our place and our special habitats to residents and curious visitors. Increased interactions with the public onsite would be very positive, but may require new thinking about onsite interpretive and educational staff.

## FACILITIES CONSTRUCTION PLAN



### Introduction

To date, PAC funds have been used to construct core facilities for the JC NERR. These include a primary complex that contains offices, a classroom, and dormitory, facilities that house a public exhibit, research space located at the Marine Field Station, and an Interpretive Trail at the Grassle Marsh. Future plans require continued updates to the Life on the Edge exhibit, construction of an auditorium to support growing public programs, and incorporation of resilient design practices and materials to reduce risk associated with flooding and sea level rise-especially for JC NERR facilities currently housed at the Marine Field Station.

Reserve staff will work with University facilities personnel to identify areas that may be required to relocate the SWMP lab and suitable waterfront facilities with ready access for boats to support field work. Should this be required in the next five years, the JC NERR will seek PAC support for construction. We also will explore shared use of partner facilities, or the construction of required facilities on partner lands. Support also will be sought to add energy efficient capabilities to existing reserve facilities. Major construction projects (i.e., buildings) require the preparation of architectural and engineering plans and state approval of capital outlay proposals. Development of architectural and engineering plans for buildings must meet the goals and objectives of the Final Environmental Impact Statement. Funds for constructing buildings may come from federal acquisition and development grants. All construction within the JC NERR boundary (core or buffer) will follow state and federal regulations and guidelines.

The construction and operation of a research and/or educational facilities will be thoroughly reviewed and examined by all landholders to ensure there are no negative impacts on the natural system. Pursuant to the National Environmental Policy Act (NEPA), a categorical exclusion, environmental

assessment, or supplemental environmental impact statement may be required prior to construction. Minor construction activities such as nature trails, boardwalks, and boat ramps do not require architectural or engineering plans. Funding for planning and constructing nature trails, boardwalks, boat ramps, and other minor improvements also can be awarded under future acquisition and development grants.

#### Existing Facilities

##### *The Jacques Cousteau Coastal Center*

The Coastal Center provides research, education, and office space. It supports three types of programs:

- Coastal decision-maker workshops for resource and marine policy professionals and a variety of local/state government officials, environmental, civic, nonprofit, and public interest groups
- State-of-the-art professional development programs for K-12 educators seeking environmental classroom and field-based curricular programs
- Science-based public education programs that increase the knowledge and skills of budding local stewards

The Coastal Center is located in the buffer zone, next to the RUMFS dorm. This location has excellent access to a variety of Reserve habitats with minimal traffic impacts on sensitive areas. Facilities within the Coastal Center include:

- Main Entry Vestibule
- Distance Learning Classroom – Used for formal classroom activities, lectures, and hands-on demonstrations, includes an audio-visual projection area and distance learning equipment
- Restrooms with showers– Used by our class participants and overnight guests
- Office space for Reserve staff and volunteers
- Bedrooms – Four bedrooms each with space for four people
- VIP Dorms – Used by staff or VIP guests that may be staying for multiple nights. Includes a small kitchen and laundry facilities
- Wet Laboratory – Used by education groups and researchers for further investigations of organisms collected in the field

##### *"Life on the Edge" Exhibit at the Tuckerton Seaport*

The Life on the Edge exhibit at the Tuckerton Seaport opened to the public in July 2002, on the upper level of the Visitor Center. The original project was a collaboration between the Tuckerton Seaport, Rutgers and the JC NERR, funded through a NOAA Construction and Acquisition Program. A NOAA PAC grant awarded funds for a repurposed Life on the Edge exhibit in 2010. In 2015, additional NOAA PAC funds were awarded to incorporate additional key exhibit design pieces and equipment to reinforce and augment visitor experiences. Some elements focus on young learners, while audio/visual components engage visitors to learn about the resource value of estuaries, and issues that affect the ecological integrity of estuarine systems and present information on recreational access of the Reserve's habitats. A mobile education cart now provides for docent guided discovery of objects and specimens to encourage visitors of all ages to explore natural science through a real, tangible experience.

On May 3, 2016, a fault in the sprinkler system caused the erroneous deployment of one sprinkler unit during a severe thunderstorm. Flooding occurred in the exhibit space and in the floors below. The exhibit, along with flooring, walls and some ceiling panels, have been removed. The exhibit components have been stored, analyzed for damage and replaced as necessary by Lynch Exhibits, who also fabricated the new exhibit components. Reinstallation of the Life on the Edge exhibit along with the new

enhancements was accomplished by the end of 2016.

### *Rutgers University Marine Field Station*

The Rutgers University Marine Field Station (RUMFS) houses several key JC NERR laboratories and provides dock space and water access for a variety of small boats. At present, the buildings, causeway and grounds of RUMFS occupy seven acres on a peninsula close to Little Egg Inlet in southern New Jersey within the JC NERR. The facilities at this site consist of an office/laboratory building (7,388 sq. ft.), an adjoining seawater laboratory (1,736 sq. ft.), and a third building with a partially renovated dry laboratories and office space (3,390 sq. ft.). A dormitory (5,828 sq. ft.) and warehouse (2,068 sq. ft.) are located adjacent to the JC NERR Coastal Center in Tuckerton.

Field Station resources also include the R/V CALETA a 28-ft. aluminum hull research vessel, equipped with an A-frame and winches, and a 48-ft. research vessel, the R/V ARABELLA, equipped with an A-frame, GPS navigation system, lab facilities, and mast mounted wind sensors. Another JC NERR boat, the R/V Resilience is 2014 Parker 2520 XLD Deep Vee Hull powered by dual Yamaha F200 outboard engines. The boat is designed for nearshore (+20nm) and estuarine operations. The R/V Resilience is used to support AUV and ROV missions; Benthic sampling and Habitat Mapping; Trawling and Hydrographic surveys; and SCUBA diving operations. The boat is equipped with state-of-the-art navigation and side scan sonar electronics, port and starboard davits equipped with 5.2 HP electric VDC winches with 250 feet of stainless steel cable.

The location of RUMFS near Little Egg Inlet provides immediate access to the adjacent Atlantic Ocean. A JC NERR sampling program that operates from RUMFS, both in the estuary and the ocean, is the Remote Environment Monitoring Unit (REMUS), an autonomous underwater vehicle that is designed to perform hydrographic reconnaissance in shallow water (3-20 m). Additionally, the NSF-sponsored research Experience for Undergraduates summer intern program sponsors students, from Rutgers and other institutions, to work and conduct research at the JC NERR. The buildings and the grounds at the Coastal Center, the adjoining dorms, and RUMFS are maintained by three full-time facilities staff members from Rutgers University.



### Planned or Proposed Projects

All future planning or proposed construction and land acquisition projects will be subject to National Environmental Policy Act/Environmental Compliance (EC) Review and Authorization.

### *Construct Public Auditorium/Meeting Space*

Demand for public programs at the JC NERR has increased dramatically and includes formal and informal education, family programs, science workshops, and CTP programs. Quite often registration for these



programs exceeds available space, interested participants are turned away, and large meetings that we conduct must be held at distant locations. Support will be sought for a 150-person auditorium to meet this demand. This facility may be co-located at the Tuckerton Seaport or situated at the Cousteau Center.

#### *Construction/Renovation of Laboratory Space for SWMP Operations at the JC NERR Coastal Center*

The JC NERR currently conducts most of its SWMP-related operations at the Rutgers University Marine Field Station (RUMFS). Two work spaces are maintained there; a water chemistry laboratory, (for nutrient sampling preparation, filtration, and sample preservation and cold storage), and an office/equipment room (for the maintenance and calibration of water-quality equipment, storage of field gear and equipment storage, and data management). RUMFS is located at the end of Great Bay Boulevard, a low-lying road that experiences occasional inundation by tidal and storm-surge driven waters. The frequency of inundation (by both aforementioned causes) has increased over the years, resulting in a greater number of days during which travel to and from the station is prevented, impeding progress and threatening monthly SWMP deadlines.

Because of the nature of the work and requisite safety protocols, most SWMP-related tasks performed at RUMFS cannot be conducted elsewhere nearby because of the lack of suitable work space and equipment. For this reason, the JC NERR would like to establish a secondary location at a relatively inland location on higher ground where SWMP operations can be conducted when access to RUMFS is impeded or if RUMFS were to sustain damages that prevent utilization of the current work space (as happened during/post Superstorm Sandy as well as during a well-contamination incident that suspended use of water at the station during the winter of 2015-2016). This may be accomplished by: renovating current workspace within the JC NERR Coastal Center, and/or constructing a new structure on the grounds, and/or renovating the wet lab (located behind the JC NERR Coastal Center) by closing in and building within the current open area or adding a second floor to the current structure (which would maintain the current area as a flexible classroom/equipment storage area).

Needs would be as follows:

- Two work stations (preferably in separate rooms); one “clean” work area/room for nutrients and one for field instruments and equipment
- Climate controlled environment (both heating and cooling)
- Water supply and multiple sinks
- Sewer tie-in for drain-disposal of (appropriate) rinsate
- De-ionized water machine
- Cabinets and shelving for storage of varied equipment, materials, and standards
- Fume-hood for the maintenance of an acid bath for sterilizing glassware for SWMP nutrient collection, filtration, and storage
- Vacuum pump for filtration of nutrient samples
- -20 (or better; a -80 is much preferred) freezer for storage of filtered nutrient samples
- Chemical waste cabinet
- Basic computing capabilities (for the calibration of equipment and submission of data and metadata documents) with internet access
- Tile or vinyl flooring (able to get wet)

#### *Life on the Edge Exhibit - Awarded FY'17 PAC Grant*

The JC NERR applied to, and was awarded funding through, the 2017 NOAA PAC competition. A priority

in the application procedure was to identify partners, projects, and processes that incorporate sustainable design principles to optimize energy performance and reduce the overall carbon footprint and greenhouse gas emissions. We proposed creative and innovative solutions in reducing energy consumption through collaboration with JC NERR's managing partner, Rutgers University. There is also a need to protect our investment of an exhibit that so far cost \$650k and the additional structural items that the Seaport has provided. Windows are leaking air and moisture into the exhibit space and window sashes are degraded to the point that windows could disengage from the frames. Faulty and failing A/C/heating installation has caused several leakages from the overflow pan in the ceiling to the exhibit displays below.

Another facet of the FY'17 PAC proposal was to make SWMP water quality parameters available to teachers and the public through "SWMP stories." The new SWMP exhibit section is envisioned to be a compact immersive display/video experience comprised of new video production and a repurposed YSI data-logger and up-to-date monitoring equipment.

The final facet of the FY'17 PAC award is a program cart that is designed to move on all terrain and can be used as a tool to connect the Cousteau Coastal Center and the Life on the Edge Interpretive Trail on the Grassle Marsh. This intentionally designed space on the move will be stored inside in a dedicated space, classroom or study center, which would be the staging ground for programs before moving outdoors with the cart loaded with material for programs that support teacher professional development, coastal decision-maker programs, and children, family, and public programs. The Outdoor activities, enhanced with the program cart, will "wheel participants in" to investigate ecological and biological concepts and reflect on their relationship to the natural world.

Activities items on cart will include tools for:

- Scientific instruments for water testing
- Activities about forest succession and competition of species
- Species ID via field guide
- Collection of Wind throw (even leftover from Sandy)
- Drawing and writing supplies to capture a sense of peace and place
- Info packets to go with interpretive signage
- Equipment for a future designated ecological demonstration project

#### *Additional/ Accessible Boat Dockage Facilities*

Due to the extreme shoaling of the access channel at the Rutgers University Marine Research Station, additional dockage for the JC NERR SWMP vessel, Mullica Explorer will be needed. Two nearby local marinas are being evaluated for additional dock space along with a slip at the Tuckerton Seaport.

#### *Grassle Marsh Trail Expansion Across the Creek*

The expansion of the Grassle Marsh Trail across the Pocket Marsh Creek is being explored. This will include a new portion of the natural trail in the upland area and an additional boardwalk across the marsh to connect to the boardwalk and overlook what is currently being constructed. This expansion will increase the total area of the loop trail to over 1 mile. This project may require tribal engagement in addition to NEPA /EC review.



### Green Infrastructure

Both the Life on the Edge Exhibit and the Life on the Edge Interpretive Trail at the Grassle Marsh, and the proposed NOAA FY'17 PAC proposal adhere to a green checklist that evaluate the environmental sustainability of the projects. The key strategies for reducing the environmental impact are:

- Reduce new material consumption by reusing material from older exhibits
- Use locally sourced materials, where possible
- Reduce waste
- Reduce energy consumption
- Reduce products with toxic emissions

# RESOURCE PROTECTION PLAN



## Introduction

The JC NERR and surrounding watershed are owned and managed by local, state, and federal agencies. These include the NJDEP, Pinelands Commission, and the USFWS. These agencies share a common goal aimed at science-based management of the watershed. Public access and use within the core and buffer areas of the reserve are coordinated with the public agencies that manage these areas. All uses within these areas are controlled by the public landowners and are subject to direct permitting or federal consistency control by the NJDEP under the rules for New Jersey's Coastal Management Program (Appendix C). These regulations protect reserve ecosystem and surrounding watersheds for long-term research and education.

## State Regulations

The reserve lies within two regulatory regions:

- The area east of the Garden State Parkway in the Coastal Area as defined by New Jersey's Coastal Management Program
- The area upstream or west of the Garden State Parkway in the Pinelands Protection Area

Both regulatory designations provide protection for the Reserve. For the JC NERR, the DEP has responsibility and full authority to manage and enforce activities and uses. Responsibilities include permit review, planning, managing public tidelands real estate, monitoring, and enforcing coastal permit and tidelands laws, undertaking coastal engineering projects, and providing financial and technical assistance to local governments. Legislative mandates for this authority include the Coastal Area Facility

Review Act (CAFRA, N.J.S.A. 13:19-1), the Wetlands Act of 1970 (N.J.S.A. 13:9A-1), and the Waterfront Development Act (N.J.S.A. 12:5-3). Under these three statutes, any development proposed within estuarine waters, on wetlands, or on uplands within 150 feet of tidal waters, beaches, or dunes must receive a coastal permit from the NJDEP. State-regulated development is reviewed using the Rules on Coastal Zone Management (N.J.A.C. 7:7E-1 et seq.) The Mullica River-Great Bay estuarine system was chosen as the site for the JC NERR, in part, because these rules preserve and protect the key land and water areas of the reserve. These rules define the land and water resources of the research reserve as Special Areas.

Special Areas are defined as those with natural resource value, importance for human use, or sensitive to disturbance that they merit specific attention. Special Areas are given special policies in Subchapter 3, and are grouped under four broad headings: Special Water Areas; Special Water's Edge Areas; Special Land Areas; and Special Coast Wide Areas.

Special areas protected under these rules include:

- Shellfish Beds Surf Clam Areas
  - Erosion Hazard Areas
  - Prime Fishing Areas
  - Barrier Island Corridors
  - Finfish Migratory Areas
  - Bay Islands
  - Submerged Vegetation
  - Beaches
  - Navigation Channels
  - Flood Hazard Areas
  - Canals
  - Alluvial Flood Margins
  - Inlets
  - Wetlands
  - Marina Moorings
  - Wetlands Buffers
  - Ports
  - Wet Borrow Pits
  - Submerged Infrastructure Routes
  - Coastal Bluffs
  - Shipwrecks and Artificial Reefs
  - Intermittent Stream Corridors
  - Intertidal and Subtidal Shallows
  - Critical Wildlife Habitat
  - Dunes
  - Public Open Space
  - Overwash Areas
  - Special Hazard Areas
  - Coastal High Hazard Areas
  - Endangered or Threatened Wildlife or Vegetation Species Habitats
- The following regulations protect the estuarine resources of the JC NERR:

## State Regulations

### *Coastal Area Facility Review Act*

The Coastal Area Facility Review Act (CAFRA, N.J.S.A. 13:19-1 et seq.) authorizes the DEP to regulate and approve the location, design, and construction of major facilities in a 1,376-square mile coastal region encompassing portions of Middlesex, Monmouth, Ocean, Burlington, Atlantic, Cape May, Cumberland, and Salem Counties. The CAFRA area also includes coastal waters. Lying within the CAFRA area are New Jersey's coastal barrier beach islands, its coastal resort areas, portions of the Pinelands, large agricultural areas, and New Jersey's fastest growing communities. Facilities regulated under CAFRA include residential developments with 25 or more dwelling units, industrial facilities, roads and sewers greater than 1,200 feet in length and commercial facilities with 50 or more parking spaces. Any development, regardless of size, within 150 feet of dunes, beaches, and tidal waterways is also subject to CAFRA review.

### *Wetlands Act of 1970*

The [Wetlands Act of 1970](#) (N.J.S.A. 13:9A-1 et seq.) authorizes the DEP to regulate virtually any form of development or disturbance on mapped coastal wetlands, except for mosquito control and continued commercial production of salt hay or other agricultural crops or activities. It protects all coastal wetlands within the proposed reserve except for inland and freshwater wetlands.

### *Waterfront Development Law*

The Waterfront Development Law (N.J.S.A. 12:5-3) authorizes the DEP to regulate the construction or alteration of a dock, wharf, pier, bulkhead, bridge, pipeline, cable, or other "similar or dissimilar development" on or adjacent to navigable waterways and streams throughout the state.

### *Tidelands Management*

Tidelands Management governs tidelands in New Jersey. Most of these lands are publicly owned and managed by the State of New Jersey. The State acts as trustee for the public, and must administer their use in the public interest. The State exercises control over through direct ownership and through its regulatory role under the Waterfront Development Law. The [Tidelands Resource Council](#) oversees management of New Jersey's tidelands. The DEP advises the Council on these applications relying on the Coastal Management Program as guidance. The DEP Commissioner has the authority to veto any Council action inconsistent with state policy.

### *Regulation and Planning of Energy Facilities*

The DEP has broad planning authority over energy-related matters, including the authority to participate in the decision making of other State agencies concerning the siting of energy facilities. The fact that energy generating and petroleum refining facilities often seek to locate in the coastal zone means that DEP energy authority is a significant element in the management system. DEP recognizes its dual jurisdiction over energy facilities sited in the coastal zone.

### *Shore Protection Act*

The Shore Protection Act (N.J.S.A. 12:6A-1) governs activities related to beach erosion, which is a major concern throughout New Jersey. The DEP is authorized to undertake actions necessary to maintain a static shoreline. In 1977, New Jersey voters approved a \$30 million bond issue to fund state matching grants for shore protection projects (the Beaches and Harbors Bond Act of 1977, P.L. 77-208). The Act required DEP to prepare a comprehensive master plan that would serve as a guide to distribute these grants. This resulted in publication of the N.J. Shore Protection Master Plan, adopted in 1981, with designated shore protection funds that serve the public interest.

### *Pinelands Protection Act*

The [Pinelands Protection Act](#) of 1979 (N.J.S.A 13:18-1 et seq.) permanently preserves an extensive and contiguous area of land in the Pinelands. The Pinelands Commission, as directed by a comprehensive management plan in 1980, implements this mandate. The portion of the proposed reserve within the Pinelands is located entirely within the Preservation Area.

### *New Jersey Coastal Management Program*

The [New Jersey Coastal Management Program](#) (NJCMP) was developed in the 1970s by the DEP. It is comprised of three parts: a coastal boundary; a set of coastal policies, and an implementation plan. To receive federal approval and funding under the CZMA of 1972, states and territories must demonstrate that they have programs with enforceable policies to regulate land uses, water uses, and coastal development, and resolve conflicts among competing uses. In addition, they must have the authority to implement the enforceable policies. The NJCMP received federal approval from the US Department of Commerce in 1978 for the Bay and Ocean Shore segment, and in 1980 for tide-flowing coastal waters (as defined by CAFRA). Regulated activities in these two regions include dredging or filling, construction projects such as docks, piers, pilings, and operation of all-terrain vehicles. In water areas, activities are restricted based upon the environmental sensitivity of the water body.

### Specific Uses for State Lands in the JC NERR

In general, the uses allowed under the landowner management plans for the core and buffer areas are limited to recreational activities such as hunting, fishing, and nature study. More specifically, the uses presently allowed within specific managed parcels are:

### *New Jersey Division of Fish, Game & Wildlife Absecon Wildlife Management Area*

The [Absecon Wildlife Management Area](#) in Atlantic County comprises 3,688 acres. Waterfowl heavily utilize Absecon, which is comprised primarily of salt marsh during the fall and winter months. Many shorebirds nest in the area. Great Bay Boulevard Wildlife Management Area: This area is located in Ocean County south of Tuckerton and includes 4,670 acres of salt marsh. [Great Bay Boulevard](#) is a 4-mile long peninsula separating Great Bay and Little Egg Harbor. The Boulevard is home to waterfowl and nesting shorebirds and used for bird watching, waterfowl hunting, fishing, crabbing, and clamming.

### *Port Republic Wildlife Management Area*

The area contains 755 acres and is located north of Port Republic and west of the Garden State Parkway in Atlantic County on the south bank of the Mullica River. This tract consists of salt marsh and upland-field habitat. The area is used for upland hunting including wild turkey, deer, and waterfowl. The Mullica River is excellent for fishing and Collins Cove is used during winter for ice fishing for white perch. Swan Bay: This tract is located on the north bank of the Mullica River west of the Wading River, and is comprised of 1,078 acres of upland and salt marsh managed primarily for waterfowl hunting.

### *New Jersey Division of Parks & Forestry*

[Bass River State Forest](#): This area covers 29,124 acres in Burlington and Ocean counties. [Wharton State Forest](#): This large tract contains 122,108 acres in Burlington and Atlantic counties. The State Forest permits hunting, fishing, nature study, camping, swimming, hiking, canoeing, boating, and horseback riding. North Brigantine Natural Area covers 677 acres, Absegami Natural Area encompasses 146 acres, and the Great Bay Natural Area covers 395 acres. All areas exist for environmental conservation and have limited uses.

### Federal Regulations

Federal lands within the JC NERR consist of those managed by the USFWS. These lands comprise the [Edwin B. Forsythe National Wildlife Refuge](#), which is a national wildlife refuge spanning 47,000 acres in southern New Jersey. Tracts in the Refuge are managed for different purposes, but all uses support the conservation or enhancement of the Mullica River and Great Bay ecosystems. Uses allowed within the refuge include nature study, hunting, fishing, picnicking, natural areas, boating, hiking, and swimming. Relevant mandates that govern use include the [Endangered Species Act](#), [Migratory Bird Treaty Act](#) and [Clean Water Act](#) including the provisions related to nonpoint source pollution.

#### Other Relevant Regulations

##### *Sewage Infrastructure Improvement Act*

The Sewage Infrastructure Improvement Act (SIIA) was adopted on August 3, 1988. It requires that all municipalities with stormwater systems discharging into the salt waters of Monmouth, Ocean, Atlantic and Cape May counties map their stormwater sewer system. These maps identify all interconnections and cross-connections between the stormwater and sanitary sewer system, and indicate whether the cross-connections have received a permit from the Department. Ultimately, municipalities must abate nonpoint source pollution entering surface waters via a three-phase plan. Phase I: municipalities develop an inventory and preliminary map of their respective stormwater sewer systems. Phase II: municipalities develop a final map of their stormwater/sanitary sewer system. This includes identification of all cross-connections and interconnections, and performance of quarterly monitoring of discharges to salt waters. Municipalities then develop comprehensive stormwater management/nonpoint source pollution control programs during Phase III. Phase III establishes statewide stormwater/nonpoint source control program at the municipal level and implements Section 6217.

##### *The New Jersey State Planning Act of 1986*

The [New Jersey State Planning Act](#) (N.J.S.A. 52:18A-196 et seq.) concerns growth pressures affecting New Jersey. Coastal county planning departments, DEP, the Pinelands Commission, and the Office of State Planning coordinate goals, objectives, and policies with the State's regulatory coastal zone management program. From this process, recommendations were made for coastal counties to adopt growth areas included in the cross-acceptance reports, with DEP then adopting the State Plan's "Planning Areas" as part of the CAFRA rules. The [State Development and Redevelopment Plan](#) (SDRP) also coordinates state, county, municipal and special district activities with respect to the coastal zone.

##### *Barnegat Bay Study Act of 1987*

The [Barnegat Bay Study Act of 1987](#) is a three-part program that permits study of the Barnegat Bay and adjacent watershed. Step One characterizes the health and use of the watershed. Step Two identifies planning goals and objectives and provides an analysis of possible management options for the watershed. Step Three, the Barnegat Bay Watershed Management Plan (June 1993), promotes healthier bay and quality of life. The Barnegat Bay study focuses on a bioregional definition of the study area. Following the National Estuary Program (NEP) as a model, this program is now a part of the NEP and guided by a comprehensive Management Plan.



## CONCLUSION



### **New and Emerging Challenges**

To advance the Vision and meet our Mission, the JC NERR must address a suite of challenges associated with:

- Environmental Change
- New and Emerging Technology
- Increasing Demand for JC NERR Programs and Services/Engagement of New Partnerships and Collaborative Opportunities
- Sustainable Funding in a Dynamic Budget Environment

#### Environmental Change

A key challenge is the emerging threat to reserve lands from environmental change, especially sea level rise. In some areas, no path exists for marsh habitat to migrate. In areas that do offer migratory opportunities, the cost of acquiring lands can be very expensive. Recent levels of PAC funding and Coastal and Estuarine Land Conservation Program (CELCP) funding don't provide enough resources for this purpose. To address environmental change more broadly, JC NERR initiatives will focus on assessing the drivers of environmental change in estuarine ecosystems, including climate change effects (e.g., sea-level rise, erosion and inundation), habitat loss and alteration, eutrophication, and invasive species. To this end, efforts will seek to determine the ecosystem condition of JC NERR estuarine waters, wetlands, and uplands habitat, to delineate the key natural and anthropogenic drivers of change affecting the system, and to develop remedial measures to mitigate impacted habitats for long-term sustainability.



The JC NERR staff will capitalize on innovative remote sensing and observational technologies to track change in ecosystem processes, land use and land cover, and coastal habitats. In addition, SWMP and other data will be compiled and analyzed to assess change in estuarine ecosystem structure, and to function linked to natural and anthropogenic stressors.

To promote the JC NERR as a research platform, the research and monitoring staff has been working to establish an operating sentinel site (i.e., Tuckerton Peninsula) that will support the research and monitoring interests of Rutgers University and JC NERR staff scientists as well as external partners in respect to long-term climate change research and studies targeting anthropogenic effects on coastal systems. To this end, nine surface elevation tables (SETs) are being installed by the JC NERR staff in three segments of the Tuckerton Peninsula salt marsh system. In addition, a tidal station is being installed in the marsh habitat to establish an operating sentinel site system. The SETs are needed to effectively measure the salt marsh elevation change relative to local sea level. Standardized protocols will be followed for connecting SET benchmarks to the NSRS using system geodetic surveying techniques.

Sentinel site projects are ongoing, such as biomonitoring of emergent salt marsh plant communities, mapping of marsh surface features, larval fish studies, and other work. This research is generating critical information for coastal wetland management strategies, along with scientific and economic data, models, and visualization tools to understand projected outcomes under future sea-level rise scenarios. Outcomes of this work include in part environmental decision support that local, state, and federal decision-makers can employ in coastal adaptation planning to enhance resiliency by sustaining coastal marshes, maritime forests, and the vital ecosystem services they provide. More equipment is needed to provide the spatial coverage to assess sea level rise, and the JC NERR (as well as other reserves) must expand this capacity to track other environmental changes of importance to coastal stakeholders (e.g., coastal acidification, invasive species, shifts in biological and habitat diversity, etc.).

Another major effort at the JC NERR with respect to environmental change is to interact more closely with land management agencies. One specific way is through the Seamless Network Initiative that the JC NERR initiated with a variety of federal and state agencies. This network may be expanded to include international partners in the future.

Finally, a key environmental challenge will be to develop timely tools and information that demonstrate the value of coastal and estuarine habitats, and the ecosystem services they provide to communities. A preliminary study is underway at the JC NERR to develop a first order valuation of key habitats to community resilience. More efforts will be required to provide the level of detail and science-based information that communities can use to inform their planning efforts.

#### New and Emerging Technology

Autonomous underwater vehicles (AUVs), small underwater robots capable of operating independently, are increasingly being used to collect physical, chemical, and biological information in the marine environment. Recent efforts have been made to expand this technology by combining it with acoustic telemetry—tagging and tracking animals with sonic tags—to provide information on the distribution and movements of marine fish and other sea life. This information is needed to improve our understanding and management of the marine environment. The JC NERR is currently working towards the integration of a network of passive acoustic (VEMCO) receivers at each of the SWMP stations. These receivers detect acoustically-tagged fish and crustaceans (both resident and migratory) that pass in proximity of stations equipped with these receivers. The integration of SWMP data in these records may yield greater resolution and understanding of the behaviors of ecologically and economically important fauna within

and among reserve waters.

Unmanned aerial systems will be evaluated for their research and data collection applications. The JC NERR is working with NOAA on a project to evaluate the effectiveness of UAS platforms to produce multiple mapping data and products in marsh and dune systems. In addition to this product the JC NERR will be exploring opportunities to partner with the Rutgers University UAS department to collect high resolution aerial imagery and elevation data within the JC NERR. The high-resolution data will aid in habitat classification and change monitoring, resulting in a useful management product for the JC NERR partners.

A hallmark of the Reserve education program is the utilization of real time data (specifically NERRS SWMP and NOAA data) and real-world science and technology in the classroom. Using advanced technologies such as underwater robotics, the Reserve integrates STEM and the marine sciences into its education programs. Underwater robotics (remotely operated and autonomous underwater vehicles) is an excellent mechanism to teach STEM in an exciting and engaging manner as well as other disciplines including history, language, and the arts. Through a number of teacher trainings (NSF-funded Sandy Hook Geosciences, Underwater Robots, Exploration and STEM at the Shore, and Benthic Habitats and Advanced Technologies) we have seen through pre- and post-surveys a dramatic increase in participants' confidence to bring underwater robotics into their classroom and use real-time/near real time data, integrate mathematics into science lessons, use the Engineering Design Process, and use hands-on lessons when teaching science. Reserve staff will continue to identify new applications of undersea technology to support its research, education and stewardship activities.

#### Increasing Demand for JC NERR Programs and Technical Assistance

Partnerships are extremely important to the success of the JC NERR, and have been forged with state coastal programs, protected area networks, county planning offices, and a host of local partners. Outreach and education efforts are supported by the work of the CTP coordinator, education coordinator, and stewardship coordinator, along with resilient community specialists and volunteers in the reserve. In addition, partnerships are being developed to support long-term implementation of sentinel site research and monitoring. The US Fish and Wildlife Service, National Park Service, and other partners are being engaged to collaborate in these research and monitoring efforts.

The demand for JC NERR programs, services, and technical assistance continues to increase. With a relatively small staff, and the likelihood that new resources will not be available to hire additional staff, the Reserve must maintain strong partnerships with existing organizations and identify new partners that can help meet this demand. Reserve staff will have to identify programs that have become “routine” to deliver, work with partners to deliver these, and thus create time to address emerging issues and new program opportunities. Existing partnerships with academic institutions, local, state, and federal agencies, and nongovernmental organizations have been and will continue to be used to meet the increasing demand and support collaborative program efforts across sectors and disciplines. Key partners include New Jersey Sea Grant, NJ Office of Coastal Management, National Park Service, US Geological Survey, US Fish and Wildlife Service, Bloustein School of Planning and Public Policy, Rutgers Department of Marine and Coastal Sciences, Rutgers Center for Remote Sensing and Spatial Analysis, Rutgers Climate Institute, Stockton University, Stevens Institute of Technology, Monmouth University, Edwin B. Forsythe National Wildlife Refuge, Pinelands Preservation Alliance, Partnership for the Delaware Estuary, Barnegat Bay Partnership, Tuckerton Seaport, and Pinelands Commission.

### Engagement of New Partners and Collaborative Opportunities

Recently, the NJDEP increased the staff and scope of the Coastal Management Office. The new staff and leadership at this office have reassessed their niche with coastal professionals and organizations resulting in new relationships and stronger collaborations with a few existing partners such as the JC NERR. The JC NERR seeks to develop this collaboration further to grow the partnership in scope, impact, and effectiveness. Of particular interest will be opportunities to collaborate on coastal resilience, public access, mitigating user conflicts in the coastal zone, and programs that provide training to meet future workforce needs in coastal management, science, education, and stewardship.

Another major partner has been the local National Estuary Program – the Barnegat Bay Partnership (BBP). Through co-sponsored programs and collaborative grant opportunities, the BBP has supported research, education, CTP and outreach programs. A primary focus of the BBP has been the effects of climate change on the resilience of the natural and built communities surrounding Barnegat Bay. As this has been one of the priority topics for the JC NERR, continued partnership on training, technical assistance and outreach initiatives are a natural fit for future collaboration.

Nontraditional partnerships will be explored, particularly with groups that benefit from the work of the Reserve. Examples include hunting and fishing organizations, chambers of commerce, the real estate and insurance industries, and coastal recreation groups.

### Sustainable Funding in a Dynamic Budget Environment

Significant challenges faced by the JC NERR include the lack of growth in the operating budget. This situation compels staff to seek external funding for projects and programs that may not align completely with reserve priorities but do generally benefit coastal stakeholders. The staff is very skilled and successful in leveraging external grants, but when grant responsibilities continue to grow, along with core reserve responsibilities, the demands on staff time and effort can be daunting. Compounding this situation is the demand for the JC NERR staff to accept leadership positions in national organizations and service on NERRS committees, thus stretching the capacity of a relatively thin but highly competent staff that are recognized leaders in their respective fields.

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## REFERENCES

- Able, K. W., T. M. Grothues, J. M. Morson and K. E. Coleman. 2014a. Temporal variation in winter flounder recruitment at the southern margin of their range: Is the decline due to increasing temperatures? H. Hjort Memorial Issue, ICES Journal of Marine Science 71(8):2186-2191 (DOI: 10.1093/icesjms/fsu094).
- Able, K. W., T. M. Grothues, J. T. Turnure, D. M. Byrne, and P. Clerkin. 2012. Distribution, movements, and habitat use of small striped bass (*Morone saxatilis*) across multiple spatial scales. Fishery Bulletin 110:176-192.
- Able, K. W., T. M. Grothues, J. T. Turnure, M. A. Malone, and G. A. Henkes. 2014b. Dynamics of residency and egress in selected estuarine fishes: evidence from acoustic telemetry. Environmental Biology of Fishes. 97(1):91-102.
- Able, K. W., T. M. Grothues, J. L. Rackovan, and F. E. Buderman. 2014c. Application of mobile dual-frequency identification sonar (DIDSON) to fish in estuarine habitats. Northeastern Naturalist 21(2):192-209.
- Able, K. W., J. L. Valenti, and T. M. Grothues. 2017. Fish larval supply to and within a lagoonal estuary: Multiple sources for Barnegat Bay, New Jersey. Environmental Biology of Fishes doi: 10.1007/s10641-017-0595-0.
- Able, K. W., M. Wuenschel, T. M. Grothues, J. Vasslides, and P. Rowe. 2013. Do surf zones in New Jersey provide "nursery" habitat for southern fishes? Marine and Coastal Fisheries 96(5):661-665.
- Biesinger, Z, B. M. Bolker, D. Marcinek, T. M. Grothues, J. A. Dobarro, W. J. Lindberg. 2013. Testing an autonomous acoustic telemetry positioning system. Limnology and Oceanography: Methods 448:46-56.
- Defne, Z. & Ganju, N.K. Estuaries and Coasts (2015) 38: 1719. doi:10.1007/s12237-014-9885-3.
- Eiler, J. H., T. M. Grothues, J. A. Dobarro, and M. M. Masuda. 2014. Comparing autonomous underwater vehicle (AUV) and vessel-based tracking performance for locating acoustically-tagged fish. Marine Fisheries Review 75(4):27-42.
- Fertig, B. M., M. J. Kennish, and G. P. Sakowicz. 2013. Changing eelgrass (*Zostera marina* L.) characteristics in a highly eutrophic temperate coastal lagoon. *Aquatic Botany*, 104: 70-79.
- Fertig, B., M. J. Kennish, G. P. Sakowicz, and L. K. Reynolds. 2014. Mind the data gap: Identifying and assessing drivers of changing eutrophication condition. *Estuaries and Coasts*, 37, (Suppl. 1): S198-S221 doi:10.1007/s1223701397465.
- Gagne, R. 1987. Instructional Technology Foundations. Hillsdale, NJ: Lawrence Erlbaum Association.
- Grothues, T. M., K. W. Able, and J. H. Pravatiner. 2012. Winter flounder (*Pseudopleuronectes*

*americanus* Walbaum) burial in estuaries: Acoustic telemetry triumph and tribulation. *Journal of Experimental Marine Biology and Ecology* 438:125-136.

Grothues, T. M. and W. C. Davis. 2013. Sound Pressure Level Weighting of the Center of Activity Method to Approximate Sequential Fish Positions from Acoustic Telemetry. *Canadian Journal of Fisheries and Aquatic Sciences*. 70(9): 1359-1371(13).

Grothues T. M., A. E. Newhall, J. Lynch, G. Gawarkiewicz, and K. Vogal. 2017. High Frequency Side Scan Sonar Fish Reconnaissance by Autonomous Underwater Vehicle. *Canadian Journal of Fisheries and Aquatic Sciences*. 74(2): 141-146 DOI 10.1139/cjfas-2015-0301.

Kennish, M. J. 2012. Restoration of Estuaries. *Nature (Education)*, 3(11):5.

Kennish, M. J. and B. Fertig. 2012. Application and assessment of a nutrient pollution indicator using eelgrass (*Zostera marina* L.) in Barnegat Bay-Little Egg Harbor Estuary, New Jersey. *Aquatic Botany*, 96: 23-30. Doi:10.1016/j.aquabot.2011.09.005.

Kennish, M. J. and M. Elliott (eds.). 2012. *Human-induced Problems (Uses and Abuses) on Estuaries and Coasts*. Volume 8, Treatise on Estuarine and Coastal Science, Elsevier, Oxford, England. 315 pp.

Kennish, M. J., M. J. Brush, and K. A. Moore (eds.). 2014a. Drivers of Change in Shallow Coastal Photic Systems. *Estuaries and Coasts*, Volume 37, Supplement 1, 242 pp. ISSN 1559-2723.

Kennish, M. J., M. S. Meixler, G. Petruzzelli, and B. Fertig. 2014b. Tuckerton Peninsula salt marsh system: A sentinel site for assessing climate change effects. *Bulletin of the New Jersey Academy of Science*, 59: 1-5.

Kennish, M. J., A. Spahn, and G. P. Sakowicz. 2014c. Sentinel site development of a major salt marsh system in the Mid-Atlantic region. *Open Journal of Ecology*, 4: 77-86. <http://dx.doi.org/10.4236/oje.2014.43010>

Kennish, M. J. (ed.). 2015a. *Encyclopedia of Estuaries*. Springer, Dordrecht, The Netherlands. 760 pp. ISBN: 978-94-017-8800-7.

Kennish, M. J. 2015b. Eutrophication. Pp. 304-311, In: Kennish, M. J., ed., *Encyclopedia of Estuaries*. Springer, Dordrecht, The Netherlands.

Kennish, M. J. (ed.). 2015c. *Encyclopedia of Estuaries*. Springer, Dordrecht, The Netherlands. 760 pp. ISBN: 978-94-017-8800-7.

Kennish, M. J. 2015d. Coastal bays. Pp. 130, In: Kennish, M. J., ed., *Encyclopedia of Estuaries*. Springer, Dordrecht, The Netherlands.

Kennish, M. J. 2015e. Coastal lagoons. Pp. 140-143, In: Kennish, M. J., ed., *Encyclopedia of Estuaries*. Springer, Dordrecht, The Netherlands.

Kennish, M. J. 2015f. Macroalgae. Pp. 387-388, In: Kennish, M. J., ed., *Encyclopedia of Estuaries*.

Springer, Dordrecht, The Netherlands.

Kennish, M. J., G. P. Sakowicz, and B. Fertig. 2016a. Recent trends of *Zostera marina* (eelgrass) in a highly eutrophic coastal lagoon in the mid-Atlantic region (USA). *Open Journal of Ecology* 6:243-253. doi:10.423/oje.2016.65025.

Kennish, M. J., R. G. Lathrop, Jr., A. Spahn, G. P. Sakowicz, and R. Sacatelli. 2016b. The JCNERR sentinel site: research and monitoring applications. *Bulletin of the New Jersey Academy of Science* 61:1-8.

Kennish, M. J. 2017a. Anthropogenic impacts on estuaries, In Finkl, C. W. and C. Makowski, eds., *Encyclopedia of coastal sciences*, 2nd edn. Springer, Dordrecht, The Netherlands. doi:10.1007/978-3-319-48657-4\_140-2.

Kennish, M. J. 2017b. Environmental quality, In Finkl, C. W. and C. Makowski, eds., *Encyclopedia of Coastal Sciences*, 2nd edn. Springer, Dordrecht, The Netherlands. doi:10.1007/978-3-319-48657-4\_135-2.

Kopp, R.E., A. Broccoli, B. Horton, D. Kreeger, R. Leichenko, J.A. Miller, J.K. Miller, P. Orton, A. Parris, D. Robinson, C.P. Weaver, M. Campo, M. Kaplan, M. Buchanan, J. Herb, L. Auermuller and C. Andrews. 2016. Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel. Prepared for the New Jersey Climate Adaptation Alliance. New Brunswick, New Jersey.

Lathrop, R. G., Jr., S. M. Haag, D. Merchant, M. J. Kennish, and B. Fertig. 2014. Comparison of remotely-sensed surveys vs. in situ plot-based assessments of sea grass condition in Barnegat Bay-Little Egg Harbor, New Jersey USA. *Journal of Coastal Conservation* 18:299-308. doi:10.1007/s11852-014-0319-y.

Newhall, A.E., Y. T. Lin, T. M. Grothues, J. Lynch and G. G. Gawarkiewicz. 2016. A method of observing acoustic scattering from fish schools using autonomous underwater vehicles. *IEEE Journal of Oceanic Engineering*. DOI 10.1109/JOE.2016.2552878.

Psuty, N. P., M. Duffy, J.F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR —2010/185. National Park Service, Fort Collins, Colorado.

Psuty, N. P., T. M. Silveira, A. J. Spahn, and D. Skidds. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II - coastal topography. Natural Resource Report NPS/NCBN/NRR—2012/591. National Park Service, Fort Collins, Colorado.

Psuty, N. P., W. J. Schmelz, and A. Spahn. 2017. Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part III – Coastal Landform Elevation Models. Natural Resource Report NPS/HTLN/NRR - 2016/xxx. National Park Service, Fort Collins, Colorado.

Turnure, J. T., T. M. Grothues, and K. W. Able. 2015. Seasonal residency of adult weakfish (*Cynoscion regalis*) in a small temperate estuary based on acoustic telemetry: A local perspective of a coast wide phenomenon. *Environmental Biology of Fishes* 98:1207-1221.



Turnure, J. T., K. W. Able, and T. M. Grothues. 2015. Patterns of intra-estuarine movement in adult weakfish (*Cynoscion regalis*): evidence of site-affinity at seasonal and diel scales. *Fishery Bulletin* 113:167-179.

Yergey, M. E., T. M. Grothues, K. W. Able, C. Crawford and K. DeCristofer. 2012. Evaluating discard mortality of summer flounder (*Paralichthys dentatus*) in the commercial trawl fishery: Developing acoustic telemetry techniques. *Fisheries Research* 115-116:72-81.

## ACRONYMS

ANJEE -	Alliance of New Jersey Environmental Educators
ACS -	American Consumer Survey
AIC -	Aquaculture Innovation Center
AUV-	Autonomous Underwater Vehicle
BB-LEH -	Barnegat Bay-Little Egg Harbor
BBP-	Barnegat Bay Partnership
CAFRA -	Coastal Area Facility Review Act
C2R2-	Coastal Climate Risk and Resilience
CELCP -	Coastal and Estuarine Land Conservation Program
CESU -	Cooperative Ecosystem Studies Unit
COCMP -	Coastal Ocean Currents Monitoring Program
CRSSA -	Center for Remote Sensing and Spatial Analysis
CTP -	Coastal Training Program
CBSM -	Community-Based Social Marketing
CVI -	Community Vulnerability Index
DEP -	Department of Environmental Protection
DOT -	Department of Transportation
ERD -	Estuarine Reserves Division
FEMA -	Federal Emergency Management Agency
GOES -	Geostationary Operational Environmental Satellite
GIS -	Geographic Information Systems
GRF -	Graduate Research Fellow
GTR -	Getting to Resilience
HA -	Hectare
IMCS -	Institute of Marine and Coastal Sciences
IOOS -	Integrated Ocean Observing System
ISD -	Instruction System Design
JC NERR -	Jacques Cousteau National Estuarine Research Reserve
KEEP -	K-12 Estuary Education Program
LISSSER -	Long Island Sound South Shore Estuary Reserve
LOE -	Life on the Edge
MARE -	Marine Activities and Resource Education
MATES -	Marine Academy of Technology and Environmental Sciences
MOA -	Memorandum of Agreement
MOU -	Memorandum of Understanding
MPA -	Marine Protected Area
MRGBE -	Mullica River-Great Bay Estuary

NCBN -	National Coastal Barrier Network
NERRS -	National Estuarine Research Reserve System
NMEA -	National Marine Educators Association
NMPA -	National Marine Protected Areas
NOAA -	National Oceanographic and Atmospheric Administration
NWS -	National Weather Service
NA/MA -	Needs Assessment and Marketing Analysis
NJ -	New Jersey
NJAES -	New Jersey Agricultural Experiment Station
NJCF -	New Jersey Conservation Foundation
NJ DEP -	New Jersey Department of Environmental Protection
NJ DOT -	New Jersey Department of Transportation
NJ FRAMES -	New Jersey Fostering Regional Adaptation through Municipal Economic Scenarios
NJMEA -	New Jersey Marine Education Association
NEPA -	National Environmental Policy Act
NMS -	National Marine Sanctuary Program
NOAA -	National Oceanic and Atmospheric Administration
NOCCI -	National Network for Ocean and Climate Change Interpretation
NPS -	National Park Service
NSRS -	National Spatial Reference System
NWR -	National Wildlife Refuge
NY -	New York
OCA -	Ocean and Coastal Acidification
OSA -	Ocean Science Applications
OCM -	Office for Coastal Management
OMWM -	Open Marsh Water Management
PA -	Pennsylvania
RM -	Research and Monitoring
RPA -	Regional Planning Association
RS -	Remote Sensing
SOC -	Secretary of Commerce
SDRP -	State Development and Redevelopment Plan
SETs -	Surface Elevation Tables
SAV -	Submerged Aquatic Vegetation
SLAMM -	Sea Level Affecting Marsh Migration
STAP -	Scientific and Technical Advisory Panel
STEM -	Science, Technology, Engineering, and Math
SWMP -	System-Wide Monitoring Program
TOTE -	Teachers on the Estuary
TPL -	Trust for Public Lands
UAS -	Unmanned Aerial System
US EPA	US - Environmental Protection Agency
USFWS -	US Fish & Wildlife Service
USGS -	US Geological Survey
VEMCO -	Passive Acoustic Receivers

**APPENDIX A: JC NERR SITE PROFILE**

**The JC NERR Site profile can be found online at the JC NERR website at:**

[http://www.jcnerr.org/pdfs/TCQ\\_siteprofile.pdf](http://www.jcnerr.org/pdfs/TCQ_siteprofile.pdf)

**APPENDIX B – 1: MEMORANDUM OF UNDERSTANDING MANAGING PARTNERS**

Memorandum of Understanding  
Between the  
National Oceanic and Atmospheric Administration and  
The Rutgers University  
Detailing the State-Federal Roles in the Management of the Jacques Cousteau National  
Estuarine Research Reserve

This Memorandum of Understanding (MOU or agreement) establishes the framework for the cooperative management of The Jacques Cousteau National Estuarine Research Reserve (NERR) in the State of New Jersey, between Rutgers University and the National Oceanic and Atmospheric Administration, Office for Coastal Management (NOAA). This agreement supersedes the previous agreement between NOAA and Rutgers University regarding the Jacques Cousteau NERR made on September, 16, 2008.

I. AUTHORITY

The authority for this agreement is the Coastal Zone Management Act of 1972, as amended (CZMA, 16 U.S.C. §§ 1451-65, 1461), and its implementing regulations at 15 C.F.R. Parts 921, 923.

II. BACKGROUND

- A. The State of New Jersey has determined the waters and related coastal habitats of the Mullica River and portions of Barnegat Bay provide unique opportunities for the study of natural and human processes to contribute to the science of estuarine ecosystem processes, enhance environmental education opportunities and public understanding of estuarine areas, and provide a stable environment for research through the long-term protection of reserve resources.
- B. The State of New Jersey has determined that the resources of the Jacques Cousteau NERR and the values they represent to the citizens of New Jersey and the United States will benefit from the management of these resources as part of the National Estuarine Research Reserve System.
- C. The Rutgers University, as the agency designated by the Governor of New Jersey, is responsible for maintaining, operating and managing the Jacques Cousteau NERR in accordance with Section 315 of the CZMA, 16 U.S.C. § 1461, and acknowledges the value of state-federal cooperation for the long-term management and protection of the reserve in a manner consistent with the purpose of its designation.
- D. NOAA finds that the State of New Jersey has satisfied the legal and

procedural requirements for designation and, pursuant to its authority under Section 315 of the CZMA, 16 U.S.C. § 1461, and in accordance with implementing regulations at 15 C.F.R. Part 921, has designated the Jacques Cousteau NERR.

- E. The Jacques Cousteau management plan approved by NOAA describes the goals, objectives, strategies/actions, administrative structure, and institutional arrangements for the reserve, including this agreement and others. In consideration of the mutual agreements herein, NOAA and Rutgers University agree to the following roles indicated in Section III of this agreement.

### III. STATE-FEDERAL ROLES IN RESERVE MANAGEMENT

#### A. Rutgers University Role in Reserve Management

The Rutgers University shall:

1. be responsible for compliance with all federal laws and regulations, and ensure that the Jacques Cousteau management plan is consistent with the provisions of the CZMA and implementing regulations;
2. ensure protection of the natural and cultural resources of the reserve, and ensure enforcement of the provisions of state law and regulations aimed at protecting the reserve;
3. ensure adequate, long-term protection and management of lands and waters included within the reserve boundary;
4. cooperate with NOAA to apply for and manage funds to support the reserve in accordance with federal and state laws, the reserve management plan, annual funding guidance from NOAA, and any other NOAA directives pertaining to reserve operations, research and monitoring, education and stewardship, and, as necessary, land acquisition and reserve facility construction;
5. conduct and coordinate research and monitoring programs that encourage scientists from a variety of institutions to work together to understand the ecology of the reserve ecosystem to improve coastal management;
6. conduct and maintain programs that disseminate research results via materials, activities, workshops, and conferences to resource users, state and local agencies, school systems, the general public, and other interested parties;
7. provide staff and endeavor to secure state funding for the manager, education coordinator, and research coordinator;
8. secure facilities and equipment required to implement the provisions within



the reserve management plan;

9. ensure adequate support for facilities operation and maintenance;
10. maintain effective liaison with local, regional, state, and federal policy makers, regulators, and the general public;
11. serve as principal contact for issues involving proposed boundary changes and/or amendments to the reserve management plan; and
12. cooperate with NOAA regarding review of performance pursuant to Section 312 of the CZMA, 16 U.S.C. § 1458, 15 C.F.R. § 921.40, and ongoing management plan approvals.

#### B. Federal Role in Reserve Management

NOAA's Office for Coastal Management shall:

1. administer the provisions of the Sections 312 and 315 of the CZMA, 16 U.S.C. § 1458 and 16 U.S.C. § 1461, respectively, to ensure that the reserve operates in accordance with goals of the reserve system and the Jacques Cousteau reserve management plan;
2. review and process applications for financial assistance from the Rutgers University, consistent with 15 C.F.R. Part 921, for management and operation of the reserve, and, as appropriate, land acquisition and facility construction;
3. advise Rutgers University of existing and emerging national and regional issues that have bearing on the reserve and reserve system;
4. maintain an information exchange network among reserves, including available research and monitoring data and educational materials developed within the reserve system; and
5. to the extent possible, facilitate the allocation of NOAA resources and capabilities in support of reserve goals and programs.

#### C. General Provisions

1. Nothing in this agreement shall obligate either party in the expenditure of funds, or for future payments of money. Each party bears its own costs to implement this agreement. NOAA may provide Federal funding in accordance with the CZMA and any requirements of the U.S. Department of Commerce through financial assistance awards that are separate from this agreement.
2. A free exchange of research and assessment data between the parties is encouraged and is necessary to ensure success of cooperative studies.

#### D. Other Provisions

1. Nothing in this agreement diminishes the independent authority or coordination responsibility of either party in administering its respective statutory obligations. Nothing in this agreement is intended to conflict with current written directives or policies of either party. If the terms of this agreement are inconsistent with existing written directives or policies of either party entering this agreement, then those portions of this agreement that are determined to be inconsistent with such written directives or policies shall be invalid; but the remaining terms not affected by the inconsistency shall remain in full force and effect. In the event of the discovery of such inconsistency, and at the first opportunity for revision of this agreement, the parties shall seek to amend or terminate this agreement in accordance with the provisions of subsection V of this agreement.
2. Any disagreement on the interpretation of a provision, amendment, or other matter related to this agreement shall be resolved informally at the lowest operating level of each party's respective organization. If such disagreement cannot be resolved, then the area(s) of disagreement shall be stated in writing and presented to the other party for further consideration. If agreement is not reached within thirty (30) days of presentation, then the parties shall forward the written presentation of the disagreement to their respective higher official for appropriate resolution.

#### IV. PROGRAM EVALUATION

In accordance with section 312 of the CZMA, 16 U.S.C. § 1458, and 15 C.F.R. § 921.40, NOAA's Office for Coastal Management will schedule periodic evaluations of Rutgers University performance in meeting the terms of this agreement and the reserve management plan. Where findings of deficiency occur, NOAA may initiate action in accordance with the interim sanctions or withdrawal of designation procedures established by the CZMA and applicable regulations at 15 C.F.R. Part 921, Subpart E.

#### V. EFFECTIVE DATE, REVIEW, AMENDMENT, AND TERMINATION

- A. This agreement is effective on the date of the last signature on this agreement and shall be in effect until terminated by either party.
- B. This agreement will be reviewed periodically by both parties and may only be amended by the mutual written consent of both parties.
- C. This agreement may be terminated by mutual consent of both parties or by unilateral termination by either party. Termination of this agreement may provide grounds for NOAA (at its discretion) to withdraw designation of the reserve from the reserve system, pursuant to applicable provisions of the CZMA and its implementing regulations as described under 15 C.F.R. Parts 921 (Subpart E) and 923 (Subpart

agreement may provide grounds for NOAA (at its discretion) to withdraw designation of the reserve from the reserve system, pursuant to applicable provisions of the CZMA and its implementing regulations as described under 15 C.F.R. Parts 921 (Subpart E) and 923 (Subpart L). Section 315 of the CZMA, 16 U.S.C. § 1461, provides that NOAA may withdraw designation of a National Estuarine Research Reserve if: 1) NOAA finds that any of the criteria for establishing the reserve no longer exist; or 2) a substantial portion of the research conducted within the reserve fails to meet reserve system guidelines. In making any decision to withdraw designation, NOAA will take into consideration factors set forth in 15 C.F.R. § 921.40.

- D. If any clause, sentence, or other portion of this agreement shall become illegal, null, or void for any reason, the remaining portions of this MOU shall remain in full force and effect.
- E. No waiver of right by either party of any provision of this agreement shall be binding unless expressly confirmed in writing by the party giving the waiver.

IN WITNESS THEREOF, the parties have caused this agreement to be executed.



Jeffrey L. Payne, Ph.D.  
Director  
Office for Coastal Management  
National Ocean Service  
National Oceanic and Atmospheric  
Administration  
U.S. Department of Commerce



Bradley Hillman  
Research Director  
New Jersey Agricultural  
Experiment Station  
Rutgers, The State  
University of New Jersey

July 23, 2018

Date

8/20/19

Date



Diane Ambrose, Ph.D.  
Director  
Office of Research and Sponsored Programs  
Rutgers, The State University of New Jersey

8/16/18

Date

MOA-2018-116/11686

## **APPENDIX B – 2: MEMORANDUM OF UNDERSTANDING TUCKERTON SEAPORT**

**Memorandum of Understanding between Rutgers, the State University and Tuckerton Seaport Regarding the Operation of the Jacques Cousteau National Estuarine Research Reserve Visitor Center and the "Life on the Edge" Exhibit**

Given the mutual benefit to Rutgers, the State University (hereinafter "Rutgers") through its New Jersey Agricultural Experiment Station, as owner and operator of the "Life on the Edge" public exhibit (hereinafter "the Exhibit") at the Jacques Cousteau National Estuarine Research Reserve (hereinafter "JC NERR") Interpretive Center (hereinafter "the Exhibit Space"), and to the Tuckerton Seaport, 120 West Main Street, Tuckerton, New Jersey (hereinafter "Seaport"), owner and operator of the Visitor Center at Seaport in Tuckerton, New Jersey, a joint partner with Rutgers in JC NERR, Rutgers and Seaport hereby enter into this Memorandum of Understanding for the operation of the Exhibit and the Exhibit Space in the Seaport Visitor Center building. Rutgers, the State University is an instrumentality of the State of New Jersey. Tuckerton Seaport and Baymen's Museum is a project of the Barnegat Bay Decoy and Baymen's Museum, a 501(c)(3) non-profit organization.

It is mutually agreed between Rutgers and Seaport that the following terms and conditions shall govern the operation of the Exhibit and the Exhibit Space at the Seaport Visitors Center building:

1. Provision of Space. Seaport shall provide the entire third floor, including the closet, of the Visitor Center building of Seaport without charge to Rutgers for the purpose of accommodating the Exhibit Space, and the Exhibit and Exhibit Space staff. The public will be informed by Seaport of free access to the Exhibit Space and the Exhibit all times Seaport is open, and it will be promoted as an integral part of Seaport experience.
2. Staffing of Exhibit and the Exhibit Space. Rutgers will provide an Exhibit interpreter tasked with education and outreach tours of the Exhibit and the Exhibit Space, as determined by Rutgers.
3. Cooperation to Ensure Maximum Use of Both Facilities. The Exhibit interpreter will refer all interested persons and groups to the Seaport Director or Director of Education and Exhibits should they wish to schedule a combined tour/program to Seaport with a tour/program at the Exhibit and the Exhibit Space. Similarly, Seaport personnel in regular contact with the public, will refer all interested persons and groups to the Exhibit interpreter should they wish to combine a visit to the Exhibit and Exhibit Space with a visit to Seaport. When

special requests are made to access the Exhibit during times when Seaport is ordinarily closed, Seaport will endeavor to arrange access for JC NERR staff, visitors and/or contractor(s) to the Visitor Center building for the duration of the visit. To further enhance the joint use of the facility, Rutgers and Seaport will cooperate in developing and delivering themed programs that promote the commonality of Seaport and JC NERR missions.

4. Maintenance/Repairs. Rutgers will provide periodic cleaning of the Exhibit and the Exhibit Space. Light cleaning of the Exhibit and Exhibit Space (removal of finger prints, touch-up of Exhibit paint, etc.) shall be the responsibility of Rutgers. Repair or replacement of any part of the Exhibit will be the responsibility of Rutgers. Repair or replacement of any part of the structural elements, fixtures and permanent appurtenances of the Exhibit Space including but not limited to the heat, ventilation and air conditioning systems, windows, doors, floors and ceiling tiles will be the responsibility of Seaport. However, RU will explore opportunities for external grant funding for major repairs in collaboration with the Tuckerton Seaport.
  
5. Insurance and Indemnification. Throughout the term of this agreement, Rutgers will maintain the following insurance:
  - a. Property insurance covering against physical loss or damage to its exhibit and the components thereof to the extent that such physical loss or damage is not attributable to the Seaport.
  
  - b. Commercial general liability insurance with minimum combined single limit of liability of \$1,000,000 per occurrence for bodily injury, death or property damage caused by Rutgers operation and maintenance of the exhibit.

Throughout the term of this agreement Seaport agrees to maintain commercial general liability insurance with minimum limits of \$1,000,000 per occurrence covering liability arising out of its ownership and maintenance of the Seaport Visitor Center premises. Seaport also agrees to maintain all risks property insurance covering the building.

Rutgers agrees to hold harmless and indemnify Seaport from and against claims for bodily injury, death or property damage directly resulting from its operation and maintenance of the "Life on the Edge" exhibit.

6. Utilities. All utilities for the Exhibit Space (gas, electric, and internet access) shall be provided without charge by Seaport to Rutgers.
  
7. Signage. All signage in the Exhibit Space must be approved by Rutgers. All signage pertaining to the Exhibit and Exhibit Space on Seaport Property must be approved by Seaport.
  
8. Control of Exhibit and Exhibit Space. Rutgers shall control the use of the Exhibit and the Exhibit Space, including the usage and settings of all Exhibit equipment (e.g., the map table, lighting fixtures, the I Pledge Booth, and projectors.)
  
9. Use of JCNERR Logo. All usage of the JC NERR logo by Seaport must receive prior written approval by Rutgers.
  
10. Advertising of Exhibit and Exhibit Space. Efforts should be made to include the Exhibit and Exhibit Space in Seaport advertising. All advertising of the Exhibit and Exhibit Space by Seaport must receive the prior approval of Rutgers. In particular, all mention of the Exhibit and Exhibit Space must prominently include a notice that admittance to the Exhibit and Exhibit Space is free at all times. Value added programs may charge a nominal fee to offset costs and the fee should be included in any related advertisement.
  
11. Funding. Funding to offset costs for value added programs as amended to this MOU will be determined on a case-by-case basis.




12. Termination. This MOU is effective as of the date of signatures of all parties, and will continue in full force until termination. Either party may terminate this agreement upon six (6) months written notice to the other party. This MOU replaces the original one at the signing of this replacement.

13. Modifications. Proposals to modify the terms of the MOU can be initiated in writing by either of the parties and are subject to written approval by each of the parties. Education, outreach, or research themes may be introduced at any time by agreement of all parties and will be addenda to this MOU.

Agreed:

Rutgers, the State University  
New Jersey Agricultural Experiment Station

By: 

Bradley Hillman  
Director


Date: 8/20/18

By: 

Diane Ambrose, Ph.D.  
Director, Office of Research and Sponsored Programs

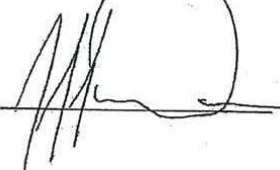
Date: 8/16/18

Tuckerton Seaport

By: 

Brooke Salvanto  
Director

Date: 7/28/18

By: 

Jeff Daum  
President, Tuckerton Seaport Board of Trustees

Date: 7.26.18

## **APPENDIX B – 3: MEMORANDUM OF UNDERSTANDING LAND MANAGEMENT PARTNERS**

**MEMORANDUM OF UNDERSTANDING**  
**Among**  
**New Jersey Agricultural Experiment Station at**  
**Rutgers, The State University of New Jersey**  
**and**  
**U.S. Fish and Wildlife Service**  
**and**  
**New Jersey Department of Environmental Protection**  
**and**  
**New Jersey Pinelands Commission**  
**and**  
**New Jersey Conservation Foundation**

I. PURPOSE

This Memorandum of Understanding (MOU) serves to establish the framework for coordination, cooperation and communication among the New Jersey Agricultural Experiment Station ("NJAES") at Rutgers, The State University of New Jersey, U.S. Fish and Wildlife Service ("USFWS"), the New Jersey Pinelands Commission ("Pinelands Commission"), the New Jersey Department of Environmental Protection ("NJDEP") and New Jersey Conservation Foundation ("NJCF") (hereinafter referred to collectively as the "Cooperators" and individually referred to as a "Cooperating Party") for the purposes of research, education and outreach, training and stewardship concerning the Jacques Cousteau National Estuarine Research Reserve ("JC NERR"). Specifically, the purpose of this MOU is to provide for advancement of estuarine conservation, and coordination, and implementation of research, education, outreach and training concerning the importance and stewardship of the estuarine resources within the JC NERR.

Recitals

WHEREAS, the pristine waters and related coastal habitats of the Mullica River and the Great Bay estuary provide representative opportunities to study natural estuarine and human processes occurring within an estuarine ecosystem; and

WHEREAS, the resources of the Mullica River and the Great Bay estuary and the values they represent to the citizens of New Jersey and the United States will benefit from the management of this area as part of the National Estuarine Research Reserve System; and

WHEREAS, the National Estuarine Research Reserve System is a partnership program between the National Oceanic and Atmospheric Administration and the coastal states established by the federal Coastal Zone Management Act; and

WHEREAS, the Mullica River-Great Bay has been designated a National Estuarine Research Reserve in New Jersey, known as the JC NERR; and

WHEREAS, the New Jersey Agricultural Experiment Station at Rutgers, The State University of New Jersey, is the agency designated pursuant to the JC NERR Management Plan as being responsible for managing the JC NERR and acknowledges the need and requirement for continuing State-Federal cooperation in the long-term management of the JC NERR in a manner consistent with the purposes supporting its designation; and

WHEREAS, the majority of the JC NERR is located in the Pinelands National Reserve;

NOW THEREFORE, in consideration of the mutual agreements contained herein, the Cooperators hereby agree as follows:

II. OBJECTIVES OF THIS MOU

1. To stimulate public awareness of the Mullica River-Great Bay ecosystem and its cultural history through research, education, public information and long-term protection of JC NERR resources.
2. To address significant coastal management issues through coordination of estuarine research, education and public information activities in the JC NERR.
3. To promote use of the JC NERR by Federal, State, public and private entities, and nongovernmental organizations for research relevant to coastal management needs and education regarding estuarine resources.
4. To provide research and education training opportunities at the graduate, undergraduate and pre-collegiate levels across a broad base of scientific fields that focus on the patterns and processes governing change and stability in estuarine systems in the JC NERR
5. To make recent findings, discoveries, facts, literature and research results available to resource managers, land owners, other researchers, outdoor recreationalists, educators, Federal, State and local agencies, and other interested members of the public.
6. To disseminate research findings through the publication of reports, bulletins, circulars, films, journal and magazine articles, public information exhibits and programs. These may include scientific and popular media.
7. Research and education activities will be designated to meet priorities defined in the JC NERR Management Plan and the Environmental Impact Statement prepared for the JC NERR.

III. AUTHORITY

A. Rutgers University - New Jersey Agricultural Experiment Station

Rutgers NJAES is responsible for the implementation of the JC NERR Management Plan and serves as the principal contact with NOAA for the State of New Jersey in all matters concerning the JC NERR. NJAES is authorized by the laws of the State of New Jersey to enter into agreements with the Federal and State Governments or agencies thereof, in order to promote the research and educational objectives of the University.

B. U.S. Fish and Wildlife Service

The USFWS has trust responsibility for fish, wildlife and plants, many of which are endangered species, migratory birds, and anadromous and inter jurisdictional fish species, which are concentrated in, or heavily dependent on coastal land and marine habitats. The USFWS is responsible for managing about 500 National Wildlife Refuges including the Edwin B. Forsythe National Wildlife Refuge. The USFWS is authorized pursuant to 16 USC 753(a) to enter into cooperative agreements with colleges and universities, states and private organizations for the purpose of developing adequate, coordinated, cooperative research and training programs for fish and wildlife services.

C. New Jersey Department of Environmental Protection

The NJDEP administers comprehensive environmental protection and management programs and large tracts of public lands dedicated for recreational and resource management purposes. The NJDEP has authority to regulate development within tidally flowed waters, coastal and freshwater wetlands and uplands within and surrounding the JC NERR. The NJDEP is authorized by the laws of the State of New Jersey to enter into agreements to investigate questions relating to natural resources, to initiate and conduct inquiries concerning these resources and to conduct or sponsor research to manage, conserve, improve and enhance the status of natural resources in the State of New Jersey. The NJDEP is the designated lead agency for the federally approved New Jersey Coastal Management Program.

#### D. New Jersey Pinelands Commission

The Pinelands Commission is an independent political subdivision of the State of New Jersey created pursuant to Section 4 of the Pinelands Protection Act, N.J.S.A. 13:18A-1 et seq., and charged with implementing the requirements of the Act. The Pinelands Commission is also the planning entity authorized in Section 502 of the "National Parks and Recreation Act of 1978" (Federal Act). The Comprehensive Management Plan sets for the policies adopted by the Pinelands Commission to protect, preserve and enhance the significant values of the land and resources of the Pinelands Area. Development within the Pinelands National Reserve must be consistent with the intent, policies and objectives of the Federal Act and the Pinelands Protection Act as articulated in the Pinelands Comprehensive Management Plan. The Pinelands Commission is authorized by the Pinelands Protection Act at N.J.S.A. 13:18A-6.g. to enter into any and all agreements or contract, execute any and all instruments, and do and perform any and all acts or things necessary, convenient, or desirable for the purposes of the Pinelands Commission or to carry out any power expressly given in the Act.

#### E. New Jersey Conservation Foundation

The mission of New Jersey Conservation Foundation is to preserve New Jersey's land and natural resources for the benefit of all. NJCF is a private, not-for-profit organization that relies on philanthropic support and grants from a variety of public and private organizations and individual donors. Through acquisition and stewardship NJCF protects strategic lands, promotes strong land use policies, and forges partnerships to achieve conservation goals. Since 1960, NJCF has protected over 100,000 acres of natural areas and farmland in New Jersey. NJCF has been active in land preservation in the New Jersey Pine Barrens region for over three decades and owns and manages more than 12,000 acres in the Heart of the Pine Barrens.

#### I. COOPERATORS MUTUALLY AGREE:

- A. Contingent upon available financial and staffing support, the Cooperators shall:
  - i. Coordinate programs, especially those which require the assistance of volunteers or volunteer groups;
  - ii. Cooperate in the planning, development and execution of research, education, training, and the preparation of publications, demonstration programs and public information programs;
- B. Each Cooperator shall have complete responsibility for injury to its own personnel and damage to its own property occurring incidental to the conduct of the Cooperators. Each Cooperator will be responsible for any injury or property damage to third parties caused by negligence of its own employees, students or agents acting legitimately within the scope of their

employment, studies or activities. Any responsibility/liability pursuant to this paragraph shall be limited and governed by the New Jersey Tort Claims Act (N.J.S.A. 59:1-1 et seq.; and

- C. All equipment purchased by or for the use of the Cooperators shall be the property of the contributing agency in the event of dissolution of the MOU, unless otherwise agreed. An equipment inventory indicating ownership, costs and condition of each item under the auspices of the Cooperators shall be maintained by the purchasing agency and made available annually to the Cooperators activities as provided by applicable federal and/or State law.
- IV. NJAES Obligations:
- A. Contingent upon the availability of sufficient financial resources and staffing support, NJAES agrees to:
    - 1. Oversee the management responsibilities of the JC NERR with the advice of the JC NERR Advisory Committee which is comprised of representatives from each of the Cooperators.
    - 2. Make available such personnel and facilities, including equipment, buildings and land under its control, as may be mutually agreed upon for implementation of activities conducted under the terms of this MOU.
- V. USFWS' Obligations:
- 1. Contingent upon the availability of sufficient financial resources as a result of its appropriation from the U.S. Congress and sufficient staffing support, USFWS agrees to:
    - 1. Make available such personnel and facilities, including equipment, buildings and land under its control, as may be mutually agreed upon for implementation of activities conducted under the terms of this MOU.
- VI. NJDEP Obligations:
- A. Contingent upon the availability of sufficient financial resources as a result of its appropriation from the State Legislature and sufficient staffing support, NJDEP agrees to:
    - 1. Make available such personnel and facilities, including equipment, buildings and land under its control, as may be mutually agreed upon for implementation of activities conducted under the terms of this MOU.
- VII. NEW JERSEY PINELANDS COMMISSION Obligations:
- A. Contingent upon the availability of sufficient financial resources as a result of its appropriation from the State Legislature and sufficient staffing support, the Pinelands Commission agrees to:
    - 1. Make available such personnel and facilities, including equipment, buildings and land under its control, as may be mutually agreed upon for implementation of activities conducted under the terms of this MOU.
- VIII. NEW JERSEY CONSERVATION FOUNDATION Obligations:
- A. Contingent upon the availability of sufficient financial resources and sufficient staffing support, the New Jersey Conservation Foundation agrees to:

1. Make available such personnel and facilities, including equipment, buildings and land under its control, as may be mutually agreed upon for implementation of activities conducted under the terms of this MOU.

IX. PUBLICATIONS

- A. The principal investigator (PI) designated for the conduct of a specific project being supported by the Cooperators shall have the primary responsibility for the quality of work being submitted for publication, as well as for adherence to the publication guidelines of the cooperating agency supporting the project. Each Cooperator shall be given the opportunity to review, prior to publication, all publications arising from work sponsored or coordinated under this MOU with that time limited to 30 days. Publication restrictions that may be incorporated into grant or contract research will be observed recognizing that NJAES does not accept grants that prohibit publication of results. Upon request, any PI working under the terms and conditions of this MOU will provide to any cooperating agency, prior to publication, a copy of any manuscript resulting from JC NERR activities; Publications may be independent or joint as agreed upon always giving credit for cooperation of the Cooperators and contributing agencies yet recognizing, within proper limits, the rights of the individual(s) doing the work.
- B. In case of failure to agree as to the manner of publication or interpretation of results, each party may publish data after due notice and submission of the proposed manuscripts to the other parties. In such instances, the party publishing the data will give credit to the Cooperators, but will assume full responsibility for any statements on which there is a difference of opinion.

X. OFFICIALS NOT TO BENEFIT

- A. As provided in applicable Federal and State statutes, no person prohibited from doing so shall be admitted to any share or part of this agreement or to any benefit that may arise therefrom.

XI. NONDISCRIMINATION IN EMPLOYMENT

- A. In connection with the performance of work under this agreement the Cooperators agree not to discriminate against any employee or applicant for employment because of ancestry, age, sexual orientation, physical or mental disability, marital, military or veteran status, gender, race, religion or national origin. This provision shall include but not be limited to the following: employment, promotion, demotion or transfer, recruitment or recruitment advertising, lay-off or termination, rates of pay or other forms of compensation, and selection for training or apprenticeship.

XII. EFFECTIVE DATE AND TERMINATION

- A. This agreement shall become effective on the date of last signature and shall continue in force for five (5) years from its effective date unless extended by mutual consent in writing by all Cooperators 90 day in advance of such termination or terminated at any time by any or all of the Cooperator(s) in accordance with Paragraph XII.B below. The terms and conditions of this agreement may be amended by mutual consent in writing by all of the Cooperators.



- B. This agreement may be terminated at any time through mutual agreement of all Cooperators in writing 90 days prior to the effective date of the termination or by any Cooperator following 90 days written notice to the other Cooperators in advance of the effective date of such termination.

IN WITNESS WHEREOF, the parties hereto have caused this Memorandum of Understanding to be executed on this XX day of XXX, 2017.

\_\_\_\_\_  
Brad Hillman  
Research Director  
New Jersey Agricultural Experiment Station  
Rutgers – The State University of New Jersey

Date: \_\_\_\_\_

\_\_\_\_\_  
Virginia Rettig  
Refuge Manager  
Edwin B Forsythe National Wildlife Refuge  
U.S. Fish and Wildlife Service

Date: \_\_\_\_\_

\_\_\_\_\_  
Catherine McCabe  
Commissioner  
New Jersey Department of Environmental Protection

Date: \_\_\_\_\_

\_\_\_\_\_  
Nancy Wittenberg  
Executive Director  
New Jersey Pinelands Commission

Date: \_\_\_\_\_

\_\_\_\_\_  
Michele S. Byers  
Executive Director  
New Jersey Conservation Foundation

Date: \_\_\_\_\_

## **APPENDIX C: FEDERAL CONSISTENCY DETERMINATION**



State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION  
Division of Land Use Regulation  
P.O. Box 420  
Trenton, New Jersey, 08625  
www.state.nj.us/dep/landuse

CHRIS CHRISTIE  
Governor

KIM GUADAGNO  
Lt. Governor

BOB MARTIN  
Commissioner

DEC 08 2017

Nina Garfield  
Program Specialist  
National Ocean and Atmospheric Administration  
NOS, Office for Coastal Management  
1305 East West Highway, SSMC4/10<sup>th</sup> Floor  
Silver Spring, MD 20910

RE: Federal Consistency Determination  
File No.: 1532-04-0014.1 CDT 170001  
Jacques Cousteau National Estuarine Research Review (JCNERR) 2017-2022 Management Plan

Dear Ms. Garfield:

The New Jersey Department of Environmental Protection, Division of Land Use Regulation, acting under Section 307 of the Federal Coastal Zone Management Act (P.L. 92-583) as amended, agrees with the certification that the above referenced management plan is consistent with the approved New Jersey Coastal Management Program.

Specifically, the project consists of revisions to the existing management plan for the JCNERR. Conservation, research, education, and management activities associated with JCNERR management plan are consistent with New Jersey's Rules on Coastal Zone Management N.J.A.C. 7:7-1.1 et seq., (as amended on September 18, 2017). However, if JCNERR is conducting any regulated activities at their facility, then they will need to receive the necessary permits and comply with the applicable rules.

**This consistency determination is issued subject to compliance with the following conditions.**

1. This consistency determination does not obviate the JCNERR from obtaining any other necessary federal, state or local approvals.

This Federal Consistency is authorized pursuant to all parties following the guidelines set forth, and agreed upon, for the construction of the proposed structures.

Pursuant to 15 CFR 930.44, the Division reserves the right to object and request remedial action if this proposal is conducted in a manner, or is having an effect on, the coastal zone that is substantially different than originally proposed.

Thank you for your attention to and cooperation with New Jersey's Coastal Zone Management Program. If you have any questions regarding this determination, please do not hesitate to call Kara Turner of our staff at (609) 633-2289.

Sincerely,

  
\_\_\_\_\_  
Ryan J. Anderson, Manager  
Division of Land Use Regulation

12/8/17  
\_\_\_\_\_  
Date

c: Kim Springer, Office of Policy Implementation

**APPENDIX D: RESPONSE TO REVIEW FROM PARTNERS AND PUBLIC REVIEW**



cost is provided for an initial 20-year period. Projections of when certain actions could occur are provided based on five year increments. Assuming all recovery actions are implemented, the cost of the first 20 years of recovery is approximately \$236 million. Given a generation time for sDPS green sturgeon of approximately 22 years, a substantial increase in adult abundance in response to habitat-based recovery actions may not be observed for 66–88 years. Additional funds will thus likely be needed to monitor adult abundance after the first 20 years, with a total added projected cost of \$25–40 million.

Many of the most costly recovery actions (e.g., barrier removal, increased enforcement, addressing entrainment at diversions) have multi-species benefits and may be covered under recovery efforts for other species. For example, the recovery plan for ESA-listed Central Valley salmonids (NMFS 2014b) includes recovery actions designed to improve watershed-wide processes that will likely benefit sDPS green sturgeon by restoring natural ecosystem functions. Specific actions to improve delta habitat, remove barriers, and reduce entrainment could aid in the recovery of sDPS green sturgeon and reduce the recovery plan cost by \$17 million.

We are unable to quantify the economic benefits of sDPS green sturgeon recovery actions, but full recovery or delisting will provide multiple benefits to the ecosystem and economy. Delisting of the sDPS will enhance fishing opportunities by lifting fisheries restrictions aimed at reducing direct or incidental sDPS mortality. The ESA regulatory burden will also be eased for fisheries, water resource, industrial, and commercial activities. Accomplishing the habitat restoration measures will also result in more functional ecosystems that support other economic activities and contribute to delisting of other species.

#### References Cited

The complete citations for the references used in this document can be obtained by contacting NMFS (see ADDRESSES and FOR FURTHER INFORMATION CONTACT) or online at: [http://www.westcoast.fisheries.noaa.gov/protected\\_species/green\\_sturgeon/green\\_sturgeon\\_pg.html](http://www.westcoast.fisheries.noaa.gov/protected_species/green_sturgeon/green_sturgeon_pg.html).

Authority: 16 U.S.C. 1531 *et seq.*

Dated: January 4, 2018.

**Angela Somma,**  
Chief, Endangered Species Conservation  
Division, Office of Protected Resources,  
National Marine Fisheries Service.

[FR Doc. 2018–00208 Filed 1–8–18; 8:45 am]

BILLING CODE 3510–22–P

#### DEPARTMENT OF COMMERCE

##### National Oceanic and Atmospheric Administration

##### National Estuarine Research Reserve System

**AGENCY:** Office for Coastal Management, National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

**ACTION:** Notice of public comment period for the Jacques Cousteau National Estuarine Research Reserve Management Plan revision.

**FOR FURTHER INFORMATION CONTACT:** Nina Garfield at (240) 533–0817 or Kim Teixeira at (240) 533–0781 of NOAA's Office for Coastal Management, 1305 East-West Highway, N/ORM5, 10th floor, Silver Spring, MD 20910.

**SUPPLEMENTARY INFORMATION:** Notice is hereby given that the Office for Coastal Management, National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce is announcing a thirty-day public comment period for the Jacques Cousteau National Estuarine Research Reserve Management Plan revision. Pursuant to 15 CFR 921.33(c), the revised plan will bring the reserve into compliance. The Jacques Cousteau Reserve revised plan will replace the plan approved in 2009.

The revised management plan outlines the administrative structure; the research/monitoring, stewardship, education, and training programs and priorities of the reserve; plans for a proposed future boundary expansion through inclusion of past and future land acquisition; and facility development priorities to support reserve operations.

The Jacques Cousteau Reserve takes an integrated approach to management, linking research and education, coastal training, and stewardship functions. The Rutgers University has outlined how it will administer the reserve and its core programs by providing detailed actions that will enable it to accomplish specific goals and objectives. Since the last management plan, the reserve has: Provided technical expertise to coastal communities to reduce risks to natural

hazards; expanded monitoring programs; installed a sentinel site for monitoring marsh ecosystem response to sea level rise; upgraded exhibits; conducted training workshops; implemented K–12 education programs; purchased a marsh; installed a trail; and promoted reclamation of ghost crab pots.

The total number of acres within the boundary is 116,116 acres, which is a modification of the original 114,665 acres identified in the previous management plan. The revised acreage is a result of updated mapping techniques rather than a boundary expansion resulting from inclusion of new habitats. The revised management plan will serve as the guiding document for the Jacques Cousteau Reserve for the next five years.

NOAA's Office Coastal Management will be conducting an environmental analysis in accordance with the National Environmental Policy Act on the proposed approval of the Reserve's revised management plan. The public is invited to provide comment or information about any potential environmental impacts of the proposed action, and these comments will be used to inform the decision making process.

View the Jacques Cousteau Reserve Management Plan revision at ([https://jcnerr.org/JCNERR\\_MNGMTPLAN\\_2018to2023.pdf](https://jcnerr.org/JCNERR_MNGMTPLAN_2018to2023.pdf)) and provide comments to the Reserve's Assistant Manager, Lisa Auermuller ([auermull@marine.rutgers.edu](mailto:auermull@marine.rutgers.edu)).

#### Keelin Kuipers,

Acting Deputy Director, Office for Coastal Management National Ocean Service, National Oceanic and Atmospheric Administration.

[FR Doc. 2018–00182 Filed 1–8–18; 8:45 am]

BILLING CODE 3510–08–P

#### CONSUMER PRODUCT SAFETY COMMISSION

##### Sunshine Act Meeting Notice

**TIME AND DATE:** Monday, January 8, 2018; 1:00 p.m.\*

**PLACE:** Hearing Room 420, Bethesda Towers, 4330 East West Highway, Bethesda, MD 20814.

**STATUS:** Commission Meeting—Closed to the Public.

**MATTER TO BE CONSIDERED:** Compliance Matter: The Commission staff will brief the Commission on the status of a compliance matter.

\* The Commission unanimously determined by recorded vote that Agency business requires calling the meeting without seven calendar days advance public notice.

## Comment 1

**From:** "Mangum, Michael" <[MMangum@co.ocean.nj.us](mailto:MMangum@co.ocean.nj.us)>

**Date:** Thursday, March 29, 2018 at 11:17 AM

**To:** Michael De Luca <[deluca@marine.rutgers.edu](mailto:deluca@marine.rutgers.edu)>

**Cc:** "Agliata, Tony" <[TAgliata@co.ocean.nj.us](mailto:TAgliata@co.ocean.nj.us)>

**Subject:** RE: Request for comments on Cousteau Reserve Management Plan

Hi Mike

Thanks for including Ocean County in the review for your new JCNERR'S management plan. You and your staff have done an outstanding job putting this new plan together with limited resources. It is very detailed and thorough. We continue to support all your efforts as they affect Ocean County. The data and mapping you collect is very useful for our management purposes as well as professional training for our staff. While I did not read it word for word, I took an hour or so to review the plan. It is both comprehensive and detailed and outlines clear objectives that make sense. One thing that may be beneficial would be a more detailed description of some of the archeological/cultural resources that are protected/threatened in the Reserve, i.e. Native American sites (The Great Bay Blvd shell mound remnant, Osborne Island, etc.) , and Revolutionary War Sites including the Mullica River ship Wrecks that Stockton has identified. (At least one I believe is on the National Register). The only other thing I noticed is I believe Wharton now has over 120,000 Acres and Bass River may have more as well. Good Luck

Mike

## Michael T. Mangum

Director

Ocean County Dept. of Parks & Recreation

732-506-9090

[mmangum@co.ocean.nj.us](mailto:mmangum@co.ocean.nj.us)

**From:** Michael De Luca [<mailto:deluca@marine.rutgers.edu>]

Sent: Thursday, March 29, 2018 9:33 AM

**To:** [elizabeth.semple@dep.nj.gov](mailto:elizabeth.semple@dep.nj.gov); [nick.angarone@dep.nj.gov](mailto:nick.angarone@dep.nj.gov); Stan Hales <[shales@ocean.edu](mailto:shales@ocean.edu)>; [mmdoyle@ocean.edu](mailto:mmdoyle@ocean.edu); [brookeS@tuckertonseaport.org](mailto:brookeS@tuckertonseaport.org); [virginia\\_rettig@fws.gov](mailto:virginia_rettig@fws.gov); [peter.straub@stockton.edu](mailto:peter.straub@stockton.edu); Evert, Steven <[Steven.Evert@stockton.edu](mailto:Steven.Evert@stockton.edu)>; Peter Rowe <[prowe@njseagrant.org](mailto:prowe@njseagrant.org)>; Richard Lathrop <[lathrop@crssa.rutgers.edu](mailto:lathrop@crssa.rutgers.edu)>; [carleton@pinelandsalliance.org](mailto:carleton@pinelandsalliance.org); Mangum, Michael <[MMangum@co.ocean.nj.us](mailto:MMangum@co.ocean.nj.us)>; Agliata, Tony <[TAgliata@co.ocean.nj.us](mailto:TAgliata@co.ocean.nj.us)>; [Nancy.Wittenberg@njpines.state.nj.us](mailto:Nancy.Wittenberg@njpines.state.nj.us)

**Cc:** Lisa Auermuller <[auermull@marine.rutgers.edu](mailto:auermull@marine.rutgers.edu)>

**Subject:** Re: Request for comments on Cousteau Reserve Management Plan

Friends and colleagues,

Please use the link below to access the draft Management Plan. Thanks again in advance for your willingness to provide comments on the draft plan.



Best,

Mike

[https://jcnerr.org/JCNERR\\_REVISEDMGMTPLAN%20 Final MOUs.fed%20consistency.pdf](https://jcnerr.org/JCNERR_REVISEDMGMTPLAN%20Final%20MOUs.fed%20consistency.pdf)

**From:** Michael De Luca <[deluca@marine.rutgers.edu](mailto:deluca@marine.rutgers.edu)>  
**Date:** Wednesday, March 28, 2018 at 3:38 PM  
**To:** "[elizabeth.semple@dep.nj.gov](mailto:elizabeth.semple@dep.nj.gov)" <[elizabeth.semple@dep.nj.gov](mailto:elizabeth.semple@dep.nj.gov)>, "[nick.angarone@dep.nj.gov](mailto:nick.angarone@dep.nj.gov)" <[nick.angarone@dep.nj.gov](mailto:nick.angarone@dep.nj.gov)>, Stan Hales <[shales@ocean.edu](mailto:shales@ocean.edu)>, "[mmdoyle@ocean.edu](mailto:mmdoyle@ocean.edu)" <[mmdoyle@ocean.edu](mailto:mmdoyle@ocean.edu)>, "[brookeS@tuckertonseaport.org](mailto:brookeS@tuckertonseaport.org)" <[brookeS@tuckertonseaport.org](mailto:brookeS@tuckertonseaport.org)>, "[virginia.rettig@fws.gov](mailto:virginia.rettig@fws.gov)" <[virginia.rettig@fws.gov](mailto:virginia.rettig@fws.gov)>, "[peter.straub@stockton.edu](mailto:peter.straub@stockton.edu)" <[peter.straub@stockton.edu](mailto:peter.straub@stockton.edu)>, "Evert, Steven" <[Steven.Evert@stockton.edu](mailto:Steven.Evert@stockton.edu)>, Peter Rowe <[prowe@njseagrant.org](mailto:prowe@njseagrant.org)>, Richard Lathrop <[lathrop@crssa.rutgers.edu](mailto:lathrop@crssa.rutgers.edu)>, "[carleton@pinelandsalliance.org](mailto:carleton@pinelandsalliance.org)" <[carleton@pinelandsalliance.org](mailto:carleton@pinelandsalliance.org)>, "[MMangum@co.ocean.nj.us](mailto:MMangum@co.ocean.nj.us)" <[MMangum@co.ocean.nj.us](mailto:MMangum@co.ocean.nj.us)>, "[tagliata@co.ocean.nj.us](mailto:tagliata@co.ocean.nj.us)" <[tagliata@co.ocean.nj.us](mailto:tagliata@co.ocean.nj.us)>, "[Nancy.Wittenberg@njpines.state.nj.us](mailto:Nancy.Wittenberg@njpines.state.nj.us)" <[Nancy.Wittenberg@njpines.state.nj.us](mailto:Nancy.Wittenberg@njpines.state.nj.us)>  
**Cc:** Lisa Auermuller <[auermull@marine.rutgers.edu](mailto:auermull@marine.rutgers.edu)>  
**Subject:** Request for comments on Cousteau Reserve Management Plan

Dear friends and colleagues,

As partners of the Jacques Cousteau National Estuarine Research Reserve, you are cordially invited to review and comment on the draft 2018-2022 Management Plan for the Reserve. The document is posted on the Reserve website at [https://jcnerr.org/JCNERR\\_REVISEDMGMTPLAN\\_Final\\_MOUs.pdf](https://jcnerr.org/JCNERR_REVISEDMGMTPLAN_Final_MOUs.pdf)

The draft is rather comprehensive and includes significant boilerplate material required by NOAA, plus a great deal of descriptive material to characterize the habitats and natural resources of the Reserve. What will be most helpful to us will be your comments or suggestions with respect to the priority mission, strategies and objectives for each of the core programs, research, coastal training, education and stewardship. These are presented in the section beginning on page 27.

We do have a timetable to complete the review process and as such it would be most appreciated if you could send us your comments no later than April 17, 2018.

Thank you in advance for your kind consideration of this request and please do contact me with any questions you may have.

All the best,

Mike

Mike De Luca  
Senior Associate Director  
Office of Research, NJAES  
Rutgers University  
88 Lipman Drive  
New Brunswick, New Jersey 08901

Manager, Jacques Cousteau National  
Estuarine Research Reserve

Director, Aquaculture Innovation Center

President, National Association of Marine  
Laboratories

Chair, Legislative Affairs  
National Estuarine Research Reserve Association

## **RESPONSE 1**

Text was added on page 20, under History, that address the additional historic/cultural artifacts within JC NERR. The acreage for Bass River & Wharton (page 110) were also updated.

## Comment 2

27 April 2018

Mr. Michael DeLuca, JCNERR Manager, and  
Senior Associate Director  
Office of Research, NJAES  
Rutgers University  
88 Lipman Drive  
New Brunswick, New Jersey 08901

Dear Mr. DeLuca,

Thank you for the opportunity to provide feedback on the Jacques Cousteau National Estuarine Research Reserve (JCNERR) draft 2018-2022 Management Plan (Plan). The draft pulls together and synthesizes the considerable work activities of the JCNERR staff, affiliated Rutgers researchers, and your many partners over the past few years; in addition, the draft provides a justification and framework for the priorities of your research, education, stewardship and outreach programs over the next 5 years. The Barnegat Bay Partnership (BBP) and JCNERR have worked together closely throughout our common history. I hope the following comments are useful to the JCNERR and help strengthen the already strong partnership between our respective community-based programs, which have been recognized as a national model of collaboration by NOAA's National Estuarine Research Reserve System and EPA's National Estuarine Program leadership teams in presentations to the Congressional Estuary Caucus this past year.

### JCNERR Priorities

Two of the three priorities (*i.e.*, Improve resilience of coastal ecosystems and communities to anthropogenic and natural drivers of environmental change, and Monitor response of coastal ecosystems to habitat change and alteration) are well articulated and described in the Plan. The last priority (*i.e.*, Develop processes governing connectivity of habitats and communities from watershed to ocean) identifies a critical concept (habitat connectivity); however, the "processes" appear somewhat uncertain and may need additional clarification.

### Research and Monitoring

I applaud the JCNERR for the quality and production of its research and monitoring efforts over its history, including the past five years. As a result of many efforts, we know much more about the condition of the Barnegat Bay-Little Egg Harbor ecosystem and its biotic resources. Some of your priorities over the next few years make use of some emerging technologies that have considerable potential to address some priority problems (*i.e.*, shoreline erosion, marsh loss) in our post-Sandy world. Others address important regional information needs, as estuaries in the Mid Atlantic are experiencing diverse stressors changing with climate (*e.g.*, coastal acidification, sea level rise) and still experiencing considerable population growth and/or coastal development. Several new JCNERR monitoring efforts (*e.g.*, marsh plant monitoring, marsh surface mapping) also represent significant opportunities to expand our collaborative efforts and might have the potential to generate additional funding important to both of our programs in the current uncertain funding climate. For example, the BBP recently installed a weather station within the JCNERRS Study Area, at one of our Mid-Atlantic Coastal Wetland Assessment sites located on a Little Egg Harbor marsh complex on the USFWS EB Forsythe National Wildlife Refuge.

### Promoting a More Resilient Coast: Coastal Training and Education and Outreach Programs

We recognize the high quality of JCNERR’s training, education, and outreach programs. The Coastal Training Program (CTP) is exemplary and widely recognized throughout the region by local elected officials, other community leaders, and environmental organizations and businesses. We often participate in the CTP in some fashion, and whole-heartedly support the focus of the CTP on Coastal resilience. We look forward to helping develop and support other online tools, as we have in the past (*i.e.*, <http://www.prepareyourcommunitynj.org/>), to address storm impacts and assist communities to better prepare for the future changes and threats along the Jersey Shore. Your education and outreach programs, which are tailored to both traditional (K-12) and local audiences (*e.g.*, the large number of senior communities in Ocean County) make good use of your great venues (*e.g.*, Tuckerton Seaport Life on the Edge, Grassle Marsh) and novel tools and technologies developed through Rutgers (*e.g.*, autonomous vehicles, Flood Mapper).

### **Boundary Expansion**

I see both opportunities and challenges presented by your potential boundary expansion to include the Barnegat Bay, which would result in the inclusion of all estuarine waters within the Barnegat Bay Partnership’s Study Area within the boundaries of the JCNERR Study Area. While we acknowledge the general hydrological justification presented in the draft Plan, several partners have questioned whether the proposed expansion is consistent with the NERRS mission to provide a national “reference” system. As noted in the NERRS Strategic Plan, “...These [NERRS] estuaries are relatively undisturbed ....”). Also, as noted in your draft Plan, the Barnegat Bay, especially its northern reaches, represents somewhat more degraded conditions from the rest of the JCNERR’s waters.

Our partners have expressed some concerns that the proposed expansion of the boundaries may also present some issues for both of our programs in these times of uncertain federal funding and wonder if it might be best to hold off any decision regarding your inclusion of the Barnegat Bay into the JCNERR Study Area. As you are probably aware, the BBP has proposed to review its Study Areas boundaries as part of the ongoing revision of its Comprehensive Conservation and Management Plan. Your proposal has emphasized the importance of our carefully considering any changes to the BBP’s Study Area; perhaps we should jointly consider and discuss the possible benefits and impacts to both our programs?

In summary, despite our uncertainty about the boundary issue, we think your proposed Plan provides a strong foundation for the JCNERR over the next five years. Please let us know if you have any questions or wish to discuss any of our comments further. We look forward to working with you.

Sincerely,  
L. Stanton Hales, Jr., Ph.D.  
Director

cc: Karen Greene, NOAA Habitat Conservation Division, BBP Advisory Committee Co-Chair  
Barbara Spinweber, EPA R2 BBP Regional Coordinator

## **Response 2**

**Develop processes governing connectivity of habitats and communities from watershed to ocean:** This should read “Develop an understanding of processes...”. That alone might clarify a bit since the development of understanding differs greatly from the development of a process. Further, processes that effect habitat connectivity include ocean and estuarine circulation features that deliver and re-distribute propagules (such as seeds, eggs, and larvae), detritus, and nutrients, or that block connectivity (such as by

the development of anoxic or hypoxic zone); fish migrations and their proximal and ultimate drivers; ranging and exploratory behavior of individual animals; bathymetric bottlenecks; predator distribution and abundance; disproportionate habitat-specific mortality; operation, development, or removal of anthropogenic structures such as culverts, water diversions and dams; and ecological traps (such as erroneously attractive roadways).

**Boundary Expansion:** The JC NERR is not actively pursuing expansion of the reserve boundary at this time. The inclusion of the Barnegat Bay in its entirety is a placeholder in the event an opportunity arises for acquisition or future research opportunities in the next 5 years. The interest in the northern part of the Bay stems from the practicality of including the entire Bay and associated watershed as a system. The research opportunities are associated with comparing the heavily-used and populated northern Bay with the less populated and natural state of the southern Bay, as well as the decommissioning of the Oyster Creek Nuclear Generating Station. Both present excellent study opportunities that could receive support from NERRS sources such as the Science Collaborative. Additionally, existing and future outreach and training programs will continue across the watershed, in partnership with the BBP and other partners. So again, the boundary expansion is not proposed, but rather a placeholder in the Management Plan should future opportunities arise. Of course, any potential expansion will be discussed thoroughly with our Partners in the Barnegat Bay Partnership.

## JC NERR MANAGEMENT PLAN UPDATE WEBINAR

The webinar was hosted on May 10, 2018.

### **Participants**

#### JCNERR Staff

Lisa Auermuller  
Greg Sakowicz  
Andrea Habeck  
Mozt Grothues  
Mike Kennish  
Mike DeLuca  
Ida Louise Scott  
Kaitlin Gannon

#### Partners and Guests

Liz Semple - Coastal Management Program - New Jersey Department of Environmental Protection  
Stan Hales – Barnegat Bay Partnership  
Stephanie Specht –Ocean County Planning  
Tony Agliata – Ocean County Planning  
Ken Able – Rutgers University Marine Field Station

A video recording of the webinar can be found at:

<https://recordings.rna1.blindsidenetworks.com/rutgers/fc2e6f7f372f56e73a615b237bea5aee25e6a466-1525967625939/capture/>