Reserve Management Needs

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Collaborative research and catalyst projects supported by the National Estuarine Research Reserve System (NERRS) Science Collaborative must address a management need of one or more reserves. This document is a compilation of the current management needs within NOAA's reserve system. Management needs are submitted by reserve managers and updated on an annual basis. This reserve management needs summary supports the development of proposals in response to 2020 NERRS Science Collaborative Request for Proposals.

Science Collaborative focus areas and reserve management needs reflect both NOAA and reserve priorities set forth in the NERRS Strategic Plan (climate change, water quality and habitat protection) as well as individual reserve management needs at the local level.

Science Collaborative Focus Areas:
These management needs are consistent with one or several of the Science Collaborative focus areas, which are:

- **Climate change:** Research and monitoring related to biophysical, social, economic and behavioral impacts of habitat change resulting from climate change and/or coastal development.
- **Ecosystem services:** Understanding how an ecosystem service approach can be utilized to support the protection and restoration of estuarine systems.
- **Water quality:** Understanding the impacts of land use change, eutrophication, and contamination in estuarine ecosystems and the options for management and mitigation.
- **Habitat restoration:** Investigating options for improving estuarine habitat resilience; processes for identifying, prioritizing, and restoring sites; and monitoring and evaluating success.
- **Monitoring data synthesis:** Syntheses of long-term monitoring data and information, originating from programs such as the NERRS System-wide Monitoring Program and associated monitoring efforts, to develop regional and national data products that address coastal management priorities for the NERRS and NOAA.

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Summary Table: Priority reserve management needs mapped with Science Collaborative focus areas.
Click on each reserve's name to read about their specific management needs.

Reserve	Climate change	Ecosystem services	Water quality	Habitat restoration	Monitoring data synthesis
Caribbean					
Jobos Bay, Puerto Rico	■			■	■
Great Lakes					
Lake Superior, WI	■	■	■	■	
Old Woman Creek, OH	■	■	■	■	■
Gulf					
Apalachicola, FL	■				■
Grand Bay, MS	■	■	■	■	■
Mission-Aransas, TX	■	■	■	■	■
Rookery Bay, FL	■	■	■	■	■
Weeks Bay, AL	■	■	■	■	■
Mid Atlantic					
Chesapeake Bay, MD	■		■	■	■
Chesapeake Bay, VA	■	■	■		■
Delaware	■		■	■	
Hudson River, NY	■	■	■		
Jacques Cousteau, NJ	■	■		■	
Northeast					
Great Bay, NH	■		■	■	■
Narragansett Bay, RI	■		■	■	■
Wells, ME	■	■	■	■	■
Waquoit Bay, MA	■	■	■	■	
Pacific Islands					
He'eia	■	■	■	■	■
Southeast					
ACE Basin, SC	■		■	■	
Guana Tolomato Matanzas, FL	■	■	■	■	■
North Carolina	■			■	■
North Inlet – Winyah Bay, SC	■		■	■	■
Sapelo Island, GA	■	■		■	■
West Coast					
Elkhorn Slough, CA	■		■	■	
Kachemak Bay, AK	■	■	■	■	■
Padilla Bay, WA	■	■	■	■	
San Francisco Bay, CA	■	■	■	■	■
South Slough, OR	■	■	■	■	■
Tijuana River, CA	■	■	■	■	■

Reserve Management Needs, By Region

Caribbean Region

Jobos Bay Reserve, Puerto Rico
Climate change Ecological-economic-livelihood assessment of mangroves: Mangroves are a key component of coastal ecosystems including human settlements. It interacts with seagrass and coral reefs ecosystems by interchanging nutrients, food, and fauna that in absence of any of those will result in a misbalance. An important part of the threats is anthropic pressure. Managers need to understand the extent of knowledge that residents have, what is the valorization of mangroves ecosystem and how they visualize how much of their resilience against climate change comes from coastal ecosystems.
Habitat restoration Mangroves provide socio-economical and ecological benefits that account for the entire ecosystem health. It has been affected by poor watershed management and by natural processes such intense storms. There is a need to understand factors and drivers that affect its resilience and how they help other ecosystems resilience as well including the human settlements.
Monitoring data synthesis Understanding environmental responses to climate and anthropic pressure: Jobos Bay reserve has a long term monitoring program that gathered water quality, meteorological, and biological data which its analysis may help to identify processes and drivers of environmental response. Managers need this data to be process in order to identify such processes and model it to forecast best management practices. List reserve management need if relevant.

Great Lakes Region

Lake Superior Reserve, Wisconsin
Climate change Understanding how climate change is influencing lake level change and flooding, the impacts of climate change on the health and restoration of freshwater estuarine and coastal habitats, and how climate change impacts public use of and benefits from the Reserve.
Ecosystem services As a means of measuring the success or impact of delisting the St. Louis River Area of Concern, assessing the sense of place and quality of life before and after delisting in neighborhoods that are proximal to (or more dependent on) remediated or restored areas of the estuary. This could be done in cooperation with other Great Lakes Areas of Concern.
Water quality • The St. Louis River is one of the largest tributaries of Lake Superior, and its large watershed includes diverse land uses, including mining, hydropower, forestry, agriculture, and urban areas. A better understanding of land use impacts on the river is needed to assess current contributing factors and future risks.

- Lake Superior has recently been experiencing bluegreen algae blooms, but the mechanisms driving these events are not well known. Developing the methodologies to better understand the role that estuaries and rivers play in these blooms would provide crucial tools for future management.

Habitat Restoration

Shoreline stabilization is an area of growing concern in the region, and understanding what natural stabilization practices are feasible, and where they can be effective, would be beneficial to land managers and owners. Currently, a lack of evidence-based practice using natural features leads to a hesitancy to apply stabilization methods.

Old Woman Creek Reserve, Ohio

Climate change

Identifying decision-making challenges to long-term implementation of agricultural best management practices when farmers are not the landowners.

Ecosystem services

Engaging stakeholders in landscape-scale implementation and evaluation of wetland restoration and enhancement for water quality improvement in Ohio's Lake Erie Black Swamp region.

Water quality

- Quantifying the relative contributions of septic versus agricultural sources of nutrients to the Old Woman Creek watershed for prioritizing and targeting nutrient reduction practices.
- Understanding different socioeconomic uses and degradation of natural resources; specifically, different uses of fisheries resources in Lake Erie in the context of human health and food security.

Habitat restoration

A Great Lakes inventory for identifying suitable sites for nature-based shorelines, prioritizing their objectives, and monitoring/evaluating their success, given high wave energy systems and landowners have different requirements and goals.

Monitoring data synthesis

Synthesis products to use in comparison with site-based monitoring data, to form a more cohesive message that resonates regionally and nationally - for example, products that can effectively and quickly compare climate, species, and vegetation data across regions.

Gulf Coast Region

Apalachicola Reserve, Florida

Climate change

- Better understand the linkages between ecosystem services and our local community well-being and values (socio-economic data). Conduct ongoing monitoring of pertinent socio-economic indicators to determine the changes over time, especially in regards to restoration projects. Outcomes: convene a social science working group. Grow capacity to conduct social science research in the Gulf. Establish metrics/measures of socio-economic data that are appropriate for use at multiple locations.
- Investigate the “tropicalization” of the Reserve. Compare trends across the Gulf and southeastern US. Explore the implications of these changes as they may affect the management of our natural resources. Collaborate with regional researchers on mangrove migration and expansion dynamics. Investigate shifting coastal ecosystems

and mechanism for the shifts (climate, storm events?) Explore community perceptions on occurrences of tropical plants, pests, and wildlife diversity.

Monitoring data synthesis

- Develop an adaptive management plan for the oyster fishery based on anthropogenic and climatic drivers or develop a broad-based Bay Management plan (for all of the fisheries) utilizing seafood workers as the primary stakeholders. What are their concerns? What strategies do they see as valid ways to address these concerns? What novel techniques could aid in restoration of the bay?
- Better understand the trophic linkages/interactions between organisms within the river and bay. We need an in-depth analysis of our system-wide environmental and biological data to identify and define key linkages. Elucidate the potential changes or impacts to these linkages based on reduced freshwater flows and/or climate change.

Grand Bay Reserve, Mississippi

Climate change

- Projects that study ecological processes related to resilience to climate change such as sediment dynamics, hydrology, prescribed fire/wildfire effects, invasion by foreign species, storm frequency and intensity, vegetation response/tropicalization.
- Projects that study the effectiveness of nature-based infrastructure to increase community and ecosystem resilience related to climate change.
- Projects that look at freshwater inflows associated with Bonnet Carre opening associated with landscape change in upper watershed v. change in precipitation.

Ecosystem services

- Projects that perform an ecosystem services valuation of the Reserve's habitats.
- Projects that lead to a better understanding of the linkages between ecosystem services and our local community well-being and values (socio-economic data).
- Projects that develop capacity at the NERRs to collect pertinent socio-economic indicators.
- Projects that conduct ongoing monitoring of pertinent socio-economic indicators to determine the change over time, especially in regard to NRDA/RESTORE projects.
- Projects that conduct discrete social science studies e.g., visitor/resource use and behavior, local economic impact of visitors, community relations, etc.

Water quality

- Projects that study water quality in terms of nutrient load associated with MS Phosphates.
- Projects that study water quality in terms of fecal coliform, including bacterial source tracking and recommendations for water quality improvements.
- Projects that study water quality in terms of Harmful Algal Blooms, including the relationship with freshwater inflows from opening the Bonnet Carre spillway.
- Projects that model water and sediment transport between Mobile Bay, MS Sound, and Grand Bay.
- Projects that study nonpoint source pollution in the upper Grand Bay estuary to the Escatawpa River.

Habitat restoration

- Projects that study different treatments on invasive species, e.g. comparing the efficacy of herbicides vs. grazing vs. prescribed burning.
- Projects that study the changes in ecological processes (e.g., sediment flow) associated with large-scale wet pine savanna restoration.

Monitoring data synthesis

- Projects that synthesize monitoring information from the Grand Bay reserve and address critical coastal management questions.
- Projects that utilize monitoring data associated with SWMP and effectiveness monitoring in education and outreach to teach natural resource management and critical thinking

Mission-Aransas Reserve, Texas

Climate change

- Identify climate change impacts: The Reserve is subjected to numerous impacts from climate change, including: a relative sea level rise rate of 5.2mm per year, our location in an area where intense drought followed by heavy rains frequent, our close proximity to the 6th largest port in the United States in terms or port tonnage, and our low topography with a history of hurricanes. We currently have much open space that is prime candidate for habitat transitions, and are also home to multiple small coastal towns with an increase in developed land and population levels. The Reserve needs to identify the predicted impacts due to climate change and determine mitigation strategies to subsequently relay that information to decision makers. Some of the major research needs for climate change include the loss of wetland to open-bay systems, ecosystem changes in response to sea level rise, ocean acidification impacts, tropicalization of the south Texas coast due to fewer hard freezes and the range extension of tropical species, especially displacement of marshes by mangroves.
- Engage local communities in coastal resiliency planning: The Reserve needs to engage local communities in resiliency efforts through training and technical support of the use of resiliency indices, initiatives, or other needs as identified through engagement with each municipality. The Reserve should continue to remain responsive to community needs to help mitigate the effects of climate change including specific support to flood- and storm-related resiliency projects.

Ecosystem services

- Describe and communicate ecosystem services: The value (monetary or non-monetary) humans place on specific habitats, processes, and fisheries influences the direction of protection and mitigation strategies for a region. The Reserve needs to identify these values and use this information to educate local decision- and policy- makers to help protect the habitats and processes associated with the most valued or at-risk ecosystems. The Reserve also needs to determine how both human and ecologically-based valuation strategies can be used to support restoration and conservation projects, and link those values to help justify project development and implementation.
- SWMP and Sentinel Site data: The Reserve needs to utilize SWMP and sentinel site data to inform proposed research of benefit to our priority issues and initiatives and make these data relevant and accessible to resource managers.

Habitat restoration

- Protect key habitats: Wave, current and ship wake erosion, subsidence, sea level rise, storms, and human development have changed the landscape of the reserve. We need to identify the most vulnerable habitats that are in decline (such as oyster reefs, fresh- and saltwater marsh, rookery islands, tidal flats, seagrass beds) and work to protect these areas in sustainable ways.
- Link declining fish, bird, and migrating species to habitat loss/change: Within the Reserve, the populations of several species have declined over the past 50 years, including the reddish egret, the piping plover, snowy plover and all species of sea turtles. We have seen an increase in whooping crane numbers over the past 50 years, however the population is still endangered as the wild migrating population only consists of around 300 individuals. Commercial and recreationally important species populations also have many risks, and understanding how populations change with change in habitat is critically important in how we manage future growth around the Reserve. The Reserve needs to determine the reasons behind specific species population

decline and work on strategies to protect these species from further decline, including habitat protection in key spawning, nesting, or feeding locations. Finally, identification of critical pollinator habitat, invasive species priority areas, examine the ecological functioning of restored systems, and other initiatives that have management implications is extremely important in the Mission-Aransas Reserve.

- Implement green infrastructure practices: The Reserve will support efforts to stabilize shorelines in sustainable ways, such as through living shorelines or green infrastructure. Nature-based solutions to resiliency and shoreline stabilization, along with the support through training or project feasibility/development assistance should continue at the Reserve.
- Understand effects of hydrological alterations to hydrodynamics of estuaries: The Reserve is located next to the sixth largest port in the U.S. in terms of shipping tonnage. The channels created to allow for ship and barge traffic traverse the Reserve in multiple locations. Deepening and dredging of the channels and intracoastal waterway, and a deep stabilized channel open to the Gulf of Mexico are alterations that need to be researched to understand their impacts on larval fish recruitment and spawning grounds/activity in estuaries.

Monitoring data synthesis

- Assess and manage freshwater inflows: South Texas is known for extreme droughts. Reservoir construction in the southern and northern watersheds outside of the reserve has exacerbated drought-related impacts, including reduced nutrient and sediment-transport to the bays as well as higher salinities. The Reserve needs to improve our understanding of these processes and identify key factors regulating and determining fresh water inflow to our bays, including impacts of nutrient loading and microbial transformations. We also need to asses ecological consequences of natural and anthropogenic variations in freshwater inflow that could lead to large changes in food webs and plant communities.
- Improve storm water management to better water quality: The Reserve should work to assist communities develop plans and projects that improve storm water runoff and address non-point source pollution. Drainage issues in local areas due to nuisance flooding can help inform the development of these projects and help improve the water quality of storm water runoff into our bays and estuaries. Land change over time through development creates more impermeable surfaces, further exacerbating drainage and storm water-related issues. Addressing projects that help mitigate these problems will be of benefit to the Reserve.
- Marine debris research: The Reserve completed a study in 2019 that shows the Mission-Aransas Reserve Gulf facing beaches have 10 times the amount of trash accumulation that any other beach surveyed in the Gulf of Mexico. Marine debris, including microplastics, is a growing concern in the Reserve and future studies should look at ecological impacts of plastics on the environment and biological communities.
- Understanding harmful algal blooms (HABs): The Reserve has several species of HABs that pose a risk to both ecological processes and human health. Research needs to be conducted to better predict conditions causing these HABs and ways to protect human health.

Rookery Bay Reserve, Florida

Climate change

Concurrent effects of freshwater inflow and sea level rise on coastal habitats: Multiple watersheds that connect to the Rookery Bay and Ten Thousand Island embayments have been modified via canals and control structures, affecting seasonal freshwater input to coastal vegetation and estuarine habitats. Natural sheet flow restoration projects are under design and/or implementation phases; however, ongoing sea-level rise and coastal flooding events will likely interact with the anticipated restoration effects. Managers in southwest Florida seek a greater understanding of the integrative impacts of freshwater management and sea level rise on habitat change, salinity regimes, and community structure and production.

Ecosystem services

Effect of storms on natural systems and human communities: Coastal wetlands and uplands perform critical ecosystem services that include storm buffering, flood reduction, and economic support. Sub-tropical systems periodically undergo spatial, biological, and physical changes from storm events. Managers need a comprehensive understanding on the resilience and recovery regimes of connected natural systems and human communities after major storm events and within the context of environmental change. Human-ecosystem connectivity models and/or socio-economic vulnerability indices across diverse communities will help identify priority issues and management techniques to promote community prosperity, safety, and enjoyment of the resource.

Water quality

Effects of land use and hydrologic connections on water quality: Southwest Florida has experienced harmful algal bloom (HAB) events; however, few HABs have been recently detected in Rookery Bay reserve. Coastal managers require an understanding of the hydrodynamic system and potential drivers of HAB events within Rookery Bay and the Ten Thousand Islands, including watershed-scale land use, groundwater movement, estuarine circulation, and drivers and trends of estuarine nutrient concentrations.

Habitat restoration

Development of new tools and technology to assess environmental change: Rookery Bay reserve has conducted extensive vegetation and benthic habitat mapping, but episodic events such as storm impacts result in rapid change that cannot easily be captured by traditional mapping techniques. We are looking for novel tools and techniques that incorporate event modeling, 3D structure surveys, remote sensing and aerial imagery to assess the impacts of historic or potential stress events on ecosystem structure and function to identify and prioritize vulnerable habitats.

Monitoring data synthesis

Incorporating long-term wildlife and environmental monitoring with habitat: Rookery Bay reserve has conducted long-term monitoring of water quality and wildlife populations within the reserve and has recently invested in passive monitoring infrastructure for faunal communities (i.e., acoustic telemetry of fish and sharks and MOTUS tower establishment). Preliminary data have demonstrated connections of wildlife populations across the Caribbean and Gulf of Mexico as well as local habitat use. Further use and enhancement of these networks and long-term monitoring data will enable habitat-specific management for local and migratory wildlife.

Weeks Bay Reserve, Alabama

- Perspective investigators can communicate topics of research directly with Dr. Scott Phipps, Weeks Bay reserve research coordinator, at scott.phipps@dcnr.alabama.gov.
- More details relating to issues of concern at the Weeks Bay reserve can be found in research and monitoring section of the Weeks Bay NERR Management Plan, page 127.

Climate change

Research is needed that indicate management strategies designed to increase the ability of coastal habitats to migrate in the face of Sea-Level Rise. In addition, the Reserve needs investigation of potential for incorporating Carbon in ecosystem services projects (Carbon Cycle Research), and support efforts that look to engage in carbon finance options that are relevant to our local habitats.

Ecosystem services

- Describe and communicate ecosystem services: The value (monetary or non-monetary) humans place on specific habitats, processes, and fisheries influences the direction of protection and mitigation strategies for a region. The Reserve needs to identify these values and use this information to educate local decision- and policy- makers to help protect the habitats and processes associated with the most valued or at-risk ecosystems.

- A Visitor Use Study for the Reserve would tell us more about who is coming, what they are doing, and what economic value visiting the Reserve brings to them or the community. The Reserve also needs to determine how both human and ecologically-based valuation strategies can be used to support restoration and conservation projects, and link those values to help justify project development and implementation.

Water quality

Research is needed to assist in understanding the impacts of land use change with a focus on mitigation and restoring wetland, shoreline and estuarine habitats.

In looking at impacts and land use change, focus areas could include:

- Research designed to relate Harmful Algal Blooms (HABs) to their causes.
- Research and monitoring that tracks or determines the sources of contaminants.
- Ecology of manmade impoundments in coastal flatwoods/pine savannah;
- Development of a decision support tool to determine a restoration cost/benefit analysis;
- Understanding impacts of shoreline stabilization and cost/benefits to coastal ecology; and
- Boundary effects of shoreline stabilization to adjacent properties in residential scale projects.

Habitat restoration

Research is needed that studies the ecological processes related to resilience - sediment dynamics, hydrology, fire, invasives, storm frequency and strength, vegetative responses to changing conditions and others. In addition, development of a hydrological cycling model is needed to inform coastal flatwoods restoration practices (i.e. prediction of change in transpiration/residence time resulting from canopy reduction and fire).

Monitoring data synthesis

The Reserve needs to utilize SWMP and sentinel site data to inform proposed research of the benefit to our priority issues and initiatives and make these data relevant and accessible to resource managers. A synthesis of this and other related data would be useful in building a collective picture of long term

estuarine dynamics.

Mid-Atlantic Region

Chesapeake Bay Reserve, Maryland

Climate change

- The Maryland Department of Planning as part of the state's Adaptation and Resilience Workgroup was tasked to establish a plan to adapt to saltwater intrusion which will be available in early 2020. Additional research and recommendations are needed to inform an approach to addressing saltwater intrusion impacts in the State and Mid-Atlantic region. The Chesapeake Bay Maryland reserve is looking to specifically to support research gaps identified in the agriculture, wetlands, and forest sectors.
- Environmental Justice issues have been gaining a greater amount of attention in Maryland, but more information is needed on learning, outreach, and communication approaches to ensure that underserved communities are given the assistance needed to prepare for and adapt to the impacts of climate change.

Water quality

We have a good understanding of nutrient and sediment water quality issues in the Chesapeake Bay and this data has informed management actions through the Bay TMDL, but other water quality issues are continually identified in our estuary such as PCBs, road salt usage, and marine debris, therefore additional information is needed to assess potential threats and investigate mitigation and outreach strategies for emerging water quality concerns.

Habitat restoration

There is a need to prioritize tidal wetland restoration and conservation to enhance coastal resilience, not only at the local level, but at a regional scale as well. Research and decision-making tools are needed to inform marsh persistance and migration strategies through land acquisiton, restoration, and partnership opportunities. Specifically, additional research is needed to advance the knowledge and practice of thin layer application of dredged sediment to wetlands challenged by increasing sea level rise and/or changing water levels.

Monitoring data synthesis

Research Reserves and associated Sentinel Site Cooperatives have been collecting site-specific data to better understand sea level rise and coastal innudation issues. However additional synthesis and "packaging" of data is needed to ensure that end users/decision-makers are able to understand and use this network of data to inform coastal decision -making.

Chesapeake Bay Reserve, Virginia

Climate change

Several critical York River estuary ecosystems (i.e., emergent tidal wetlands and associated upland ecotones, underwater grass beds) are sensitive to and vulnerable to short-term, stochastic and longer-term, large-scale climate factors; most often cited stressors include relative sea level rise (of which local land subsidence is significant), salt water intrusion, increasing temperatures, enhanced storm damage and spread of invasive species. These stressors and associated impacts on ecosystems (and key species) need to be better described/quantified and integrated into ecosystem vulnerability assessments and forecasting models so as to support effective natural resource management.

Ecosystem services

In a concerted effort along with ecosystem vulnerability and forecasting, research that advances the development and implementation of ecosystem restoration strategies that mitigate current and anticipated stressors is a priority. This effort would include identifying and quantifying ecosystem services (e.g., water quality, carbon sequestration, erosion control, and habitat) under different environmental conditions and climate change scenarios.

Water quality

The York River estuary continues to suffer from chronic water quality issues driven by excessive loads of sediment, nutrients (N, P) and to varying degrees oxygen consuming material (e.g., organic matter). Evidence of such aquatic stressors includes routine low DO, harmful algal blooms and reduced water clarity that impact finfish, shellfish and underwater grass habitats. Watershed and bay source estimates of primary contaminants need to be refined and re-evaluated along with the development of updated watershed and point source management strategies (that include relevant climate change and water withdrawal/injection scenarios) intended to mitigate the effects of excessive contaminant loadings.

Monitoring data synthesis

Increased issue awareness and access to relevant information products/tools are foundational elements required to develop the appropriate strategies to protect and restore York River and associated small coastal basin water quality, ecosystems and human communities. The Reserve would like to increase efforts to communicate (thru education, outreach and advisory service) information derived from the SWMP, the Sentinel Site Initiative and other efforts, in support of watersheds and seascapes, as well as and human community resilience.

Delaware Reserve, Delaware

Climate change

- Research to better understand the ability of tidal wetlands to store and sequester carbon at the present and how that capacity could change with future sea level rise and tidal wetland loss.
- Research to better understand the future impacts of sea level rise on the capacity of tidal wetlands and shorelines to protect coastal resources, such of communities and natural areas, from coastal storms and tidal flooding.

Water quality

Research to better understand the source, transport, and fate of pollutants including organic contaminants, metals, microplastics, and/or excess nutrients in the estuarine system (from uplands to open water).

Habitat restoration

- Research to advance the knowledge and practice of thin layer application of dredged sediment to wetlands challenged by increasing sea level rise and/or changing water levels.
- Research to compare and evaluate management strategies for habitat restoration in the estuarine system (including forested uplands, non-forested uplands, and tidal wetlands). This could include better understanding invasive *Phragmites* removal or upland tree planting approaches and how habitat function and biodiversity will change by applying these different management strategies.

Hudson River Reserve, New York

Climate change

Storm surge barriers are being considered in various configurations throughout New York Harbor by a team of agencies, including US Army Corps of Engineers, New Jersey, New York State, and New York City. These and other end users have identified research needs to aid the assessment of long-term impacts of surge barriers to estuary physical and biological conditions. Research will explicitly need to consider effects of climate change as part of the future conditions and how surge barrier management and resulting estuary effects evolve with sea level rise or changes to storms. Understanding the impact of storm surge barriers on physical processes, sediment transport and sediment delivery to tidal wetlands is critical to ensure resilient habitats throughout the 152 miles of the Hudson River Estuary.

Ecosystem services

The Mid-Atlantic region is facing higher projected rates of sea level rise compared to global projections. Natural resource managers need tools to assess how sea level rise threatens habitats, particularly tidal wetlands, and how habitat resilience can be increased. Several Mid-Atlantic end users have identified the need for research to advance the knowledge and practice of thin layer placement (TLP) of dredged sediment to wetlands that are challenged by increasing sea level rise and/or changing water levels. Tools can be developed collaboratively to assess if a tidal marsh could have an increased resilience to sea level rise by using TLP, and to project what amount of dredge material applied at what interval will allow the marsh to keep pace with sea level rise.

Water quality

Invasive water chestnut (*Trapa natans*) provides poor habitat and reduced water quality by contributing to low dissolved oxygen conditions. NYSDEC Invasive Species Managers need to understand better the interactions of native submerged aquatic vegetation (*Vallisneria americana*) and water chestnut in the Hudson River Estuary and Mohawk River by determining if the removal of water chestnut facilitates the return of native species. Outcomes of the research could include recommendations for restoration of native plant ecotypes, strategies for measuring and addressing impacts of habitat shifts on fisheries, and assessment of recreational and economic benefits of water chestnut removal.

Jacques Cousteau Reserve, New Jersey

Climate change

- Water and habitat quality of the Mullica River-Great Bay Estuary have been excellent due to limited development and low nutrient loading, but periodic upwelling, ocean acidification, and saltwater intrusion along with increased precipitation and storminess projected due to climate change are likely to lead to changes in the estuary. The changes identified around this topic spurred questions about the interaction between temperature, wind, oxygen, and sea surface temperature with changes in habit shifts. For example: How does sea level rise effect juvenile habitat for fish? How will climate shifts impact phytoplankton with the Jacques Cousteau reserve boundary? And what are the projections for disease vectors of jellyfish, oysters, mosquitos, ticks, and flesh eating bacteria as the climate changes?
- The Jacques Cousteau reserve includes parts of a drowned river valley and a barrier island lagoon with a common inlet, and estuarine exchange processes include forcing by buoyancy driven flows modified by friction, but those could change due to stratification modified through changes in precipitation and warming or mixing from a change in storm frequency and intensity. The discussion about these changes in abiotic parameters was heavily focused on answering research questions about sediment budget, sea surface temperature, and net carbon sequestration. The need for more information on sediment budget in the estuary was identified as a high level need for the scientific community.

Ecosystem services

The Jacques Cousteau reserve drowned river valley and its accompanying barrier island lagoon is a more alkaline system downstream and more acidic upstream. As a result of increased storm activity and increased freshwater inputs from precipitation, we can expect to see changes in pH pulses through the system. The reserve presents an ideal location for the study of pH and nutrients on the environmental forcing of the evolution of algal blooms, especially toxic species. The focus of this discussion was to fill in a knowledge gap about the evolution of marsh ponds and pools. For example: What is the relationship between marsh ponds and marsh stability? What will sea level rise do the stability of marsh ponds & pools? What are the environmental variables that create opportunities for water bodies to form in the wetlands and how will they evolve with global climate change and negative sediment budget?

Habitat restoration

Research to advance the knowledge and practice of thin layer application of dredged sediment to wetlands challenged by increasing sea level rise and/or changing water levels.

Northeast Region

Great Bay Reserve, New Hampshire

Climate change

- New Hampshire needs additional information about how the direct and indirect impacts of climate change will effect habitats, keystone species, and ecosystem function in coastal New Hampshire. This information must be linked to suggested management actions that are likely to be effective at maintaining those ecosystem functions.
- Advance behavior-change science to understand the influences on municipal and landowner decisions and the use of economic data in coastal decision making.

Water quality

Managers need enhanced understanding of the interactions between abiotic and biotic conditions in Great Bay in order to prioritize decisions aimed at improving water quality. We need to underestand the hydrology, biological processes, sediment and light dynamics, changes in pH, etc. that influence ecosystem processes in Great Bay and link those models and science to potential managment actions.

Habitat restoration

- New Hampshire needs a better understanding of experimental approaches to facilitate habitat transition and migration due to climate change impacts, and practical tools to support the use of these approaches in New Hampshire.
- Current and past efforts on restoring on subtidal habitats (seagrasses and oyster reefs) have had variable success. Research aimed at novel and/or effective techniques for improving success within these habitats are needed.

Monitoring data synthesis

- Advance visualization and analysis tools to display NERRS data in innovative ways to communicate changes in environmental conditions.
- Advance mechanisms to prepare NERRS data to be ingested into larger regional or national models that will forecast or predict environmental change and/or causal factors (acidification, for example).
- Advance mechanisms to prepare NERRS data to be ingested into larger regional or national models that will forecast or predict environmental change and/or causal factors (acidification, for example).

Narragansett Bay Reserve, Rhode Island

Climate change

- Sea level rise is negatively impacting Rhode Island's coastal marshes. The reserve and the entire Narragansett Bay region need enhanced tools and strategies for mitigating the effects of sea level rise and other stressors on coastal salt marshes.
- There is a need across a variety of habitats (upland to subtidal) to better understand habitat vulnerability in the face of various stressors resulting from climate change such as variation in precipitation, temperature, competition among species, phenology etc.

Water quality

Storm water management continues to be a key issue throughout the watershed. Increased storm intensity due to climate change, coupled with continued development are driving the need for additional tools to help mitigate the negative consequences that storm water brings to coastal habitats.

Habitat Restoration

Ongoing restoration and management work within the reserve in estuarine and upland habitats and throughout the Narragansett Bay region is challenging due to climate change. New information, data, methods as well as monitoring and reporting metrics are needed.

Monitoring data synthesis

Develop user-based information from the SWMP monitoring and sentinel sites programs. The reserve has been at the forefront in establishing salt marsh sentinel monitoring and national metrics and products based on this work. However, there is a need to further enhance, refine and develop these products.

Wells Reserve, Maine

Climate change

- Impacts of invasive species and range extensions of others on the biophysical features of estuaries and coastal ecosystems.
- Address environmental stressors on finfish and shellfish species that help to guide the management of healthy coastal and estuarine fisheries.
- Expand current biomonitoring efforts and investigate novel tools to assess habitats and species of conservation concern towards a more holistic reserve management strategy.
- Evaluate alternative and creative strategies for monitoring salt marsh health and species composition that inform a more comprehensive assessment of sea-level rise and management strategies towards coastal resilience.

Ecosystem services

- Connectivity of invasive species to coastal and marsh dynamics and their impact on ecosystem services that more clearly convey to coastal resource managers the potential for habitat loss and alternation.
- Evaluation of climate change risk to coastal communities and assessment of adaptation strategies, including barriers to managed retreat and the human health consequences of climate change affecting estuaries. Social science research is needed to reveal social, economic and behavioral barriers to decision making related to policies and individual decisions about managed retreat and the human health affects related to climate change in estuaries.

Water quality

- The design and implementation of a carbonate chemistry monitoring system (i.e., ocean acidification), enabling us to measure trends over both a short- and long-term time series, that help to serve coastal end-users in fostering practical decision making tools.
- Creation and cultivation of an ecoacoustic learning community workgroup to gather data and monitoring programs for team partner needs and applications within and between reserves.

Habitat restoration

- Research to better understand the challenges of developing relocation policies and methods for engaging communities in dialogues that build resilience.
- Foster living shoreline approaches and beach replenishment strategies to local communities and monitor their success.

Monitoring data synthesis

Synthesis of long-term water quality, vegetation, and sea-level rise data to inform coastal management. The development of new analytical tools for these data products are needed to amplify and address future monitoring efforts.

Waquoit Bay Reserve, Massachusetts

Climate change

- *Climate Change* - Research is needed on the biophysical and socio-demographic impacts of climate change on estuarine systems, including but not limited to, water quality, ecosystem service provision, marsh sustainability, salt marsh habitat change, species response, and community risk to climate change. Changes in freshwater inputs and other meteorological factors (temperature, wind speed and direction) and their effects on salinity and flow regimes, as well as impact of temperature increase on existing nutrient management models, are important for understanding restoration remediation options within the watershed and Bay.

- *Community Resilience* – Research is needed on developing decision-support tools and targeted information to better enable coastal communities to engage in effective resilience planning that involves different sectors of society and protects people, infrastructure and natural resources. Social science research is also needed to better understand impacts of climate change on different socioeconomic groups and approaches for ensuring that adaptation planning meets the need of the most vulnerable. Social science research is also encouraged to examine strategic partnerships necessary as well as innovative ways to work with local communities and decision-makers to advance application of decision-support tools and implementation of adaptation solutions.
- *Reserve Resilience* – Better understand the vulnerability of the lands, habitat, and infrastructure of the Waquoit Bay Reserve to climate change and develop specific adaptation strategies to mitigate the most severe impacts.
- *Acidification* – As the major drivers of coastal and ocean acidification are somewhat distinct, further research into the exchanges of nearshore with oceanic water is invited to help elucidate the major contributors to acidification related threats for coastal ecosystems and better understand coastal acidification impacts on shellfish aquaculture and sediment processes.

Ecosystem services

- *Blue Carbon* - Research is invited to further understand blue carbon in a variety of coastal habitats and strategies for applying blue carbon science to support coastal restoration, habitat protection and climate policies.
- *Aquaculture* – Further investigate the effectiveness of using aquaculture to mitigate nutrient impacts on water quality.

Water quality

- *Pollution from excess nutrients and contaminants of emerging concern* – Research is needed to help communities make decisions on different strategies that can be used to reduce nitrogen loading. Specifically, research about the performance and efficacy of non-traditional methods of remediating excess nitrogen (e.g. use of shellfish aquaculture, constructed wetlands, permeable reactive barriers, etc.) that have been prioritized by managers and other decision-makers as desirable options to investigate. Additionally, social science research is needed to determine the social and economic barriers and factors that affect public acceptance of these non-traditional approaches and effective strategies for engaging and educating local audiences to expedite the pace at which solutions are developed and implemented.
- *Harmful Algal Blooms (HABs)* – *Pseudo-nitzschia* and other Harmful Algal Blooms (HABs) are important water quality indicators and potential food safety hazards. Research is needed to better understand the link between nutrient pollution, warmer temperatures and increased risk of potentially lethal HABs.

Habitat restoration

Cape Cod's shallow embayments have undergone dramatic physical changes due to decades of eutrophication and changing climactic regimes. Even with restoration of water quality, there are many questions about management and recovery of submerged aquatic vegetation and, associated fish and benthic communities. Additionally, wetlands degraded by climate change and other anthropogenic factors should be examined for their suitability for various restoration options such as facilitated migration, hydrological modifications, sediment augmentation, and related restoration techniques.

Pacific Islands

He'eia Reserve, Hawaii

Climate change

Optimizing biogeochemical conditions for maximizing productivity in response to habitat change, invasive species removal, and indigenous management practices: What are the dissolved oxygen limitations in our flooded field and aquaculture agro-ecosystems? Which macro- or micro-nutrients are limiting to primary productivity and

targeted biomass production? How do rising sea level and warming temperatures influence trophic food web dynamics in our nearshore ecosystems?

Ecosystem services

Refining models to incorporate cultural ecosystem services into ahupua'a-based restoration and management of the Reserve: Development and assessment of biocultural indicators of human wellness and spirituality, community connectivity, and intergenerational learning.

Water quality

Quantifying the potential impacts of groundwater and surface water flow on downstream effects in estuarine and nearshore reef ecosystems: focus on eutrophication and wastewater contamination on macroalgae growth and filter feeders.

Habitat restoration

Monitoring native biota as indicators of restoration success: We are interested in understanding 1) the birdscape and how our native birds utilize our flooded field agro-ecosystems and estuarine environment, 2) how far our native fish traverse through our watershed as invasive fauna are removed and waterways are opened up, 3) if there is an increase in species biodiversity of native vegetation in our newly formed wetland after removal of invasive mangroves, 4) changes in landcover classifications through habitat mapping and accuracy assessments, 5) changes in elevation and sediment flow in restored wetland using Surface Elevation Tables.

Monitoring data synthesis

Modeling trophic interactions and production in the He'eia estuary and near shore reef ecosystem: Native food fish stock assessment, species biodiversity, and connectivity in He'eia Fishpond.

Southeast Region

ACE Basin Reserve, South Carolina

Climate change

- Improve understanding of how key habitats, ecosystems, natural, or human communities respond to changing environmental conditions and improve capacity of systems to adapt.
- Develop tools and information that guide a robust Reserve plans for public access while ensuring the health of natural resources.

Water quality

Understand and communicate factors impacting water quality with focus improving water quality.

Habitat restoration

Develop information, tools and techniques to support and promote habitat conservation within the ACE Basin.

Guana Tolomato Matanzas Reserve, Florida

Climate change and coastal development

The major tributary of the southern component of the Guana Tolomato Matanzas reserve, Pellicer Creek, has a watershed that is approximately 90% undeveloped and these natural lands represent important marsh migration and wildlife corridors. Projected population growth threatens this watershed. A collaborative development plan involving: landowners, government officials and other stakeholders that considers the impact of updated rates of sea level rise and synthesizes available information integrating water resources, elevation data, estuarine habitat

migration, future public infrastructure needs, and biodiversity is needed to prioritize the location of potential land conservation easements.

Ecosystem services

Guana Tolomato Matanzas reserve is a bar-built estuary with a dynamic coastline and an increasing population. Coastal NE Florida needs habitat mapping, sediment transport, hydrodynamic, and ecosystem valuation studies to investigate 1) the impacts of climate, dredging, shoreline armoring, and sand placement on nearshore and estuarine structure and function, and 2) the ecosystem benefits and tradeoffs of different management options.

Water quality

Guana Lake is an approximately 8-mile long, 2,400-acre impounded estuary within the Guana Tolomato Matanzas reserve. Surface water enters the lake primarily through one weir and exits through another weir. This waterbody offers a unique opportunity to study nutrient, fish, and plankton dynamics in a relatively confined hydrologic regime. There is a need to design, following a large mesocosm approach, a network of automated monitoring sensors and other monitoring techniques that could inform the Reserve management community of the impact of watershed actions on water quality, harmful algal blooms and biodiversity.

Habitat restoration

The Guana Tolomato Matanzas reserve includes approximately 12,000 acres of intertidal wetlands (salt marshes and mangrove stand). At five of six long-term monitoring sites, wetland elevations have been stable over the last seven years despite relatively high rates of sea level rise over the same period. A general lack of riverine sediment delivery and upland paths for wetland migration and accelerated sea level rise are a cause for concern about wetland persistence. Analyses of changes in wetland elevation, lateral migration, and condition over time are needed to identify and prioritize restoration and conservation strategies including thin layer placement of dredged material. Such a broad spatial scale will require use of remote sensing in combination with field measurements.

Monitoring data synthesis

Integrate NERR datasets (15-minute interval continuous water quality, including fluorescence, and marsh surface elevation measurements) into local and statewide regulatory and zoning decisions affecting the Reserve habitats, sediment transport and water quality.

North Carolina Reserve, North Carolina

Climate change

- Sediment dynamics are poorly understood in estuarine ecosystems, but have important consequences on the ecological and economic functions of these systems. The North Carolina reserve seeks research partnerships that provide information on sediment dynamics regarding a) the rapidly changing geomorphology of Beaufort Inlet , how these changes are affecting surrounding protected areas such as the Rachel Carson Reserve and infrastructure such as the state port and town of Beaufort, and how to harness this information to improve the resilience of protected areas and protect local infrastructure, or b) the vulnerability of ocean beach habitats at the Masonboro Island Reserve under current conditions and opportunities to enhance resilience under various scenarios of sand placement.
- Coastal and estuarine ecosystems face several threats including sea level rise, coastal storms, and coastal development. The North Carolina reserve seeks research partnerships to provide a) ecosystem service or economic valuation of estuarine ecosystems (i.e., green infrastructure), b) how these services and values are altered by the threats identified above, c) how these services and values compare to gray infrastructure, or d) strategies for promoting protection and adoption of green infrastructure.

Habitat restoration

- An estuarine shoreline management approach that minimizes ecological impacts and maximizes resilience of human communities is a coastal management priority in North Carolina. The North Carolina reserve seeks

research that a) develops clearly defined standards for monitoring performance of shoreline stabilization options, b) evaluates performance of alternative living shoreline materials in a variety of environmental settings, c) develops tools to quantify biophysical drivers critical to the success of living shorelines, or d) recommends design guidelines based on site conditions for living shoreline options.

- Over the last three decades, many habitat restoration projects have occurred within North Carolina reserve and surrounding estuarine ecosystems. The North Carolina reserve seeks analyses and syntheses of these projects to improve understanding of a) the biophysical factors underpinning restoration success or failure, b) the ecosystem services restored habitats provide and how these functions change over time or based on their environmental setting, or c) the research and monitoring gaps needed to address the questions identified above. Ultimately, the North Carolina reserve would like restoration to move towards a more holistic, ecosystem-services based approach that ensures restoration practices incorporate the future vulnerability of restored habitats.

Monitoring data synthesis

As part of the NERRS System-wide Monitoring Program, the North Carolina reserve collects long-term water quality and meteorological data. These data can be used to examine impacts of human activities (e.g., land-use/land cover), climate, and storms on water quality. The North Carolina reserve seeks research partnerships to analyze these data for these impacts, understand end user and decision-maker needs for this information, and develop meaningful and accessible data products for end users.

North Inlet – Winyah Bay Reserve, South Carolina

Climate change

- Little is known on how climate change might compound or reduce existing stressors such as eutrophication and biological and chemical contaminants. There is a need to examine the synergistic effects of climate change and anthropogenic stressors on coastal habitats and ecosystem functioning and to use this information to help managers assess how management practices may exacerbate or mitigate future climate threats.
- Climate change will continue to shift species habitat distributions, altering the dynamics of ecosystems. Working along with other reserves in the southeast region, we seek research that examines the implications of shifting abundances of key foundation species and strong interactors within estuarine communities.

Water quality

Stormwater management associated with increasing coastal development continues to be an issue of concern for the North Inlet-Winyah Bay reserve and the communities we serve. Additional research is needed to determine the ecological effectiveness and cumulative impacts of existing and emerging stormwater control measures and development practices on coastal conditions.

Habitat restoration

There is growing awareness that enhancing ecosystem resilience can lead to improved management outcomes both in terms of preventing initial degradation and improving restoration results. Interactions among key species and between biotic and abiotic ecosystem components can drive feedbacks that enhance (or degrade) ecosystem resilience. Research is needed to improve understanding of these feedbacks and their associated threshold values in order to take advantage of the management benefits provided by considering ecosystem resilience.

Monitoring data synthesis

Understanding and communicating short- term variability and long-term change in coastal ecosystem conditions, both locally and regionally, is essential for effective coastal management. Analyses of reserve collected data (biotic and abiotic) using cutting-edge statistical tools (convergent cross mapping, structural equation models, or machine learning techniques, among others) is needed to provide understanding of the causal factors and interactions among factors that drive estuarine system states.

Sapelo Island Reserve, Georgia

Climate change

- We need quantification and characterization of the impacts of climate change to estuarine species (e.g., abundance, disruptions in reproduction, growth, migration, and habitat occupancy), to estuarine productivity, and to the overall health of estuarine ecosystems along the Georgia coast.
- We need research into the social implications of climate change and sea level rise, including but not limited to the trade-offs involved in implementing different mitigation strategies in economically challenged, vulnerable coastal communities in McIntosh County, GA and the potential challenges to developing a sustainable economic future in a service- or ecotourism-based economy.

Ecosystem services

We need a valuation of the ecosystem services provided by Georgia estuarine ecosystems, including but not limited to, the economic value of salt marshes in attenuating waves during storm surge events.

Habitat restoration

We need new approaches for understanding/predicting where and how rapidly shoreline erosion is occurring along the central Georgia coast, and the degree to which sea level rise is affecting patterns and rates of change.

Monitoring data synthesis

We need additional and more detailed assessments of patterns in: a) our long-term System Wide Program Monitoring (SWMP) data, and; b) long-term data on local tides and relative sea level rise, in the context of land use and other changes to the Georgia coast.

West Coast Region

Elkhorn Slough Reserve, California

Climate change

Climate adaptation planning to integrate sustainability of estuarine habitats with other regional needs

Water quality

- Historical analyses to understand past extent of estuarine habitat to inform planning for sea level rise and restoration
- Study of farmer decision-making regarding fertilizer use, including potential role for incentives to mitigate fertilizer run-off via biofilters or other approaches
- Development of new approaches for remediating legacy nutrients in estuarine sediments

Habitat restoration

Investigating drivers of salt marsh, oyster, and eelgrass resilience and testing restoration strategies

Kachemak Bay Reserve, Alaska

Climate change

- Carbon policy in the Kachemak Bay region
- Effects of climate change on watershed function
- Environmental drivers of coastal ecosystems
- Translating long-term monitoring programs to stakeholders

Ecosystem services

- Translating long-term monitoring programs to stakeholders
- Assessing effectiveness of Kachemak Bay reserve programs on salmon habitat protection
- Carbon Policy in the Kachemak Bay Region

Water quality

- Translating long-term monitoring programs to stakeholders
- Effects of climate change on watershed function
- Assessing effectiveness of Kachemak Bay reserve programs on salmon habitat protection
- Carbon policy in the Kachemak Bay region

Habitat restoration

- Carbon policy in the Kachemak Bay region
- Environmental drivers of coastal ecosystems
- Effects of climate change on watershed function
- Translating long-term monitoring programs to stakeholders

Monitoring data synthesis

Translating long-term monitoring programs to stakeholders

Padilla Bay Reserve, Washington

Climate change

- Sea-level rise is evident in Padilla Bay and threatens saltmarsh, SAV and other intertidal organisms and habitats. Our reserve needs to establish more precise, reliable mechanisms (e.g. sentinel site protocols) to document local sea-level rise, estimate extent of saltmarsh and SAV habitat loss/change, and identify and implement strategies to protect and expand these habitats as sea-level increases.
- The effects of ocean acidification are particularly pronounced in the waters of the Pacific Northwest, where seasonal upwelling brings corrosive, low pH water into the Puget Sound/Salish Sea and impacts calcifying organisms and the regional shellfish industry. There is increasing evidence that eelgrass can serve as a sink for atmospheric and ocean CO2 and locally mitigate decreases in ocean pH. However, the capacity for eelgrass to serve as a long-term carbon sink (i.e. blue carbon) remains loosely quantified. The Reserve needs to help quantify the role that eelgrass has in long-term sequestration of atmospheric/ocean carbon and the potential for eelgrass habitats to provide refuge for marine organisms (juvenile fish, crabs, calcifying organisms) potentially affected by fluctuating ocean pH.

Ecosystem services

- There is a regional priority in the Pacific Northwest to develop and expand shellfish aquaculture in coastal waters of Washington State. We see a growing regional need and opportunity for the Reserve to identify ecosystem services associated with both eelgrass and shellfish aquaculture and explore management strategies that focus on the mutual, and potentially synergistic, benefits of both.
- We seek to understand how an ecosystem service approach can be utilized to support the protection and restoration of Padilla Bay. To this end, we need to develop socio-ecological frameworks for eelgrass and carbon-rich tidal wetlands in the PNW that including benefit-relevant indicators of human well-being associated with measurable ecosystem services. These frameworks can be used to link ecological services and sociocultural benefits of eelgrass and blue carbon ecosystems and thus serve as a tool to establish priorities for climate adaptation, coastal restoration, research, and disaster preparation and response.

Water quality

Fecal coliform contamination is a recurring problem in Padilla Bay, leading to the closure of local shellfish beds to harvest. The Padilla Bay watershed includes livestock, hobby farms, and a range of septic systems - many of which are failing. The Reserve needs to identify sources of fecal coliform contamination and assist local stakeholders and management agencies, including our partner agency - Dept of Ecology, to reduce the inputs so waters of Padilla Bay and the associated watershed can be "fishable, swimmable and drinkable".

Habitat restoration

- Restoration of eelgrass habitat has been identified as a top regional priority in the Puget Sound/Salish Sea, with the goal of increasing eelgrass coverage in the Puget Sound by 20% by the year 2020 (from a 2000-2008 baseline). As one of the largest contiguous eelgrass beds in North America, Padilla Bay reserve has a scientific and resource management responsibility to work with regional stakeholders to preserve existing eelgrass habitat, contribute to restoration science, identify means of restoring degraded habitats, and identify strategies for facilitating the expansion of eelgrass into new areas. The Reserve needs to continue existing research and monitoring regarding the basic ecology of eelgrass, as well as explore environmental factors (e.g. eutrophication, extreme weather events, sea level rise) that promote or inhibit success of eelgrass communities.
- Padilla Bay has a wide range of non-native species found throughout the Reserve, many of which are invasive and pose a threat to the local ecosystems and habitats. Predictions suggest that the number and incidence of invasive species will only increase. The Reserve needs to continue efforts to monitor and eradicate existing invasive species, as well as monitor for potential threats, evaluate their impacts on ecosystem services, and identify management strategies to reduce the occurrence of invasive species within Reserve boundaries and prevent further degradation of local estuarine and upland habitats. We are also interested in better quantifying the use of Padilla Bay eelgrass meadows by juvenile salmonids and other forage fish species, and developing management or conservation strategies to promote forage fish habitat utilization and expansion in Padilla Bay.

San Francisco Bay Reserve, California

Climate change

Continue science collaborative process to assess preferred alternatives to modifying road barrier to connectivity between bayward marshes and landward marshes at China Camp State Park.

Ecosystem services

Build on knowledge of brackish marsh optimization of carbon sequestration relative to fresh and salt water marshes and, using experience gained at Rush Ranch, evaluate comparative economic benefits to restoring brackish marshes in the Suisun region.

Water quality

Utilize water quality monitoring program to explore how tidal marshes can improve water quality and reduce harmful algae blooms in the San Francisco Estuary.

Habitat restoration

Explore how NERR sentinel sites can contribute to emerging tidal wetland regional monitoring program (WRMP) by tracking external drivers of habitat change and relating conditions at NERR sites to questions involving tidal wetland restoration projects.

Monitoring data synthesis

Identify gaps and opportunities to increase stakeholder and end-user engagement on adaptation and restoration planning and implementation activities of the San Francisco Bay reserve by developing projects and tools derived from NERR activities that directly inform local, regional, and state-wide adaptation planning processes.

South Slough Reserve, Oregon
Climate change Increase our understanding and communication of locally and regionally relevant issues related to climate change and carbon dynamics (e.g. sea-level rise, ocean/estuarine acidification, increasing temperature, increasing erosion, increasing frequency of harmful algal bloom events, and effect on biological invasions), including assessments of vulnerability and management needs, and understanding regional perceptions of climate change to inform communication strategies.
Ecosystem services Increase our understanding of ecosystem services (e.g. carbon sequestration, food production, water provision, timber production, cultural identity, etc.) related to estuarine habitats (including uplands, riparian areas, tidal marshes, and seagrass beds) and native species (e.g. eelgrass, lamprey, salmonids, shellfish, etc.) in order to identify and prioritize local and regional management needs and communicate the importance of natural resources to PNW coastal communities.
Water quality Increase our understanding of the impacts of human activities on estuarine water quality and habitats (e.g. land-use effects on contaminant and bacterial loading, changes in sedimentation/erosion, introduction pathways of invasive species, etc.) and identify and implement management options (including restoration of watershed functions and native species such as eelgrass, native oysters, Pt. Reyes bird's beak, lamprey species, and sea otters) and communication strategies to improve habitat quality.
Habitat restoration Conduct restoration projects with appropriate experimental designs and create restoration inventories (including inventorying past projects and identifying areas with restoration potential) to examine restoration method effectiveness (including importance of upland connections to wetlands, effects of invasive species on restoration success, and use of habitat suitability modelling) in order to improve restoration design, assessment and ultimately success.
Monitoring data synthesis Synthesize and interpret local and regional data from the System-Wide Monitoring Program (including Sentinel Site data) to identify environmental degradation issues and improvement opportunities and provide decision-making tools (including modelling outputs) to meet demonstrated needs of coastal managers and decision makers and education tools for NERR educators and classroom teachers.

Tijuana River Reserve, California
Climate change Characterization of estuarine - ocean interactions and how they are influenced by climate change, beach nourishment, and nearshore processes.
Ecosystem services Biodiversity support of estuarine ecosystems, and assessment of potential impacts of climate change, altered hydrology, and biological invasions.
Water quality Socioecological assessment of the Reserve's binational watershed as it relates to inputs and management of freshwater, sediment, debris, and pollutants.
Habitat restoration Development of adaptive approaches to manage and restore resilient marsh, transition zone, and dune habitats.
Monitoring data synthesis Use of monitoring to develop "triggers" for management action.