Annual Summary of Reserve Management Needs

For the 2021 Collaborative Research RFP

Compiled October 2020

Collaborative research 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 the 2021 NERRS Science Collaborative Request for Proposals. Potential applicants are encouraged to review the management needs described here and reach out to the point of contact listed for a reserve to discuss the reserve's current needs and opportunities for collaboration. Project ideas that emerge after this document was developed and do not align perfectly with a specific management need statement, including project ideas that engage multiple reserves, can be considered for funding if the relevance and value to the reserve system and potential end users are well justified in the proposal.

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 and human dimensions research 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 resilience:** 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.

For questions about this summary, please contact:

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Reserves & Management Need Key Words

Key words for each reserve's management needs are listed below. Click on a reserve's name to jump to their management need statements.

Caribbean Region

- Jobos Bay, Puerto Rico - Mangrove ecosystem services; freshwater budget; mangrove resilience; applications of monitoring data for management

Great Lakes Region

- Lake Superior, WI - Climate trends and adaptation; community benefits of restoration; wetland sedimentation; algal blooms; nature-based shorelines
- Old Woman Creek, OH - Soil health; wetland restoration; rural wastewater impacts; marine debris; nature-based shorelines

Gulf of Mexico Region

- Apalachicola, FL - Tropicalization of habitats; ecosystem services and community well-being metrics; oyster fishery management; trophic linkages
- Grand Bay, MS - Ecological resilience; nature-based infrastructure; freshwater inflows; ecosystem services and socioeconomic metrics; water quality impacts; invasive species; pine savannah restoration; applications of monitoring data
- Mission-Aransas, TX - Climate change impacts; coastal resiliency planning; biodiversity monitoring; communicating ecosystem services; freshwater inflows; wastewater and stormwater management; marine debris; algal blooms; habitat protection; impacts to fish, bird and migrating species; green infrastructure; estuary hydrodynamics; applications for reserve monitoring data
- Rookery Bay, FL - climate impacts on endemic species; human behavioral change; impacts of freshwater management; social impact of restoration; benthic habitat assessments
- Weeks Bay, FL - Prescribed fire & marsh ecotones; blue carbon, visitor studies; habitat valuation & restoration prioritization tools; marine debris; microbial source tracking; algal blooms; restoration of ecosystem functions; impacts of altered hydrology

Mid Atlantic Region

- Chesapeake Bay, MD - Wetland resilience & restoration; environmental justice & climate change; use of monitoring data to adaptively manage habitat restoration; emerging water quality concerns; benthic habitats; sea level rise & flooding
- Chesapeake Bay, VA - Climate stressor on coastal ecosystems; ecosystem services under climate scenarios; episodic and human impacts on water quality; nearshore restoration community of practice; expanding use of monitoring data
- Delaware - Stressors & bird populations; pollution impacts on wetlands; controlled burns in wetlands, phytoplankton communities
- Hudson River, NY - Surge barrier management & wetlands; remote sensing to estimate fish stocks; coastal blue carbon; invasive water chestnut
- Jacques Cousteau, NJ - Soundscape monitoring; environmental change & estuarine dynamics; predicting biophysical disturbance; nature-based solutions for marsh adaptation; impact assessment of resilience initiatives

Northeast Region

- Great Bay, NH - Climate impacts on habitats; behavior-change science & municipal decisions; water quality impacts; habitat migration; restoring intertidal and subtidal habitats; data visualizations of environmental change; data processing techniques for modeling
- Narragansett Bay, RI - Sea level rise & coastal marshes; application of ecosystem service valuation; stormwater management; evaluating habitat restoration success; user needs for monitoring products
- Wells, ME - Invasive species biology; sentinel organisms, social science research & climate risks; ocean acidification; ecoacoustic biodiversity monitoring; social challenges of climate adaptation; data science & monitoring syntheses
- Waquoit Bay, MA - Climate impacts on estuarine systems; habitat restoration & biogeochemical processes; marsh resilience; nutrients & emerging contaminants; coastal acidificiation & aquaculture; enhancing community resilience.

Southeast Region

- ACE Basin, SC - Marsh vulnerability & resilience; integrated assessment of biological, water quality and meteorological data; behavior change & stormwater;
- Guana Tolomato Matanzas, FL - Collaborative conservation planning for climate impacts; cultural ecosystem services for diverse users; hydrologic and pollutant source modeling; freshwater marsh sentinel site monitoring plan; water quality metrics for regulatory use
- North Carolina - Sediment dynamics; submerged aquatic vegetation; estuarine shoreline management; application of monitoring data
- North Inlet-Winyah Bay, SC - Synergistic effects of stressors; climate & shifts in species distributions; salt marsh adaptation strategies; stormwater management; feedback & thresholds for ecosystem resilience
- Sapelo Island, GA - Climate impacts on natural and human communities; enhancing resilience of island resident community; altered island hydrology; living shorelines; water quality changes & estuarine biota

West Coast Region

- Elkhorn Slough, CA - Coastal adaptation planning; supporting local decision makers; eutrophication sources and impacts; habitat restoration; streamlining restoration permitting pathways
- Kachemak Bay, AK - Innovative methods to understand environmental change; local values & conservation options; preserving ecosystems & salmon; management applications of monitoring products
- Padilla Bay, WA - Assessing and addressing local climate impacts; ecosystem functions & services; land use & water contamination; research to increase restoration success; anthropogenic drivers of estuarine variability
- San Francisco Bay, CA - Sediment dynamics & marsh resilience; coastal road adaptation; carbon sequestration & brackish marsh restoration; bacterial contamination; wetland adaptation & engagement;
- South Slough, OR - Climate resiliency planning; ecosystem service studies to inform habitat management; managing impacts on water quality and habitats; advancing restoration success; applications of monitoring data for managers and educators
- Tijuana River, CA - Nearshore ecosystem dynamics; psycho-social resilience; equity, diversity & coastal planning; estuarine biodiversity; cultural ecosystem services in urban and bi-national contexts; impacts on water quality; inter-agency collaboration to advance management; marsh & dune restoration; bio-sentinels; data driven triggers for management

Pacific Islands Region

- He'eia, HI - Watershed restoration & biogeochemistry; integrated approaches for cultural ecosystem services; sediment, nutrients & bioindicators; Native Hawaiin watershed management; syntheses of historical and current cultural and scientific data

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	Habitat Resilience	Water Quality	Monitoring Data Synthesis
Caribbean					
Jobos Bay, Puerto Rico		■	■	■	■
Great Lakes					
Lake Superior, WI	■	■	■	■	
Old Woman Creek, OH	■	■	■	■	
Gulf of Mexico					
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	■	■	■	■	
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	■	■	■	■	■
Pacific Islands					
He'eia, HI	■	■	■	■	■

Caribbean Region

Jobos Bay Reserve, Puerto Rico
Contact: Aitza E. Pabon-Valentin, apabon@drna.pr.gov, (787) 538-2352
Ecosystem Services Mangroves are a key component of coastal ecosystems and coastal communities. Mangroves interact with seagrass and coral reefs by interchanging nutrients, food, and fauna; that in absence of those will result in a misbalance. Another threat is anthropic pressure. Managers need to understand the knowledge that local communities have, how they value mangroves ecosystems and how they visualize how much of their resilience against climate change comes from coastal ecosystems. Another related component that managers, researchers, and stakeholders need to understand is the effect of climate change in the integrity of mangrove populations, the drivers of mangrove degradation as well as mangrove community resilience.
Water Quality There is uncertainty regarding the components of the water budget in the South Coast aquifer as well as the net freshwater contribution to the estuary. Changes in agriculture irrigation methods and reduced precipitation over time, have reduced the freshwater contributed to Jobos Bay. Other factors are the impact of urban development, which has changed water infiltration in the watershed and the delivery of freshwater to the reserve. Also, the reserve needs to know the location of the aquifer discharge points. Knowing the amount of groundwater entering the system is important to developing management measures, especially for species of interest and to develop groundwater management.
Habitat Resilience Mangroves provide socio-economic and ecological benefits that account for the entire ecosystem's health. This ecosystem has been affected by poor watershed management and by natural processes such as intense storms during the last few years. There is a need to understand factors and drivers that affect mangrove resilience and how they help other ecosystems as well as human settlements.
Monitoring Data Synthesis Jobos Bay reserve has a long-term monitoring program that gathers water quality, meteorological, and biological data. Its analysis may help identify processes and drivers of environmental response. The Jobos Bay reserve site profile was completed in 2002 and partially updated in 2008. Since then, a wealth of information has been generated, which is dispersed across several documents and databases. Having this information available is essential to promoting future research and for the development of specific management measures. Also, managers need these data to be processed to use in forecast models to identify and implement best management practices.

Great Lakes Region

Lake Superior Reserve, Wisconsin
Contact: Dustin Haines, Research Coordinator, Dustin.Haines@wisc.edu
Climate Change *Trends and adaptation*: Our region is predicted to undergo strong future warming and our partners have identified climate change as a top reserve research priority, but few studies in our reserve specifically target climate change. Therefore, our reserve needs to study how climate change is manifesting in the estuary in terms of measurable biotic and abiotic trends, how climate change impacts community connection with the Lake Superior watershed, and what opportunities exist for our reserve to help our ecological and human communities adapt and continue to function in a new climate regime.
Ecosystem Services *Community benefits of restoration*: The St. Louis River Area of Concern, in which our reserve is situated, is planned to be delisted by 2025, and our reserve has been involved in many aspects of this work. But the effects of these efforts on neighborhoods near the estuary are largely unknown. Therefore, our reserve hopes to engage partners (including researchers, agencies, and other Areas of Concern) in assessing the sense of place and quality of life before and after delisting in neighborhoods proximal to (or dependent on) remediated or restored areas of the estuary.
Water Quality *Wetland sedimentation*: Sediment transport data is lacking in the St. Louis River estuary, and little is known about how legacy land use change and flood events impact sedimentation within wetland complexes, therefore, foundational research is needed to characterize sedimentation rates under various hydrologic regimes to increase understanding of wetland resilience to climate change. *Blue-green algal blooms*: Lake Superior has recently been experiencing blue-green algae blooms and there is concern about the potential for these blooms to cause harm to human and biotic communities, but the mechanisms driving these events are not well known. Therefore, developing the methodologies to better understand the role that estuaries and rivers play in these blooms would provide crucial tools for future management.
Habitat Resilience *Nature-based shorelines*: Shoreline communities and natural habitats in our estuary and coastal Lake Superior are experiencing high rates of erosion, and people are actively working to stabilize them. But a lack of evidence-based practice using natural features leads to a hesitancy to apply nature-based stabilization methods, resulting in frequent use of shoreline hardening practices. Therefore, our reserve hopes to partner with researchers, managers, and engineers to understand what practices are feasible and where they are effective to improve shoreline restoration and resiliency.

Old Woman Creek Reserve, Ohio

Contact: Janice Kerns, Reserve Manager, Janice.Kerns@dnr.ohio.gov

NOTE: For all focal areas, research proposals need to adequately address an **educational component or communication piece** in a meaningful way. Researchers must demonstrate that there is an understanding of how the research results will be useful to the intended audience and what will be the most effective way to communicate the results to this audience. If researchers have questions or would like to discuss effective communication and education strategies, email the Education Coordinator, Jennifer.bucheit@dnr.state.oh.us.

Climate Change

Barriers to improving soil health and its impacts on a changing coastal ecosystem: A healthy soil is more resilient to extremes in weather. Changes in farming practices over the last 50 years have degraded soil through loss of organic matter, compaction, and loss of water holding and nutrient capacity. For Old Woman Creek Reserve, two-thirds of the watershed consists of row crop agriculture where farmers tend not to be the landowners. To meet the needs of this audience, Old Woman Creek Reserve collaborates with soil and water conservation district partners to facilitate agricultural field days that promote long-term implementation of best management practices such as cover crops. To improve these interactions, more research is needed to identify cultural and economic barriers to effective adoption of best management strategies by farmers and landowners to safeguard their livelihoods in a changing climate. Additionally, the ability to quantify landscape level trends in soil health will help qualify the implications of the actions taken within a watershed and coastal ecosystem experiencing increased storms and drought events.

Ecosystem Services

Landscape-scale implementation and evaluation of wetland restoration and enhancement for water quality improvement in coastal Ohio: In 2019, Ohio's Governor Mike DeWine implemented the H2Ohio Initiative to ensure safe and clean water through reducing phosphorus by creating, restoring, and enhancing wetlands. OWC NERR and the Lake Erie Aquatic Research Network have taken the lead in developing a monitoring program to determine the effectiveness of these restoration activities. This program therefore provides a platform to answer larger landscape-level research questions concerning where and how restoration projects should be implemented, what are the tradeoffs between habitat and species motivated restoration compared to those with a nutrient and sediment reduction focus, and what new technologies can be used to help determine how effective these projects are at meeting their goals.

Water Quality

Wastewater inputs into small rural drainage systems: Nutrient enrichment, second only to siltation, is a significant impairment to the OWC watershed based on an Ohio EPA Total Maximum Daily Load report from 2005 and monitoring data collected by the Reserve. Current efforts by Reserve staff and partners have focused on mitigating agricultural sources to some success but cultural barriers to BMP adoption and failing septic systems have been difficult to address and resolve. Thus, there is a need to quantify the relative contributions of septic versus agricultural sources of nutrients to the Old Woman Creek watershed. Moreover, future research must focus on understanding pollutant and nutrient reduction practices that are accessible for rural communities, who often lack infrastructure and resources to implement at a meaningful scale. Quantifying these contributions and subsequent strategies will therefore help foster policy changes and funding to mitigate nutrient impacts.

Marine debris impacts on Great Lakes ecosystem services: Single-use plastic items associated with the food, fishing, and pharmaceutical industries are the most frequent items found in the Great Lakes environment and their abundance presents a threat to human health and the local economy. Especially for Lake Erie, where over 11 million people derive their drinking water from the lake and utilize its fisheries and natural resources but the examination of the extent these single-use plastic items have on ecosystem services has not been fully analyzed. Therefore, examining the plastics density in Lake Erie coastal zones and its relative impact on ecosystem services, e.g. native wildlife populations, water quality, shoreline aesthetics/recreation, would allow for this impact to be more fully understood.

Habitat Resilience

Nature-based shoreline suitability in Lake Erie's coastal region: Increased water levels and more frequent storm events in the Great Lakes are causing increased erosion along the lakeshore and most coastal landowners are choosing to protect their shorelines by hardening the shoreline but hardened shorelines displace natural habitats, alter shoreline characteristics, and adversely impact the availability of sand resources, Thus, we need to develop an inventory to identify suitable nature-base shorelines (NBS), identify the hurdles of coastal landowners taking on NBS projects, and monitor/evaluate the success of these projects to meet their objectives, given high wave energy systems and the diversity of landowners requirements and goals.

Gulf Coast Region

Apalachicola Reserve, Florida

Contact: Jason Garwood, Research Coordinator, Jason.garwood@dep.state.fl.us

Climate Change

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

Ecosystem Services

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 regarding 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.

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

Contact: Ayesha Gray, Reserve Manager, Ayesha.Gray@dmr.ms.gov

Climate Change

We are particularly interested in projects that would provide management relevant information about:

- 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.
- The effectiveness of nature-based infrastructure to increase community and ecosystem resilience related to climate change.
- Freshwater inflows associated with Bonnet Carre opening associated with landscape change in upper watershed versus change in precipitation.

Ecosystem Services

We particularly interested in projects that would:

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

Water Quality

We are particularly interested in projects that would provide management relevant information about:

- Nutrient load associated with MS Phosphates.
- Fecal coliform, including bacterial source tracking and recommendations for water quality improvements.
- Harmful Algal Blooms, including the relationship with freshwater inflows from opening the Bonnet Carre spillway.
- Water and sediment transport modeling between Mobile Bay, MS Sound, and Grand Bay.
- Nonpoint source pollution in the upper Grand Bay estuary to the Escatawpa River.

Habitat Resilience

We are particularly interested in projects that would provide management relevant information about:

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

Monitoring Data Synthesis

We are particularly interested in projects that would:

- Synthesize monitoring information from the Grand Bay reserve and address critical coastal management questions.
- 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

Contact: Ed Buskey, Research Coordinator, ed.buskey@utexas.edu

Climate Change

Identify climate change impacts: The Reserve is subjected to numerous impacts from climate change, including: tropicalization of plant species, alterations in contaminant bioavailability/toxicity, relative sea level rise rate of 5.2mm per year, our location in an area where intense drought followed by heavy rains is frequent, and more intense hurricanes. The Reserve currently has a lot of undeveloped land that is a 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 of climate change and determine mitigation strategies from the impacts of the Coastal Bend and to subsequently relay that information to decision makers. Some of the major climate change-focused research needs for the Reserve include understanding the implications and rates of the loss of wetland to open-bay systems; identifying ecosystem changes that are occurring in response to sea level rise; gathering information on the impacts of ocean acidification; and determining the impacts of the tropicalization of the south Texas coast due to fewer hard freezes and the range extension of tropical species, especially displacement of marshes by mangroves and changes in biogeochemical cycling, especially the storage/decomposition of carbon in coastal sediments and the production of greenhouse gases including carbon dioxide and methane.

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.

Biodiversity monitoring data: Changes in species composition of our natural communities is going unnoticed except in species specific research projects. The use of DNA barcoding and eDNA needs to be developed to potentially assess biodiversity of all biota within the reserve, understand trophic relationships, monitor for species range extensions driven by climate change and for invasive species. The use of bioacoustic monitoring (using recorded sound to describe a habitat's biodiversity) allows Reserves to gather baseline data and analyze changes to habitat biodiversity both geographically or temporally. Creating an ecoacoustic community of practice for the Reserve System that would develop standard monitoring protocols, gather baseline and change analysis data, would benefit Reserves system-wide as well as engage and inform community partners.

Ecosystem Services

Describe and communicate ecosystem services: The value (monetary or non-monetary) humans place on specific habitats, processes, risks, 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.

Water Quality

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 and contaminant loading and microbial transformations. We also need to assess ecological consequences of natural and anthropogenic variations in freshwater inflow that could lead to large changes in food webs and plant communities.

Improve wastewater and stormwater management to better water quality: The Reserve should work to assist communities in developing plans and projects that improve municipal wastewater effluent and storm water runoff and address non-point source pollution. Understanding effects of chemicals and drainage issues in local areas caused by nuisance flooding can help inform the development of these projects, and ultimately improve the water quality of stormwater 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 2017 that shows the Mission-Aransas Reserve Gulf-facing beaches have 10 times the amount of trash accumulation than the beach shorelines located along the eastern side of 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.

Habitat Resilience

Protect key habitats: Wave, current and ship wake erosion, subsidence, sea level rise, storms, climate change, and human development have changed the landscape of the reserve. We need to examine the most vulnerable habitats that are in decline (such as oyster reefs, fresh- and saltwater marsh, rookery islands, tidal flats, seagrass beds, coastal prairie), identify their associated stressors and risks, and work to protect these habitats in sustainable ways.

Link declining fish, bird, and migrating species to habitat loss/change and anthropogenic impacts: Within the Reserve, the populations of several species have declined over the past 50 years, including the reddish egret, the piping plover, snowy plover, blue crab, southern flounder, 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 and food webs 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, baseline data gathering, examining the ecological functioning of restored systems, assessing environmental toxicants, 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, environmental contamination, 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 6th 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 these channels and the intracoastal waterway, and a deep stabilized channel open to the Gulf of Mexico are alterations that need to be researched to understand their physical and chemical impacts on larval fish recruitment, spawning grounds/activity in estuaries, and water level impacts on habitat.

Monitoring Data Synthesis

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.

Rookery Bay Reserve, Florida

Contact: Brita Jessen, Research Coordinator, Brita.Jessen@dep.state.fl.us

Climate Change

Climate change is altering the natural range of botanical and wildlife species in the sub-tropics. Rookery Bay reserve has recently partnered with a local botanical garden to identify and protect some species of concern or importance to enhance resilience across the southeast United States and Caribbean. However, we need enhanced tools, assessments, and projections to identify the greatest threats of impact (e.g., sea level rise, fire, pests, storms), evaluate the effectiveness of different management approaches, and recommend best practices to enhance adaptation and successful management actions for endemic species.

Ecosystem Services

We are seeking research or novel method development to better understand how Rookery Bay reserve programs and engagement with the community result in short- or long-term behavior change. These programs include visitor interactions in the classroom or field, professional training and workshops, facilitation of working groups, citizen science to assist with habitat and wildlife management actions, and K-12 formal programs. Suggested assessments include an evaluation of behavior change, or a framework to better understand the mechanisms of behavior change in our community. We welcome an emphasis on the inclusion of diverse audiences.

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. Freshwater restoration projects are currently under design and/or implementation phases; however, we don't know what effects these projects will have on the coastal ecosystem including fisheries. Managers in southwest Florida seek a greater understanding of the integrative impacts of freshwater management and other changes (e.g., nutrient input, sea level rise) for coastal habitat, salinity regimes, and community structure and production.

Rookery Bay reserve seeks to build upon the 2019 Science Catalyst project led by Dr. Lydia Olander and Sara Mason at the Duke Nicholas School of the Environment (project page here). With strong community guidance, two Ecosystem Services Conceptual Models (ESCM) were designed with a focus on mangrove coastlines. One model was a generalized mangrove system model, whereas another model focused on a large mangrove die-off area known as Fruit Farm Creek (FFC) within Rookery Bay NERR. Restoration at FFC will begin spring 2021, which presents an excellent opportunity to apply the ESCM to study the social impact of this $2.5M restoration.

Habitat Resilience

Rookery Bay reserve conducted extensive habitat mapping in 2015, but episodic events, resource use, and management actions such as beach renourishment or land use changes have likely altered this habitat. We are seeking new assessments of benthic habitats (with an emphasis on oyster and seagrass areas and sediment transport) to (a) assess the impact of natural or human-influenced events on submerged habitat structure and function, (b) identify and prioritize vulnerable habitats and/or (c) model and compare potential management solutions.

Weeks Bay Reserve, Alabama

Contact: Dr. Scott Phipps, Research Coordinator, scott.phipps@dcnr.alabama.gov

More details relating to issues of concern at the Reserve can be found in the research and monitoring section, page 127 at WBNERR Management Plan.

Climate Change

NERRS Sentinel Site monitoring data is designed to detect changes in natural community structure and composition and attribute these changes to related climate stressors. At the Weeks Bay NERR interpretation of Sentinel Site data may be confounded by the reintroduction of prescribed fire as a natural community management tool. Research is needed to understand the effects of prescribed fire on marsh communities with an emphasis on understanding ecotone boundary shifts.

The Reserve needs investigation of the carbon budget in ecosystem services projects, and support efforts that look to engage in carbon finance options that are relevant to our local habitats.

Ecosystem Services

The Reserve hosts thousands of visitors per year but lacks the manpower to assess how visitors discovered the Reserve, why they stopped in and how they plan on using the Reserve amenities. Therefore completion of a visitor use study is needed to measure the economic value visiting the Reserve brings to them or the community and inform staff on how to best meet the needs of visitors while preserving the ecological integrity of Reserve lands.

Management of Reserve habitats is restricted to what can be achieved with available resources. A restoration decision support tool that incorporates how both human and ecologically based valuation strategies can be used to support restoration and conservation projects is needed to identify and prioritize management efforts.

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.

Water Quality

Marine debris is a threat to human health, environment, and the economy. The Reserve and its partners participate in many regional programs to prevent and clean up marine debris but marine debris remains a persistent problem therefore Reserve staff need an understanding of citizen knowledge and attitudes towards marine debris and the development of an outreach program that results in measurable behavior change that reduces local sources of marine debris. Research into the regional human and ecological impacts of marine debris is also needed to guide management decisions by local stakeholders and for incorporation within existing outreach and education programs.

Investigation of bacterial contamination and source tracking within the watershed is needed for management purposes.

Waterways within the Weeks Bay NERR experience periodic planktonic and benthic algal blooms (algal mats) and are a concern to local stakeholders. The drivers of these events are poorly understood. Research is needed to identify causation and ecological impact of these blooms.

Habitat Resilience

Human activity has altered natural ecosystems within the Reserve but the impacts of these alterations and how to best manage or restore ecosystem composition and function are not fully understood therefore additional information in the following focus areas is needed for management purposes.

- Ecology of manmade impoundments in coastal flatwoods/pine savannah
- Development of a restoration decision support tool to determine best use of limited resources

- Understanding impacts of shoreline stabilization and cost/benefits to coastal ecology
- Boundary effects of shoreline stabilization to adjacent properties in residential scale projects.
- Development of a hydrological cycling model to inform coastal flatwoods restoration practices (i.e. prediction of change in transpiration/residence time resulting from canopy reduction and reintroduction of fire regimes).
- Development of a carbon budget for coastal wetlands (coastal flatwoods, swamps, marshes, bogs, etc.) and its response to the use of fire as a management tool.

Monitoring Data Synthesis

How have changes in hydrology due to land use change affected key estuarine characteristics such as residence time, nutrient loading, HABs resilience and productivity?

What are the primary drivers of nuisance flooding?

Mid-Atlantic Region

Chesapeake Bay Reserve, Maryland

Contact: Kyle Derby, Kyle.Derby@maryland.gov

Climate Change

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 persistence and migration strategies through land acquisition, restoration, and partnership opportunities. Specifically, additional research is needed to advance the knowledge and practice of thin layer application of dredged sediments as well as strategies and research needs to inform an approach to addressing saltwater intrusion and salinization impacts in the State and Mid-Atlantic region. The Reserve is looking specifically to support research gaps identified in the agriculture, wetlands (including management, restoration, and conservation prioritization), and forest sectors.

Environmental justice and social science considerations are critical to addressing the impacts of climate change and meeting habitat protection/restoration goals. However, there is a need to more purposefully integrate such considerations as well as diversity, equity, inclusion, and justice (DEIJ) in the work to do outreach and engagement with communities that are most affected by climate change, including communities of color and low-income communities, as well as work to engage communities in habitat migration projects.

Ecosystem Services

The Maryland Department of Natural Resources Resiliency Through Restoration (RtR) Initiative aims to reduce Maryland's vulnerabilities and enhance resiliency of local communities, economies, and natural resources through living shorelines, marsh enhancement and other restoration practices. The Maryland Reserve has been a foundational member in developing and implementing monitoring protocols to better understand and track the benefits of these projects, but it is unclear how monitoring data can be translated into effective tools to inform broader restoration efforts and adaptive management needs, therefore, an applied science process is needed that advances the use of existing monitoring data in site-specific adaptive management and state-wide restoration. The pathway through which the data and information moves could inform both adaptive management of resilience-specific projects and implementation of best management practices across the state.

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, ocean acidification, and marine debris, therefore additional information is needed to assess potential threats and investigate mitigation and outreach strategies for emerging water quality concerns.

Habitat Resilience

Benthic habitats are critical to the health of the Chesapeake Bay and its fisheries, and in recent years, several drastic shifts in these vulnerable habitats, including an increase in submerged aquatic vegetation (SAV) coverage, have been observed, but their vulnerabilities to environmental stressors are not well understood, therefore more data collection and analysis of the benthic habitats in the Reserve are needed to inform appropriate management and restoration strategies.

Monitoring Data Synthesis

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

Chesapeake Bay Reserve, Virginia

Contact: William Reay, Reserve Manager, wreay@vims.edu, (804) 684-7119

Climate Change

Several critical York River estuary ecosystems, most notably tidal herbaceous and woody wetlands, wetland-upland ecotones and underwater grass beds, are sensitive and vulnerable to short-term, stochastic stressors, as well as long-term, broader geographic-scale climate change factors. The most often cited stressors include relative sea level rise (of which local and regional land subsidence is significant), saltwater intrusion due to rising sea levels and periodic drought conditions, freshwater flushing events and mechanical damage due to enhanced storm activity, increased seasonal temporal variability and water temperatures, and spread of invasive species. While CBNERR-VA successfully monitors and documents these stressors and their associated impacts on ecosystems (and key species), translating results to support effective natural resource management and the ability of the management community to respond effectively remains a significant challenge. Emphasis placed on developing a greater understanding of critical interactive processes leading to habitat vulnerability and development of actionable mitigation strategies to enhance natural resource resiliency is desired.

Ecosystem Services

There is a dearth of site-specific information on ecosystem services under different climate scenarios, and options for reasonable restoration approaches to mitigate the loss of these valuable services. Research that advances the identification, quantification and valuation of ecosystem services (e.g., water quality, carbon sequestration, erosion control and habitat) under different environmental conditions and climate change scenarios, as well as research that explores ecosystem restoration strategies, that mitigate current and anticipated stressors, is a site priority.

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). Moreover, emerging issues such as estuarine and coastal water acidification are becoming of greater local concern. Additional insight into how episodic events (e.g., inter-annual variations in hydrologic budgets, large-scale storm events), longer-term climatic changes and man-induced activities (water withdrawal and discharge) affect estuarine water quality and material flux is warranted. Moreover, the utility of this work would benefit through a collaborative effort between communities engaged in research, water management and resource protection.

Habitat Resilience

In the 2019 U.S. Army Corps of Engineers Chesapeake Bay Comprehensive Plan, the Commonwealth of Virginia identified the York River, Piankatank River, and Mobjack Bay as a priority area for natural and nature-based (NNB) shoreline resiliency projects to benefit coastal communities. This region has also received attention as a potential NOAA habitat restoration focus area. To promote coastal resiliency efforts in Virginia, CBNERR-VA, in conjunction with regional partners, is supporting the development of a York-Piankatank-Mobjack Bay NNB nearshore restoration "Community of Practice" to collectively advance coastal community resiliency projects. Climate-adaptive nearshore nature-based resiliency projects would include those focused on wetlands, oyster reefs, living shorelines and submerged aquatic vegetation. Goals of this community of practice include: 1) identification and prioritization of a site selection process, 2) creation of detailed design plans for climate adaptive NNB nearshore restoration projects in this geography, 3) collaborative efforts to implement selected resiliency projects, and 4) the development and use of common protocols for the monitoring and evaluation of projects. Once implemented, these projects should promote coastal community resiliency by reducing waves and shoreline erosion - protecting human health and safety and enhancing quality of life, while at the same time providing habitat for critical Chesapeake Bay species of ecological and economic concern. Creative efforts to further advance the "Community of Practice" and coastal resiliency efforts is a priority.

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 the York River and associated small coastal basin water quality, ecosystems, and human communities. The Reserve lacks data, however, relating to audience access of reserve data, tools, and products, specifically as it relates to information derived from the SWMP, the Sentinel Site Initiative and other monitoring efforts. Moreover, despite reserve efforts to translate science and outcomes to coastal stakeholders through education and outreach, there remain knowledge gaps among coastal stakeholders that could be effectively targeted with comprehensive needs assessments and tailored strategies that augment or complement those in existence at the reserve. New approaches (including methodologies, processes, and curriculums) and products (including reports, tools, and communications campaigns) are necessary to bolster current reserve effort and ensure reserve offerings are robust and relevant. Research to determine who uses Reserve data, tools, and products, how they use these outputs, and what more these audiences might need to augment their work is regarded as a site priority.

Delaware Reserve, Delaware

Contact: Kari St. Laurent, Research Coordinator, Kari.StLaurent@delaware.gov, (302) 735-3413

Water Quality

Marsh birds are important tidal wetland organisms and the DNERR has been participating in marsh bird monitoring since 2012 but many marsh bird populations in the St. Jones Watershed have been declining thus we need research to better understand marsh bird population dynamics, stressors, and causes of these declines to best protect these important species.

Pollution from nutrients, organic contaminants, and heavy metals are a major anthropogenic stressor and could impact tidal wetland ecosystems but we have little data on how estuarine food webs are being impacted thus we need research to better assess ecosystem level impacts of pollution to best inform if mitigation or remediation is needed.

Habitat Resilience

The invasive reed *Phragmites australis* is pervasive in tidal wetlands and controlled burns are one method to reduce its area of impact but we need to better understand the ecosystem response to *Phragmites* removal therefore we

need research on how controlled burns may act to input biochar, impact erosion, and/or alter other tidal wetland processes.

Monitoring Data Synthesis

Primary productivity is a fundamental process in estuarine waters and the NERRS SWMP data collect monthly chlorophyll-a and nutrient concentrations to monitor water quality but we do not have a grasp on the algal communities present at our SWMP sites thus we need research to better characterize the diel, seasonal, and annual changes in phytoplankton communities within our system.

Hudson River Reserve, New York

Contact: Sarah.Fernald, Research Coordinator, Sarah.Fernald@dec.ny.gov

Climate Change

Gated storm surge barriers across New York Harbor are being considered under the US Army Corps of Engineers (USACE) Harbor and Tributaries (HAT) study. A team of researchers and agencies, including NJ, NY State, and NY City have been collaborating to assess the impacts barriers would have on conditions in the Hudson River Estuary. HAT Study funding is presently on hold, but may be resumed at any time, and thus there is a period of opportunity for additional supplementary research. Specifically, research is needed on the effects of climate change on future conditions and surge barrier management, and the impact on sediment supply and physical processes critical to ensuring resilient tidal wetland habitats.

Estimates of stock abundance of spawning anadromous fish are an important metric for their successful management, especially for priority species Atlantic Sturgeon, Striped Bass, American Shad, Blueback herring, and Alewife. Many fishery researchers work in the Hudson River, but with limited coordination among groups. Further, obtaining meaningful abundance estimates with traditional techniques is not feasible. Remote sensing (acoustic tags, active and passive acoustic techniques, eDNA) allows estimating population sizes without handling every fish. HRNERR seeks to form a collaborative fisheries forum to apply remote sensing techniques to estimate anadromous adult fish spawning stock size in the Hudson.

Ecosystem Services

Coastal blue carbon, the long-term removal of carbon from the atmosphere by burial of organic matter through photosynthesis in estuarine plants, could serve as a climate mitigation incentive to prioritize protection of estuarine habitats. New York state and national partners are participating in the “Prioritizing Wetlands for Resilience and Carbon” project to map and model carbon sequestration potential for coastal waters, including the Hudson River. Controls on rates of storage, gaseous emissions, and interactions with other elements (nitrogen) are poorly understood. Research is needed on the balance among inputs/outputs under rapidly changing environmental conditions to best inform potential new policies.

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

Contact: Tom Grothues, Research Coordinator, Grothues@marine.rutgers.edu

Climate Change

Soundscape Monitoring: Marsh and coastal habitats are changing in response to climate change and local sea level rise and the National Estuarine Research Reserve System implements a robust monitoring program to track vegetation and elevation change, but, the monitoring program lacks information on changes in both land and marine animal composition. Therefore, the addition of bioacoustic monitoring (using recorded sound to describe a habitat's biodiversity) would allow research and stewardship sectors to gather baseline data and analyze changes to species biodiversity both geographically or temporally. Creating a NERRS ecoacoustic community of practice would catalyze development of standard monitoring protocols, ensure baseline and change analysis data were collected, and would engage and inform community partners about faunal composition changes in local habitats.

Ecosystem Services

Impacts of a Changing Environment on Estuarine Dynamics: Water and habitat quality of the Mullica River-Great Bay Estuary are excellent due to limited development and low nutrient loading, and periodic upwelling, ocean acidification and saltwater intrusion along with increased precipitation and storm frequency are changing estuary dynamics, but, science-based information is needed by the coastal management community to determine how this changing environment influences this estuarine system. Therefore, research into changing ecosystem dynamics and range shifts in habitats and species will help coastal managers improve the resilience of coastal communities.

Habitat Resilience

Predicting Biophysical Disturbance: Estuaries nationwide are characterized by strong gradients in salinity, temperature, pH, and trapping or export of sediments from terrigenous or marine sources and they connect disparate marine communities as migration waypoints or nurseries, but management of coastal systems can be improved by better understanding the role of estuarine dynamics (runoff, precipitation, groundwater, land cover, tidal forcing, pH, nutrients, storms, sea level rise, and marsh pond reservoirs) on the evolution of marsh community (i.e. toxic algal blooms, marsh plants and structural stability, range and phenology shifts of species, net carbon sequestration and marsh metabolism). Therefore, research is needed to help predict the consequences of natural and anthropogenic disturbances elsewhere; predictions that are vital to land management, economic development, community stability, and fisheries.

Nature-Based Solutions for Marsh Adaptation: Rapid sea level rise threatens coastal wetlands with inundation and erosion and our reserve is supporting statewide efforts to increase the resilience of wetlands through nature-based solutions including living shorelines and thin layer application of dredged sediment, but knowledge gaps about the implementation and efficacy of these techniques limits their widespread use. Therefore, our reserve and coastal management partners need more research, including baseline data collection, pilot projects, and performance monitoring, to advance the knowledge and practice of nature-based solutions for helping coastal wetlands adapt to sea level rise.

Impact Assessment of Resilience Initiatives: Since Superstorm Sandy, New Jersey's coastal managers have prioritized efforts to increase the resilience of built and natural communities to climate change and flooding and our reserve is viewed as a leader in providing data, tools, and technical assistance to increase coastal resilience, but the impact of these efforts on overall coastal community resilience has not been assessed. Therefore, our reserve and coastal management partners need research to assess the effectiveness of resilience resources, the barriers that may exist to use these resources, and how to improve development and delivery of technical assistance to coastal communities.

Northeast Region

Great Bay Reserve, New Hampshire
Contact: Chris Peter, Research Coordinator, Christopher.Peter@wildlife.nh.gov
Climate Change New Hampshire needs additional information on how direct and indirect impacts of climate change (e.g. sea-level-rise, ocean acidification, rising temperatures) are affecting our critical habitats, keystone species, and ecosystem function in coastal New Hampshire, including research that links driving forces of climate change and better ways to track these impacts (e.g., eDNA, phenology, sentinel organisms etc.). Resulting research should contribute to improved management and ecosystem function.
Ecosystem Services Advance behavior-change science to understand the influences on municipal and landowner decisions and the use of socio-economic data in coastal decision making.
Water Quality Managers would benefit from enhanced understanding of how anthropogenic stressors (land use changes, emerging contaminants, excess nutrients, hydrological change, sedimentation), are impacting our water quality and critical habitats in Great Bay, which link findings to potential management actions.
Habitat Resilience 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 subtidal and intertidal habitats (e.g., salt marshes, seagrasses, oyster reefs) have had variable success. Research aimed at furthering our understanding of stressors, identifying suitable sites and effective techniques, or other management options 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).

Narragansett Bay Reserve, Rhode Island

Contact: Jennifer West, Coastal Training Program Coordinator, Jennifer.West@dem.ri.gov, (401) 714-6110

Climate Change

Sea level rise is negatively impacting the coastal marshes through the Reserve and the entire Narragansett Bay region. We need a better understanding of:

- The efficacy of mitigation strategies, such as the protection of migration corridors, in increasing the resilience of our coastal marshes and adjacent communities.
- The vulnerability of a variety of habitats (upland to subtidal) to various climate change stressors such as variation in precipitation, temperature, competition among species, and phenology.
- The social and economic barriers (and opportunities) to sound decision-making related to climate change adaptation and increased community resilience.

Ecosystem Services

The value (monetary or non-monetary) that humans place on specific natural resources and processes influences the management strategies for ecosystems throughout the Narragansett Bay region. To advance this concept, we need a better understanding of:

- The value that people place on ecosystem services of various coastal and estuarine habitats, particularly salt marshes, such as carbon sequestration, water purification, storm buffering and flood reduction, wildlife habitat, recreation, and cultural identity.
- How ecosystem services valuation studies may be used to support and inform protection and restoration efforts.
- Effective techniques for educating and engaging local decision-makers in better protecting and restoring high-valued and at-risk resources and processes.

Water Quality

Stormwater continues to be a key issue throughout the Narragansett Bay region. Increased storm intensity due to climate change, coupled with continued development, are driving the need for additional tools to help mitigate its negative effects on coastal habitats. We need a better understanding of:

- The barriers to the implementation of best management practices, particularly low impact development and green infrastructure.
- The efficacy of education and engagement strategies to advance the adoption of stormwater best management practices, particularly at the local level.

Habitat Resilience

While numerous restoration projects have taken place in a variety of habitats within the Reserve and throughout the Narragansett Bay Region, there is limited information on the results of these interventions. We need a better understanding of:

- How habitat functions and values have changed as a result of restoration projects.
- Which techniques are the most effective at increasing the resilience of habitats to various climate change stressors?

Monitoring Data Synthesis

The Reserve has been at the forefront in establishing salt marsh sentinel monitoring and national metrics and developing products based on this work. However, there is a need to further develop, enhance, and refine user-based products from the SWMP and sentinel sites programs. We need a better understanding of end user needs and preferences regarding the information, products, and tools needed to inform local, regional, and state-wide efforts to increase resilience to the impacts of climate change.

Wells Reserve, Maine

Contact: Dr. Jason Goldstein, Research Director, jgoldstein@wellsnerr.org, (207) 646-1555 x136

Climate Change

Invasive species biology: Anthropogenic and climate-mediated processes are driving shifts and range extensions in the distribution of estuarine species (e.g., green and blue crab), and these systems are vulnerable to high rates of invasions. *However*, interactions between native vs. non-native species in our estuaries and coastal waters remain poorly understood. *Therefore*, we seek a better understanding of these connections as it pertains to coastal and marsh dynamics including the biophysical features of estuaries and coastal ecosystems.

Sentinel organisms: Our Nation's estuaries provide 'early alert' indicators about the effects of climate change *and* the mechanisms of environmental change. *However*, there is limited fine resolution data to assess the impacts of these changes to the organisms that reside there. *Therefore*, we wish to expand our understanding of the responses and changes to sentinel organisms in estuarine environments to better understand climate vulnerability, strengthening our ability to collect, assess, and evaluate climate change as part of SSAM-1 and engage end users as scientists.

Ecosystem Services

Climate risk: Evaluation of climate change risk to coastal communities and assessment of adaptation strategies, including managed retreat, social vulnerability, and the human health consequences of climate change. Social science research is needed to reveal social, economic, and behavioral barriers that affect decision making related to policies and individual decisions about climate adaptation and mitigation where ecosystem services and community resilience concerns intersect.

Water Quality

Ocean acidification: Coastal acidification is a growing concern in estuarine waters, *and* we recently embarked on a regional acidification monitoring initiative to better understand the potential vulnerabilities coastal resources are facing due to changing marine carbonate chemistry; *but* data gaps and standardized approaches are lacking for this type of monitoring. *Therefore*, we seek to expand coastal monitoring to include acidification parameters that provide a unique and untapped opportunity towards a more integrated decision-making initiative.

Biodiversity monitoring: Changes in the species composition of our natural communities are going unnoticed except in species specific research projects, *however* the use of bioacoustic monitoring (using recorded sound to describe a habitat's biodiversity) allows research and stewardship sectors to gather baseline data and analyze changes to habitat biodiversity over spatio-temporal scales. *Therefore*, creating an ecoacoustic community of practice that would develop standard monitoring protocols, gather baseline, and change analysis data, would benefit Reserves system-wide as well as engage and inform community partners.

Habitat Resilience

Climate adaptation: Research to understand the social challenges of climate adaptation strategies impacting tidal wetlands, coastal carbon sequestration and marsh migration pathways and associated methods for engaging communities in dialogues to build resilience as well as to foster adoption of nature-based solutions to habitat restoration, including living shoreline approaches and beach replenishment strategies and monitor their success.

Monitoring Data Synthesis

SWMP data science & synthesis: The System-wide Monitoring Program (SWMP) measures changes to water quality and sea-level rise to inform coastal zone management, *and* we seek to better synthesize these data to compare changes within our ecological communities, *but* we lack the analytical tools to comprehensively analyze such large datasets. *Therefore*, the development of new tools and analyses are needed to amplify these data with better precision to facilitate monitoring of other parameters (e.g., carbonate chemistry) in the future.

Waquoit Bay Reserve, Massachusetts

Contact: Megan Tyrrell, Research Coordinator, Megan.Tyrrell@mass.gov

Climate Change

Research is needed to better understand climate change impacts on estuarine systems, including but not limited to, water quality, ecosystem service provision, habitat change and recovery, nutrient cycling, and species response. We also invite research that examines the effects of changes in freshwater inputs and other factors on salinity and flow regimes, as well as the impact of temperature increase on nutrient management models. This information will be useful for informing restoration and remediation efforts within the watershed and Bay. We also seek research that utilizes monitoring data such as data from the Reserve's System-Wide Monitoring Program (SWMP) and citizen science programs.

Ecosystem Services

As coastal ecosystems become increasingly stressed the need for restoration to bring back healthy functions and essential ecosystem services has never been greater. Many restoration projects that the Reserve and other partners have been involved in have been successful in achieving discrete habitat or species goals. But there is incomplete understanding of how these types of projects affect larger ecosystem processes and functions. We seek research projects to further explore the impacts of restoration projects on biogeochemical processes (e.g. on carbon or nitrogen cycling) and other ecosystem functions in a watershed setting, to help guide decisions of resource managers and increase restoration success.

Research has shown that rising sea levels are threatening salt marshes across New England. Locally we are observing impacts such as increase in the size of pools and declining abundance of vulnerable species in marshes within the Reserve and elsewhere. Research is needed to help managers better understand and respond to changes occurring in marsh environments, as well as identify effective management strategies to enhance marsh resilience and protect and restore ecosystem services. We also invite research on adaptation strategies such as facilitated migration as well as studies that demonstrate the value of salt marshes and assess true costs if marsh ecosystem services are lost or impacted.

Water Quality

Water Quality: Addressing pollution from excess nutrients and contaminants of emerging concern is a pressing management issue for many communities. Stakeholders on Cape Cod have prioritized the need for research-based information on the efficacy of watershed and embayment options including non-traditional methods of remediation (e.g. shellfish aquaculture, floating and constructed wetlands, reactive barriers, phytoremediation, etc.) to preserve and restore clean water. Research is also needed on effective policy, regulatory, financing and community engagement approaches to guide adaptive management, as well as on socioeconomic factors that affect public acceptance and implementation of solutions.

Coastal Acidification and Aquaculture: Many coastal communities are providing aquaculture leases for animals and macroalgae to improve water quality and simultaneously provide economic opportunities for growers. The dual benefits of providing economic opportunities through locally grown food and improving coastal conditions is appealing but there are many uncertainties regarding anthropogenically induced environmental conditions and sustaining cultured species through vulnerable life history stages. Therefore, we need more research examining growth and survival under coastal acidification, eutrophication, increased temperatures, and potentially stressful oxygen and salinity conditions in our nearshore waters.

Habitat Resilience

Enhancing Community Resilience: Many municipalities are dealing with intensifying impacts from coastal hazards. State and local officials have been supporting efforts to strengthen community resilience and the Reserve has been working with partners to educate and equip stakeholders to take action to reduce vulnerability. But decision-makers need information on where and how nature-based solutions can best be applied to reduce risk, strengthen

shorelines, and protect people, property, and ecosystems. Information on better ways to communicate about risks and involve the community in planning is also needed. The Reserve is also interested in exploring ways to enhance our own resilience which may include use of pilot projects.

Southeast Region

ACE Basin Reserve, South Carolina

Contact: Denise Sanger, Research Coordinator, sangerd@dnr.sc.gov

Climate Change

ACE Basin marshes are vulnerable to sea level rise, and managers are only beginning to understand the consequences of the potential changes. But little research has been done to assess these changes. Therefore, we need to better understand how salt marshes, a dominant ecosystem, will change and develop potential adaptation or mitigation strategies.

Long-term meteorological and estuarine data exists for the ACE Basin Reserve, and analyses indicate increases in short-term variability and long-term trends occur. But integrated assessment of biological data with meteorological and water quality data has not been conducted. Therefore, integration and syntheses of the long-term meteorological, water quality and biological datasets to understand the ecological implications of these changes is a high priority.

Water Quality

The metropolitan areas of Charleston and Beaufort surrounding the ACE Basin continue to develop and cause water quality impacts. But these citizens are not aware of their collective impact on the health of our coastal waterways or solutions that will have a positive effect on water quality. Therefore, we need effective communication messages, strategies, and tools to foster behavior change that will minimize stormwater impacts to the ACE Basin estuary.

Guana Tolomato Matanzas Reserve, Florida

Contact: Michael Shirley, Director, Michael.Shirley@floridadep.gov

Climate Change

Pellicer Creek has a watershed that is 85-90% undeveloped and population projections indicate that by 2060 over 500k additional people will move into the watershed (an increase of 179%) and at the same time it is estimated that, due to sea level rise, significant amounts of salt marsh habitats will be converted to open water. A collaborative stakeholder-driven conservation plan 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 land acquisition efforts.

Ecosystem Services

Ecosystem resources of the Guana River have served many communities from the past to the present, but development and sea level rise threaten the sustainability of these services. Many of these communities are not represented in stakeholder groups and organizations so there is a risk that management actions will not equitably support all ecosystem service values. A detailed study and broader stakeholder engagement are needed to

understand how different cultures, past and present, have utilized and expressed value for ecosystem services and inform management actions that will serve diverse user groups and maximize resource conservation.

Water Quality

The Guana River is a highly-managed, urban, impounded estuary with degraded water quality. Studies are currently underway investigating nutrient dynamics (sources and fates) and engaging stakeholders to develop a water quality remediation plan. To be most effective, detailed hydrologic and pollutant source modeling are needed to inform those investigations and actions.

Habitat Resilience

A 27-acre freshwater marsh is located on the peninsula between the mesohaline Guana and Tolomato rivers. Current restoration is focused on removal of invasive species as well as using prescribed fire every 2-5 years to maintain this ecosystem. A freshwater marsh sentinel site monitoring plan is needed to track short-term variability and long-term change to adaptively manage biodiversity of this area with respect to sea level rise and climate change.

Monitoring Data Synthesis

NERRS System-wide Monitoring Program (SWMP) and associated monitoring efforts play an important regulatory role in several states. A stakeholder driven project that examines the metrics and standard being used by these states and the potential for expanding regulatory use in other states, including Florida, would significantly increase the broader utility, funding and significance of SWMP at the national, regional, state, and local level.

North Carolina Reserve, North Carolina

Contact: Brandon Puckett, Brandon.Puckett@ncdenr.gov and Whitney Jenkins, Whitney.Jenkins@ncdenr.gov

Climate Change

Sediment dynamics: Sediment dynamics are poorly understood in estuarine ecosystems but have important consequences on their function. The North Carolina NERR 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 improve the resilience of protected areas and protect local infrastructure, or b) the vulnerability of ocean beach and marsh habitats at the Masonboro Island Reserve and opportunities to enhance resilience via sand placement.

Submerged aquatic vegetation: North Carolina has the largest polyhaline seagrass ecosystem along the Atlantic coast and is uniquely positioned whereby two seagrass species occur at their southern and northern range limits, making this an ideal setting for understanding the implications of climate change on this important resource. But we lack a coordinated monitoring approach to assess and evaluate climate related impacts and the potential persistence of this unique seagrass ecosystem. The North Carolina NERR seeks research partnerships to develop and test protocols for a seagrass monitoring program that may include intensely monitored 'sentinel sites', synoptic surveys, and stratified sampling.

Habitat Resilience

Estuarine shoreline management: Managing estuarine shorelines to minimize negative ecological impacts and maximize resilience is a coastal management priority in North Carolina. The North Carolina NERR and partners have conducted stakeholder engagement, training, and research on living shorelines (LSs), but implementation remains limited. The North Carolina NERR seeks research that a) identifies strategies to encourage adoption of and address barriers to implementation of LSs on private property, b) evaluates performance of alternative LS materials, c) develops tools to quantify biophysical drivers critical to the success of LSs, or d) recommends design guidelines based on site conditions for LSs.

Monitoring Data Synthesis

SWMP data synthesis: As part of the NERRS System-wide Monitoring Program, the North Carolina NERR collects long-term abiotic (e.g., water quality) and biotic (e.g., emergent vegetation) data. These data can be used to examine impacts of human activities (e.g., land-use/land cover), climate, and storms on estuarine ecosystems, but we do not understand end user and decision-maker needs for this information. The North Carolina NERR seeks research partnerships to understand end user and decision-maker needs for this information, analyze these data for these impacts, and develop meaningful and accessible data products for end users based on identified needs.

North Inlet – Winyah Bay Reserve, South Carolina

Contact: Roburt Dunn, Research Coordinator, robert@baruch.sc.edu

Climate Change

Little is known on how climate change might interact with existing stressors such as eutrophication and biological and chemical contaminants, among others. 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.

Salt marshes are one component of coastal ecosystems that are particularly vulnerable to the effects of climate change. We seek research that builds on previous salt marsh data collection efforts in NI-WB NERR and expands our capacity to confront the management challenges facing salt marshes as the climate changes, including the development of possible adaptation or mitigation strategies.

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 Resilience

There is growing interest in the use of nature-based techniques to increase the resilience of human and natural communities to climate change. Various coastal habitats, such as marshes and oyster reefs, have the potential to mitigate problems with flooding, drought, water quality, and shoreline erosion. Providing these benefits could require the preservation, restoration, or creation of such habitats. However, more research is needed to improve understanding of how interactions among biotic and abiotic ecosystem components influence the effectiveness of these techniques. An assessment of potential opportunities for integration of nature-based techniques in local development is also needed.

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, including SWMP, marsh Sentinel Site, and other long-term data sets, are needed to improve understanding of the drivers of estuarine system states.

Sapelo Island Reserve, Georgia

Contact: Rachel Guy, Research Coordinator, Rachel.Guy@dnr.ga.gov, (912) 485-2251

Climate Change

Effects of climate change and sea level rise on natural and human communities: Available long-term data indicate that average air and water temperatures on Sapelo Island have increased significantly over time, and also that the rate of sea level rise has increased over the last twenty years and these increases are of sufficient magnitude to expect impacts to estuarine/coastal species, estuarine productivity, and the health of estuarine ecosystems, and because other evidence corroborates that such impacts are occurring. Therefore, we need quantification and characterization of the impacts of climate change to estuarine and coastal species, natural communities, and ecosystems. Also, because there are economically challenged, disadvantaged and vulnerable coastal human communities in McIntosh Co., but studies or assessments of such communities have not been completed, therefore we need research into the social impacts and implications of climate change and sea level rise.

Water Quality

Enhancing the resilience of the island resident community: The private community on Sapelo affects water quality, habitat integrity and ecosystem functions within the Reserve and has been affected by major land use changes in the past and continues to be affected by ongoing socio-economic/demographic changes but is increasingly vulnerable to sea level rise and nuisance flooding. Therefore, we need social science research to better understand these complex, interacting factors to help enhance the resilience of the community and the multiple interacting, interdependent State agencies and institutions on the island.

Habitat Resilience

Characterizing and mitigating altered island hydrology: Many of the large freshwater swamps and other wetlands found on Sapelo historically have been drained by extensive ditching carried out in the past, and now with sea level rise and nuisance flooding, some of these ditches may be facilitating the flow of salt and brackish tidal waters into upland natural habitats and the private residential community on Sapelo, the latter differentially affecting traditional Gullah Geechee residents and properties. But we don't know which ditches are having or may have the most significant impact on upland areas, therefore we need research on patterns of altered hydrology on the island and how flooding impacts to both natural and human communities might best be mitigated.

Benefits of, and need for more, living shorelines: Sapelo Island Reserve has two living shorelines, and living shorelines are increasingly being used as a nature-based infrastructure solution to shoreline erosion, but studies of the effects of these structures on surrounding habitats have not been completed. Therefore, we need research that will investigate the effects of living shorelines on adjacent habitats, compared to hardened-shoreline techniques. In addition, because ongoing shoreline erosion is occurring in the Reserve and on Sapelo and increasing sea level rise is almost certainly affecting patterns and rates of shoreline change, but we do not have data or spatial information on erosion rates, we therefore need new approaches for understanding/predicting where rapid shoreline erosion is occurring, the degree to which sea level rise is a contributing factor, and which eroding sites would be the most appropriate for the installation of new living shorelines.

Monitoring Data Synthesis

Effects of shifting water quality on estuarine species and systems: Sapelo Island Reserve has been collecting continuous water quality data since 2004 through the System Wide Monitoring Program and we know that climate change will play a role in shifting water quality values, but we don't know how such changes might affect estuarine organisms and ecological processes, therefore we need research that expands our knowledge of relationships between changing local water quality and patterns in the composition, abundance and persistence of estuarine aquatic biota.

West Coast Region

Elkhorn Slough Reserve, California
Contact: Kerstin Wasson, kerstin.wasson@gmail.com, for natural science questions and Dan Brumbaugh, dan@elkhornslough.org, for social science and policy questions.
Climate Change Assessment of adaptation strategies is important, including coastal defense via habitat restoration and management, new gray and green infrastructure, and managed retreat of both habitats and infrastructure. As part of these assessments, we need multi-disciplinary research to reveal (1) potential community risks associated with sea-level rise, coastal flooding, heat waves, wildfires, etc; (2) political, cultural, economic, and other behavioral barriers and pathways to better collective and individual decision-making; and (3) targeted decision-support tools and communication to better enable vulnerable coastal communities to engage in effective resilience planning. No reserve is an island (metaphorically!) so we need to support environmental stewardship beyond the boundaries of Elkhorn Slough Reserve. Given that adapting to the effects of climate change is adding to the challenges facing many coastal decision-makers as they address multiple land-use goals and objectives across different sectors, it is important to strengthen the ability of diverse coastal decision-makers to understand and holistically address and balance complex local and regional environmental challenges.
Water Quality Given high levels of eutrophication at Elkhorn Slough, further investigations are needed to determine nutrient sources and processing and how this varies in wetlands with different management, adjacent land use, and oceanic influence, as well as to test and monitor strategies for decreasing eutrophication impacts.
Habitat Resilience Elkhorn Slough habitats (eelgrass, salt and brackish marshes, freshwater wetlands, oyster beds) have been degraded and their extent has declined, so a better understanding of past drivers of loss and strategies to restore these habitats – in place and through migration – are critically needed to enhance their future resilience. One of the biggest barriers to continued restoration of Elkhorn Slough habitats is the permitting process. In collaboration with agency partners, we need to evaluate permit streamlining pathways and the necessary agency commitments to implement policy changes at the regional, state, and federal level.

Kachemak Bay Reserve, Alaska
Climate Change *Contact*: Coowe Walker, cmwalker9@alaska.edu **Understanding environmental change** in **Alaskan** coastal ecosystems requires approaches that can assess both climate and human drivers. Kachemak Bay Reserve has well-established watershed, nearshore and ocean ecology programs that provide platforms for innovative methods that capture and interpret data about habitat change and human dynamics for use in locally relevant climate and management scenarios. There is a need for new information including soundscape monitoring, remote sensing, and community monitoring to expand information and skillsets available to coastal decision-makers.

Ecosystem Services

Contact: Syverine Bentz, isbentz@alaska.edu

Healthy ecosystems of the Kachemak Bay Reserve provide commonly recognized natural benefits to coastal communities in the form of jobs, food, and recreational opportunities. Coastal stakeholders are aware of these benefits, but there is often a disconnect between behaviors and decision-making around for long-term sustainability and maintenance of functional ecosystems. There is a need for a deeper understanding of the ways human and natural systems interact through an ecosystem service approach, as well as **community-relevant engagement** that links local values and conservation options.

Water Quality

Contact: Coowe Walker, cmwalker9@alaska.edu

Kachemak Bay Reserve has years of research outlining how connectivity from the landscapes around headwaters to the nearshore is critical to salmon productivity. In a low regulatory environment, growing populations and industries put intact systems at risk of disconnection. Decision-makers require an **understanding** of **land use** change **and human impacts,** coupled with information about hydrology and nutrient cycling to select management and mitigation strategies that will preserve ecologically intact systems of the Kachemak Bay area, and serve as examples for other parts of Alaska.

Monitoring Data Synthesis

Contact: Steve Baird, sjbaird@alaska.edu

Kachemak Bay Reserve's **long-term ecosystem monitoring** programs include environment (water quality, nutrients and weather) and biological monitoring (salt marsh vegetation, marine primary productivity, harmful algae and invasive species). These datasets have potential to be developed into sentinel site applications to understand seasonality and trends to plan for future change relevant to the Gulf of Alaska bioregion. There is a need to analyze and outreach these datasets in the context of coastal management priorities for stakeholders in subarctic ecosystems.

Padilla Bay Reserve, Washington

Contact: Dr. Jude Apple, Director, JApple@padillabay.gov

Climate Change

Climate change and increasing atmospheric CO2 are altering sea level, water temperature, pH, and other factors that cause shifts in the distribution, health, and/or performance of species in Padilla Bay. These effects manifest in eelgrass, saltmarsh, mudflat, rocky intertidal, beach, and other coastal habitats. Despite the diverse research and monitoring efforts and Padilla Bay, we often lack precise, measurable, and reliable metrics of emergent effects of climate change and increasing CO2 on local waters. We need to predict how our ecosystem will change over time and identify means of promoting resilience in natural habitats. Therefore, we need to assist local and regional stakeholders in identifying strategies to protect or increase threatened habitats and species, and seek projects that help us understand how climate change will alter species, ecosystem services, and the human communities connected with and reliant upon our coastal ecosystem.

Ecosystem Services

Padilla Bay comprises native & non-native eelgrass, wetland and estuarine habitats, and agricultural lands that represent a valuable ecological, economic, and cultural resource for the region. Although these resources are changing dramatically, we lack quantitative evidence connecting ecosystem functions with ecosystem services. Processes of interest at Padilla Bay include utilization of eelgrass by fish, eelgrass-shellfish interactions, and carbon sequestration. Therefore, we seek projects that use an ecosystem service approach to understand the

socio-ecological systems of Padilla Bay, and use this information to guide protection and/or restoration of local and regional estuarine ecosystems and services in the face of global change.

Water Quality

The Padilla Bay watershed includes natural areas, pastures, agricultural fields, hobby farms, and older homes with compromised septic systems. Fecal coliform contamination is a recurring problem in Padilla Bay and the surrounding waters, leading to the closure of local shellfish beds. Further, the lands surrounding Padilla Bay, and particularly Bayview Ridge, are seeing the effects of development and land-use change. The implications of these changes on water quality, community resilience, and landscape-estuary interactions is unclear. Therefore, the Reserve needs to identify causes of fecal coliform contamination, assist local stakeholders and management agencies to reduce these inputs, and explore linkages between large-scale changes in land use and water quality. We are also seeking opportunities to expand the use of our 100-acre demonstration farm to explore the relationship between agricultural practices, carbon sequestration, and nutrient delivery to coastal waters.

Habitat Resilience

Habitat resilience in Padilla Bay and across the region is being impacted by human and climate-driven processes. Priorities at Padilla Bay include sediment dynamics, which are critical to restoration and long-term resilience of our coastal habitats; eelgrass habitat restoration; and assessing the ecosystem-scale effects of invasive invertebrate and plant species that can alter biodiversity, sediment processes, and food web dynamics. Given these priorities, we need to better understand the stressors, impacts, and methods for increasing restoration success and are, therefore, particularly interested in projects that quantify processes related to sediment, eelgrass, and invasive species, or that test restoration methods.

Monitoring Data Synthesis

Natural and anthropogenic factors act at multiple spatiotemporal scales to drive change in estuarine ecosystems. Understanding how varying drivers interact at different temporal (e.g., short-to-long term) and spatial (e.g., watershed-to-global) scales is essential for addressing management needs. Thus, we are interested in quantitative analyses (e.g. multivariate, time-series, spatial) that synthesize long-term, system-wide monitoring data collected at Padilla Bay and across the NERRS, specifically when applied to investigate natural and anthropogenic drivers of variability in estuarine responses (e.g. in eelgrass, water quality, productivity).

San Francisco Bay Reserve, California

Contact: Matt Ferner, Research Coordinator, MFerner@sfsu.edu

Climate Change

The SF Bay community passed a $500 million parcel tax to restore 30,000 acres of tidal wetlands over the next 20 years and the NERR is a key partner in this collaborative enterprise but there are several gaps in knowledge regarding sediment supply and transport, inundation regimes, surface versus groundwater affects, and salinity regimes; therefore, more research needs to be focused on sediment dynamics and these other issues to better understand marsh ecology and marsh resilience in the face of SLR and how these findings can enhance marsh resiliency through adaptation.

A low-lying County road transects the ancient tidal marsh at China Camp State Park and alters marsh hydrology, sediment dynamics and ecology. The SF Bay NERR has worked with the local community to reach consensus on a set of potential solutions that could solve this problem but additional work is needed to identify the most feasible alternative and to develop that alternative into a project and see it through to implementation; therefore, we seek projects that further research, design, and facilitate community collaboration to identify a preferred alternative for future construction.

Ecosystem Services

California is committed to reducing greenhouse gas concentrations in part by developing carbon sequestration capacity and the brackish tidal marshes in the Suisun Bay region appear to be great ecosystems for maximizing CO2 uptake against methane release but this storage capacity is still not well understood; therefore. more comparative research and stakeholder involvement is needed to demonstrate the carbon sequestration value of restoring brackish marshes.

Water Quality

Both human activities and natural processes can lead to bacterial contamination of bay waters that can result in local beach closures, for example, at China Camp State Park. This problem can diminish the value of public beaches for landowners and local communities; therefore, we need increased capacity to investigate and more carefully monitor bacterial concentrations at the Reserve sites.

Habitat Resilience

There are opportunities to increase stakeholder and end-user engagement on adaptation and restoration planning and implementation activities involving tidal wetlands locally, regionally, and statewide and the Reserve offers opportunities for developing projects and tools that can be used for this purpose but there is a need to synthesize and deliver this scientific and engagement information and tools for this purpose in appropriate venues; therefore, the Reserve should serve as a resource for these endeavors.

Monitoring Data Synthesis

Extreme weather conditions associated with climate change appear to be driving shifts in vegetation and biotic response over time and patterns of change are observable but not well understood or properly characterized for management purposes; therefore, we seek to synthesize various sources of data gathered by the Reserve through long-term monitoring – e.g., vegetation transects, variable water levels, species 'boom and bust' cycles, and other local data – to better understand the impacts of these variable extreme weather conditions and analyze potentially appropriate management responses.

South Slough Reserve, Oregon

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Climate Change

Increase our understanding, communication, and dissemination 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, adaptation and resiliency planning, and understanding regional perceptions of climate change to inform and implement communication strategies.

Ecosystem Services

Increase our understanding of ecosystem services (e.g. carbon sequestration, food production, water provision, timber production, and cultural identity) related to estuarine habitats (including uplands, riparian areas, forested tidal swamps, tidal marshes, and seagrass beds) and native species (e.g. eelgrass, lamprey, salmonids, shellfish) in order to identify and prioritize local and regional management needs and communicate the importance of natural resources to Pacific Northwest 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, and introduction pathways of invasive species) and identify and implement management options (including restoration of watershed functions and

native species such as eelgrass, native oysters, salt marsh plant species, Sitka spruce swamp, lamprey species, and sea otters) and communication strategies to improve habitat quality.

Habitat Resilience

Conduct experimental restoration projects and assess past projects to better understand upland connections to wetlands, invasive species effects (e.g. green crabs on eelgrass restoration), movement/impact of fire, and use of habitat suitability modelling to improve restoration success. Improve our understanding of traditional management practices and nature-based solutions to support natural processes, benefit native plant and animal communities (including culturally significant species), reduce invasive species impacts, and increase resilience (e.g. climate change, wildland fire, invasive species). Enhance awareness of human perspectives and methods for sharing knowledge about restoration benefits.

Monitoring Data Synthesis

Synthesize and interpret local, regional, and national data from the System-Wide Monitoring Program (including Sentinel Site data) to identify environmental degradation issues and improvement opportunities to: 1) provide decision-making tools (including modelling outputs) to meet the needs of coastal managers and decision makers and 2) produce education tools for NERR education staff and volunteers and for both formal and non-formal educators.

Tijuana River Reserve, California

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Climate Change

Characterize the complex interactions (e.g., physical, chemical, biological, and socioecological) between the watershed, estuary, and ocean, including influences of climate change, land use, beach nourishment, and nearshore processes.

Increase understanding of needs related to psychosocial resilience among climate change adaptation/environmental professionals and develop resources for internal needs and external support for coastal decision-maker audiences.

Embed justice, equity, diversity, and inclusion in adaptation planning, public access, and natural resource management.

Ecosystem Services

Assess factors that influence estuarine biodiversity, such as habitat support for endangered species or the impacts of biological invasions.

Explore cultural ecosystem services, especially in an urban and binational context, and including public health and wellbeing.

Water Quality

Elucidate the impacts and potential management of sediment, debris, pollutants, flooding, and anthropogenic freshwater in coastal wetlands.

Establish inter-agency collaboration on issues related to infrastructure management, beneficial sediment uses and green infrastructure/living shorelines, and permitting.

Habitat Resilience

Develop adaptive, science-based approaches to manage and restore resilient marsh, transition zone, and dune habitats.

Integrate habitat resilience efforts with infrastructure and public access opportunities.

Develop monitoring approaches to complement ongoing Reserve-based abiotic and biotic monitoring, such as the use of living organisms as “biosentinels.”

Monitoring Data Synthesis

Use long-term monitoring data to develop "triggers" for management action and adaptation pathways.

Pacific Island Region

He’eia Reserve, Hawaii

Contact: Kawika B. Winter, Reserve Manager, Kawikaw@hawaii.edu

Climate Change

Landscapes in our Reserve have altered dramatically due to large changes in land-use, development, and currently, restoration following Indigenous management practices, and our collaborators and partners have been collecting baseline measurements of biophysical, social, economic, and behavioral impacts of habitat change. But it is still unknown how our watershed, as it undergoes restoration, responds to impacts of climate change such as more intense and frequent storms, rising sea level and frequent king tides, warming temperatures, decreasing pH, and subsequent effects on the trophic food web of our nearshore ecosystems. Therefore, our stewards of place and restoration specialists need to learn about how to optimize biogeochemical conditions (i.e., dissolved oxygen, macro- or micro-nutrients) in our watershed to maximize productivity, invasive species removal, and Indigenous management practices.

Ecosystem Services

The primary research question for our Reserve is to examine the effects of Indigenous and contemporary ecosystem-based management practices on ecosystem services in He’eia, in order to evaluate restoration success. And current research and stewardship collaborators and partners are conducting activities that align with our ecosystem services approach. But a great need is present for developing and refining models to connect many of the seemingly disparate collections of ecosystem services measurements in our watershed. Therefore, we seek research projects that attempt to connect our various habitats, animals, and concepts through innovative tools that help to model a whole-ahupua’a approach, such as participatory, collaborative research with agroecosystem managers and students, on nutrient management in wetland/estuarine habitat and its impacts on productivity or yield. We are also aiming to incorporate cultural ecosystem services into ahupua'a-based restoration and management of the Reserve, through the development and assessment of biocultural indicators of human wellness and spirituality, community connectivity, and intergenerational learning.

Water Quality

Landscapes in our Reserve have altered dramatically due to large changes in land-use and development, with problems involving high rates of sediment erosion, high abundances of invasive species, and nutrient enrichment in nearshore coastal regions, and our Reserve, collaborators and partners are working to restore Indigenous agro-ecology practices (e.g., native agroforestry, flooded taro fields as sediment retention basins), to increase native species biodiversity and help mitigate erosion issues. But studies are still needed to evaluate the efficacy of our restoration on priority ecosystem services in our watershed. Therefore, we seek research examining sediment input into nearshore coral reef ecosystems, nutrient dynamics and fishpond productivity, and bioindicators of watershed abundance and health, such as native birds, fishes, and plants. In addition, we are focused on mitigating specific contamination by wastewater and invasive species, micro- and macroalgae growth, filter feeders, and nearshore water quality.

Habitat Resilience

The primary objective of our Reserve is to restore our watershed to the native abundance of its past, which represented a highly sustainable method of managing resources and sustaining a population. We view this Native Hawaiian watershed management practice as the ultimate form of estuarine habitat resilience, and we are currently working towards identifying best practices for restoring and recovering this resilience while adaptively managing current scenarios. But our Reserve recognizes the need and the challenge to incorporate local and Indigenous knowledge, and the concept of kilo, to effectively co-develop and co-manage research and restoration projects. Therefore, we are interested in following our research framework which emphasizes co-development and co-management of research projects with Indigenous and local communities, effectively merging and synthesizing two worldviews while monitoring native biota as indicators of restoration success, optimizing nutrient flows down the watershed to maximize productivity, and establishing biodiversity metrics as a way to improve habitat resilience.

Monitoring Data Synthesis

While our Reserve has recently started collecting NERRS-sanctioned long-term monitoring data, it is important to establish context for our current measurements by examining past information collected in our Reserve. And our collaborators and partners have amassed a large collection of data and information about our place, including the people and their relationships to the place. But currently, the data and information exist in different databases and are not easily retrievable for comparison or modeling for future data. Therefore, cross-sector collaborative efforts to synthesize historical and current cultural and scientific data are needed, with the goal of creating national products such as the digital Site Profile, as well as developing useful models to guide the future of restoration (e.g., hydrography, nutrient dynamics, and trophic interactions and production in the He'eia estuary and nearshore reef ecosystem).