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North Carolina Sentinel Site Cooperative: Report on the 2017 Partners Meeting

NOAA Auditorium, Beaufort, NC
February 21, 2017

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U. S. DEPARTMENT OF COMMERCE
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North Carolina Sentinel Site Cooperative:
Report on the 2017 Partners Meeting

EXECUTIVE SUMMARY

The North Carolina Sentinel Site Cooperative (NCSSC) was established in 2012 as part of a National Oceanic and Atmospheric Administration (NOAA) effort to provide coastal communities and resource managers with information on the potential impacts of sea level rise on coastal habitats. The NCSSC utilizes a collaborative business model to bring together stakeholders, including data producers and end users, through a Core Management Team (CMT) and advisory committee. The goal of the Cooperative is to leverage resources across organizations and integrate the multiple efforts within the NCSSC geography to provide better information to help stakeholders address the challenges associated with sea level rise (SLR) and coastal inundation.

The NCSSC interacts with many stakeholders within the Cooperative's geography, in an effort to leverage resources and build partnerships. This includes facilitating collaborative workshops, understanding and addressing information needs, conducting and analyzing research and monitoring across organizations, improving access to high quality data, effectively communicating information to stakeholders through coordinated educational programs and community involvement, and leading by example through implementation of management strategies by Cooperative participants. The Cooperative was formed to capitalize on and enhance the individual strengths of stakeholders to collectively address sea level rise impacts within the coastal zone in a more holistic and efficient manner.

The *2017 Partners Meeting* was hosted by the North Carolina Sentinel Site Cooperative and the NC National Estuarine Research Reserve on 21 February 2017, at the NOAA Auditorium on Pivers Island in Beaufort, North Carolina. This meeting had a richer diversity of participants than previous NCSSC meetings. The 51 meeting participants included research scientists, coastal managers, town planners, and education professionals from universities, government agencies, and non-profits involved in efforts related to sea level rise, inundation, and coastal resiliency in the central coast of North Carolina.

Prior to the meeting, a pre-meeting survey asked participants to rank potential NCSSC actions that could help their organization use sea level rise data and projected effects in programming and planning. In the survey, participants ranked communication products highest, followed by funding, coordination meetings, and trainings. In the survey, participants also identified and ranked gaps related to sea level rise, inundation, and coastal resilience in the NCSSC. These gaps, in ascending order of importance, are as follows:

1. Effects of sea level rise on water quality and ecosystem health
2. Better understanding of the economic effects of sea level rise
3. Sea level rise and inundation outreach resources targeting specific audiences (e.g. coastal property owners, local government)
4. Understanding sediment supply and how sediment supply impacts coastal habitat resilience

5. Formal (K-12) and non-formal education materials that incorporate sea level rise science, local data, and localized effects of sea level rise
6. Local scale sea level projects to inform decision-making
7. Stakeholder training on the use of tools and models (e.g. NOAA sea-level rise viewer) to inform decision making related to sea level rise and inundation
8. Identify how land subsidence is impacting the NCSSC geographic area
9. Effects of sea level rise on essential fish habitat
10. Citizen science opportunities related to sea level rise and inundation
11. Better understanding of water level measurements, including identification of local tidal datum and links to sea level rise

Meeting participants became familiar with the NOAA Sentinel Site Program (SSP) and the NCSSC through presentations during the meeting. Jennifer Dorton (NCSSC Coordinator) provided background information about the SSP, NCSSC, and efforts by the NCSSC to address information gaps and build partnerships. Sarah Spiegler (NCSSC Outreach Specialist) summarized results from the pre-meeting survey sent to meeting participants about prioritizing information gaps. The workshop agenda also included presentations from NOAA National Ocean Service's National Centers for Coastal Ocean Science (NCCOS), the University of North Carolina Chapel Hill's Institute of Marine Sciences (UNC-IMS), and the City of Jacksonville about the success of NCSSC partnerships in research, monitoring, and education to address the effects of sea level rise in the Cooperative's geography.

During the meeting, participants were placed into breakout groups to discuss the prioritized gaps from the pre-meeting survey, add any gaps that were not captured on the survey, and further prioritize gaps within the Cooperative. The participants in the first breakout groups during the meeting were tasked with identifying the top three to five gaps based on importance for the Cooperative to address. The gaps identified by each breakout group were synthesized and resulted in three prioritized gaps for the NCSSC for the next three years:

1. Effects of sea level rise on ecosystem health and observations/monitoring
2. Better understanding of localized effects of sea level rise, especially socio-economic effects
3. Communication of sea level rise impacts and bridging the communication gap between science and decision makers

The second breakout group during the meeting had a separate discussion section for each of these top three identified gaps. Participants self-selected which of the three breakout group sections to attend to discuss what resources are currently available to fill these gaps, and what else Cooperative partners would need to address these gaps. This included identifying potential resources, partnership building, collaborative project development, and pursuit of funding opportunities. Participants were also asked to discuss whether the current geographic boundary of the NCSSC was appropriate for the identified gaps and research needs.

These next steps and action items for the NCSSC were identified following the second breakout group discussions:

1. Host a NOAA Tools Training
2. Create a NCSSC Communications Plan
3. Host a NCSSC Science Symposium
4. Determine if there is interest in a NERRS Science Collaborative project
5. Determine how to include the socio-economic effects of sea level rise in the update of the NCSSC Implementation Plan
6. Host annual NCSSC meetings
7. Recruit new Core Management Team members

There was a high level of energy and engagement at the 2017 meeting. Scientists, coastal managers, and educational professionals were provided an opportunity to learn from other meeting participants in a collaborative setting. Most participants expressed the opportunity to network with those outside of their profession as a valuable part of the meeting. Many of the participants at the meeting discussed the values of integrating the impacts of sea level rise on ecosystem health, community vulnerability, and built environments for informing management decisions for coastal communities. The original focus when the NCSSC was formed in 2012 was to address the impacts of sea level rise and inundation on coastal habitats. A broader outlook for the NCSSC that also considers the impacts of sea level rise on built environments may allow for more diverse involvement in the Cooperative going forward.

The Core Management Team, meeting participants, and relevant stakeholders will continue to work together and build partnerships to update the NCSSC Implementation Plan and fill the gaps and priorities identified at this meeting to move the NCSSC forward.

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LIST OF ABBREVIATIONS

APNEP: Albemarle Pamlico National Estuary Partnership
CAMA: North Carolina Coastal Area Management Act
CCFHR: NOAA Center for Coastal Fisheries and Habitat Research
CMT: NCSSC Core Management Team
DoD: U.S. Department of Defense
DoI: U.S. Department of the Interior
ECU: East Carolina University
EPA: U.S. Environmental Protection Agency
GPS: Global Positioning System
LIDAR: Light Detection and Ranging
NC: North Carolina
NCCF: North Carolina Coastal Federation
NCCOS: NOAA National Centers for Coastal and Ocean Science
NCCR: North Carolina Coastal Reserve
NCDCM: North Carolina Division of Coastal Management
NCDMF: North Carolina Division of Marine Fisheries
NCEI: NOAA's National Centers for Environmental Information
NCGS: North Carolina Geodetic Survey
NCNERR: North Carolina National Estuarine Research Reserve
NCSG: North Carolina Sea Grant
NCSSC: North Carolina Sentinel Site Cooperative
NCSU: North Carolina State University
NCSU CMAST: North Carolina State University Center for Marine Sciences and Technology
NCWRC: North Carolina Wildlife Resources Commission
NERRS: National Estuarine Research Reserve System
NMFS: National Marine Fisheries Service
NOAA: National Oceanic and Atmospheric Administration
NOS: National Ocean Service
NPS: U.S. National Park Service
OCM: NOAA Office of Coastal Management
SAV: Submerged Aquatic Vegetation
SECART: NOAA Southeast and Caribbean Regional Team
SECOORA: Southeast Coastal Ocean Observing Regional Association
SET: Surface elevation table
SSP: NOAA Sentinel Site Program
UNC-CH: University of North Carolina, Chapel Hill
UNC-IMS: University of North Carolina Chapel Hill’s Institute of Marine Science
UNCW: University of North Carolina, Wilmington
USACE: U.S. Army Corps of Engineers
USFS: U.S. Forest Service
USFWS: U.S. Fish and Wildlife Service
USGS: U.S. Geological Survey

BACKGROUND OF NCSSC

The North Carolina (NC) Sentinel Site Cooperative (NCSSC) was established in 2012 as part of a National Oceanic and Atmospheric Administration (NOAA) effort to provide coastal communities and resource managers with information on the potential impacts of sea level rise on coastal habitats. The goal of the NCSSC is to bring together stakeholders to leverage resources across organizations, integrate the multiple efforts within the NC Sentinel Site Cooperative geography, and provide better information to help stakeholders adapt to sea level rise and coastal inundation. The NC Sentinel Site Cooperative is one of five pilot Sentinel Site Cooperatives implemented by NOAA. The other four sites include the Hawaiian Islands, the San Francisco Bay, the Chesapeake Bay, and the Northern Gulf of Mexico. More information is available at http://oceanservice.noaa.gov/sentinelsites/.

NOAA established this Sentinel Site Program (SSP) to utilize existing assets, programs, and resources to address coastal management issues of local, regional, and national significance through a place-based, issue-driven, and collaborative approach. The Cooperatives in the SSP capitalize on existing investments in NOAA trust resources, such as National Marine Sanctuaries, National Estuarine Research Reserves, observing systems, and partner capabilities in research, monitoring, management and decision-making to address sea level change and coastal inundation. The SSP outlines an innovative business model to better leverage resources across NOAA and its partners to increase efficiencies, integrate multiple parallel efforts, and provide information and tools to help communities and resource managers adapt to sea level change and inundation. Such a collaborative approach has not been undertaken in this geography nor on sea level rise and inundation in NC. The goal of the Cooperative is to capitalize on and enhance the individual strengths of the stakeholders to collectively address this challenge in a more holistic and efficient manner.

North Carolina represents a unique suite of characteristics that make it well suited to host a Sentinel Site Cooperative. The coast of North Carolina has one of the highest vulnerabilities to sea level rise on the Atlantic coast (Thieler and Hammar-Klose, 1999; CCSP, 2009), due to its high wave exposure, low-relief coastal slope, and abundance of barrier islands. Many of North Carolina's coastal habitats are protected within existing management boundaries, including U.S. National Park Service (NPS) National Seashores (Cape Lookout and Cape Hatteras), National Forests, States Forests, State Parks, U.S. Department of Defense (DoD) installations, North Carolina Coastal Reserves (NCCR) and National Estuarine Research Reserve (NCNERR), U.S. Fish and Wildlife Service (USFWS) National Wildlife Refuges, and The Nature Conservancy Nature Preserves. These locations provide comparatively undisturbed (by human) references to measure and observe both the vulnerability and resiliency of natural communities to sea level rise.

The NCSSC geography is the central North Carolina coast, as depicted in Figure 1. The selected geography is particularly well instrumented and studied due to its physical setting, biological diversity, and high concentration of marine science facilities in the area. This includes the multi-partner NOAA laboratory, which houses NOAA National Ocean Service (NOS) and National Marine Fisheries Service (NMFS) programs, and the NCCR/NCNERR offices. The headquarters for the North Carolina Divisions of Coastal Management (NCDCM) and Marine Fisheries

(NCDMF), three graduate marine science research institutions (Duke University, University of North Carolina at Chapel Hill (UNC-CH), North Carolina State University (NCSU)), Cape Lookout National Seashore, Cedar Island National Wildlife Refuge, Croatan National Forest, Fort Macon and Hammock's Beach State Parks, North Carolina Aquarium at Pine Knoll Shores, North Carolina Maritime Museum, North Carolina Coastal Federation (NCCF) headquarters, and the Port of Morehead City are all located within the Cooperative's geography. The Cooperative geography also includes United States Marine Corps Base Camp Lejeune and Marine Corps Air Station Cherry Point. Camp Lejeune is the largest Marine Corps base on the East Coast.

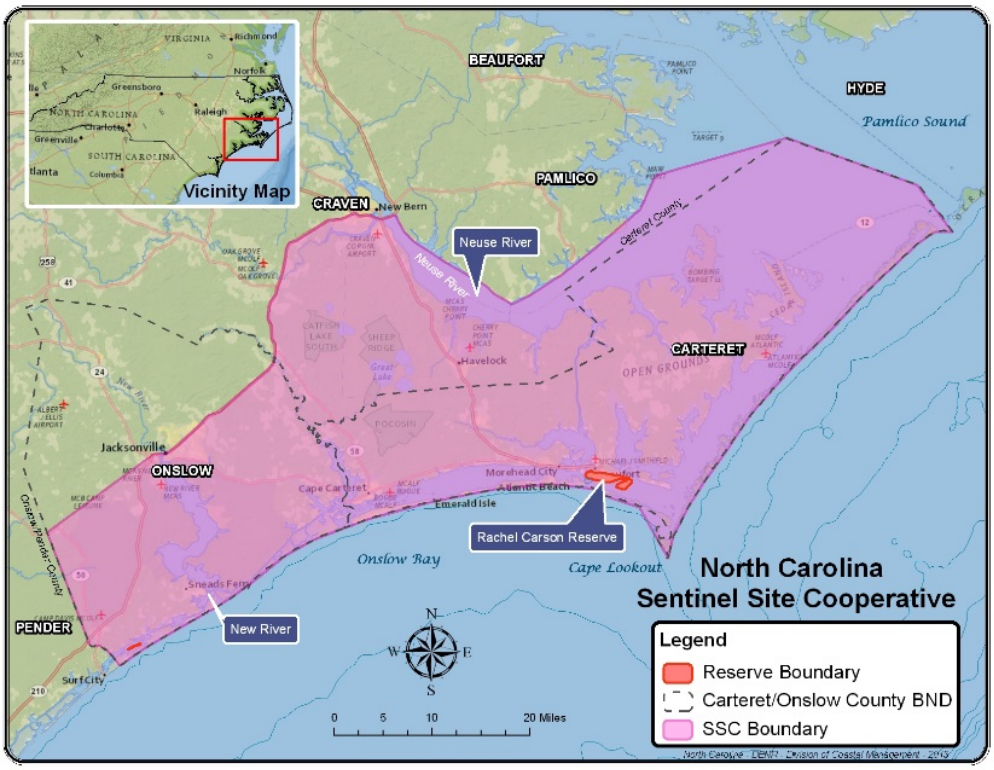

Figure 1. North Carolina Sentinel Site Cooperative geography.

Within the NCSSC's geography, the economy is explicitly linked to the ecosystem services provided by the area's natural resources. The geographical region encompassed by the Cooperative relies heavily on tourism, ecotourism, shipping, and commercial and recreational fishing to sustain its economy. The area's military installations also utilize the physical setting of the central coast for various training scenarios which are critical to their operations.

This combination of characteristics presents a unique opportunity for the Cooperative to accomplish the end-to-end implementation of science to decision-making, ensuring the resiliency of these ecosystems and communities to sea level rise impacts. The geography of the NCSSC in the central coast of Eastern North Carolina was originally chosen in 2012 to ensure the success of the Cooperative. The five Sentinel Site Cooperatives did not initially receive any new funding by the NOAA Sentinel Site Program (SSP). Therefore the relatively small geography of the NCSSC, as compared to the other four Sentinel Site Cooperatives, was designated as more

manageable for the NC program by the NCSCC Core Management Team. Part-time coordinators for the five Sentinel Site Cooperative programs were hired in 2014 through funding from the SSP. The NC Cooperative offers the potential of future expansion to other sections of the North Carolina coast based on its success since 2012. Cooperative results from North Carolina may also be transferable to the mid-Atlantic and southeast regions of the United States with similar environments and economies.

NCSSC Mission and Goals

The stated mission of the NCSSC is to "work collaboratively and leverage resources across partners to provide research, monitoring, and information for addressing coastal resiliency concerns such as flooding, inundation, and sea level rise."

The three goals of the NCSSC, as outlined in the Implementation Plan (IP) are listed below.

- *Goal 1:* Impacts of sea level rise on coastal ecosystems will be better understood through NCSSC research and monitoring, and its translation to support coastal decision making.

- *Goal 2:* Resource managers receive and apply the NCSSC scientific information to enhance sustainable and resilient conservation strategies for coastal ecosystems.

- *Goal 3:* Coastal residents are better informed to address sea level rise impacts.

More specific action items related to these goals can be found in the NCSSC IP, available here: http://oceanservice.noaa.gov/sentinelsites/pdf/NC_SSC_Implementation_Plan.pdf

Information and feedback from this 2017 Partnership meeting will inform the next update of the plan for the years 2017-2020 by the NCSSC Core Management Team (CMT). The three goals of the NCSSC are quite broad by design, however the successes of the Cooperative are seen in specific actions, partnerships, and projects (see *Selected NCSSC Accomplishments, 2013-2017*, below). The update of the IP for the next three years will likely continue with similar goals. The impacts of SLR on built environments in addition to coastal habitats, and the expansion of the Cooperative geography will be considered when updating the IP, based on partnership needs and the direction of the NCSSC desired by the CMT.

2013 NCSSC Research and Monitoring Coordination Workshop

The NCSSC last hosted a partner meeting, the *Research and Monitoring Coordination Workshop*, in March 2013. At this workshop, the Cooperative was described by many participants as being important to enhance partnerships in the area, to facilitate cooperation and decrease redundancies in research and monitoring, for citing in future funding proposals, and to raise the overall awareness of the effects of sea level rise in the area. The top priorities identified by 2013 workshop participants are below:

1. The need for more water level data.
2. The development of a central clearinghouse for Cooperative data.

3. Increased awareness of sea-level rise issues and impacts.
4. Understanding sediment supply and dynamics and effects of land use changes on sediment dynamics.
5. Improved coastal LIDAR data and bathymetry.
6. Economic assessment of sea-level rise impacts on the built environment and ecosystem services.
7. More water quality and data collection stations.

More information from the 2013 NCSSC workshop is available in the Technical Memo here: http://oceanservice.noaa.gov/sentinelsites/pdf/NC_SSC_SLR_Research_Coordination_Wkshop.pdf

In the NCSSC 2013 Technical Memo (Appendix F post-workshop evaluations, page 53) the following were listed as important next steps for the NCSSC:

- Potential partnerships and collaborations;
- Collaboration with other agencies;
- Future collaboration in funding proposals and research topics.

Selected NCSSC Accomplishments, 2013-2017

Since 2013, the NCSSC has taken steps to move forward on the priorities and next steps outlined above. After the 2013 workshop, the NCSSC and SSP recognized that a dedicated person for coordinating the daily activities of the Cooperatives was necessary. The Sentinel Site Program (SSP) Coordinating Committee, led by Nina Garfield (NERRS) and Galen Scott (USGS), secured NOAA funding for a part time NCSSC Cooperative Coordinator for the Fiscal Years (FY) 2014-2016, and in partnership with NC Sea Grant hired Jennifer Dorton as the NCSSC Coordinator. In 2016, a grant proposal was submitted to the SSP by Jennifer Dorton and John Fear (Deputy Director, NC Sea Grant) to fund a NCSSC Coordinator (Jennifer Dorton), and a NCSSC Outreach Specialist (Sarah Spiegler) to be based in Beaufort, NC. This funding also included money for two one-year NCSSC graduate student fellowships, and NCSSC sponsored meetings, travel and food costs.

Some key accomplishments of the NCSSC since the 2013 *Research and Monitoring Coordination Workshop* are listed below:

- The **NCSSC Quarterly Newsletter** disseminates information on Cooperative activities, posts information on upcoming meetings and events, and shares research that addresses flooding, inundation, sea level rise, and coastal resiliency within the Cooperative geography. Readership has expanded to over 150 recipients.

- A **SET inventory** for all five of the NOAA Sentinel Site Cooperatives was completed by NCCOS researchers Carolyn Currin (member of the NCSSC Core Management Team) and Jenny Davis, both located at the NOAA Beaufort lab. Information in the inventory includes the location of each SET, as well as details on the ecology and hydrology at each

location. The information has been compiled into a single database and is available by contacting either Currin or Davis. A summary of the work can be found here: http://oceanservice.noaa.gov/sentinelsites/pdf/set-inventory-summary.pdf.

- A **NC High Water Level and Storm Surge Monitoring meeting** was hosted by the National Weather Service (NWS) Office in Newport/Morehead City, NC, in conjunction with NOAA Southeast and Caribbean Regional Team (SECART) and the NCSSC. The meeting was held March 17-18, 2015 at the NOAA Beaufort Lab. The meeting goals included: 1) identify which agencies are currently monitoring water level and coastal vegetation; and, 2) determine who is willing to participate in an effort to measure high water levels and storm impacts in coastal NC. Meeting participants included local, state and federal agencies and academic institutions. Participants were willing to assist US Geological Survey (USGS) with deployment of temporary water level sensors prior to storm events and help the NWS collect post-storm event water levels. The NWS and NCSSC hosted a second meeting at the NOAA Beaufort Lab on 20 April 2017 to bring old and new workshop participants back together to move forward with the first meeting goals (more information can be found in *Summary of Outcomes, Completed Action Items*, below*)*.

- The **NCSSC Clearinghouse** provides access to sea level rise and coastal resiliency research and monitoring projects located within the Cooperative's geography. During the 2013 *Research and Monitoring Coordination Workshop*, the NCSSC Core Management Team and partners identified the need for an on-line resource that provides access to sea level rise information within the Cooperative boundaries. The initial Clearinghouse development was completed through NOAA Southeast and Caribbean Regional Team (SECART) support, in partnership with East Carolina University (ECU). The NCSSC Clearinghouse is hosted on the NC Coastal Atlas (https://www.nccoastalatlas.org/). The goal of the Clearinghouse is to spatially identify research and monitoring projects, provide contact information for project investigators, and citations for published research results. The Clearinghouse can be found at: https://www.nccoastalatlas.org/maps/by-title/nc-sentinel-site-projects. The initial Clearinghouse design was reviewed by NCSSC Core Management Team Members and Cooperative partners. Continued development of the Clearinghouse was conducted with user feedback about the Clearinghouse functionality and design. The clearinghouse is also utilized as a tool to conduct outreach within the Cooperative.

- The **2015 NOAA Ecological Effects of Sea Level Rise** (EESLR) Federal Funding Opportunity (FFO) requested that proposed efforts be conducted within Sentinel Site Program locations. Five proposals from the NCSSC were submitted that would focus efforts within the Cooperative's boundaries. Two proposals were funded in the NCSSC geography:

    - *Developing and Evaluating the Coastal Recovery from Storms Tool (CReST): A model designed to assess resilience and reduce storm and sea level rise impacts on natural and engineered beaches and dunes*. (PI Peter Ruggiero, Oregon State University, 2015-2017). This EESLR project covers the area from Emerald Isle

on Bogue Banks to the northeast end of North Core Banks. The resulting modeling tool will assess beach and dune evolution in both natural (Cape Lookout National Seashore) and managed systems (Atlantic Beach, NC) in response to sea level rise and extreme storms. The CReST tool developed in this project will be used to estimate recovery and vulnerability to future storm events under a variety of sea level rise, storm change, and management scenarios at both Cape Lookout National Seashore and Atlantic Beach. The University of North Carolina at Chapel Hill is also a partner on this project.

The NCSSC has hosted multiple meetings with the Ruggerio project members and coastal managers (National Park Service and Carteret County) to share initial project findings. Discussions at these meetings regarding beach/dune management issues and needs within the NCSSC, and climate change scenarios (sea level rise, possible changes to storminess, etc.) helped inform modeling efforts for the CReST tool.

- *Understanding and predicting changes in coastal marsh ecosystem services: realizing the combined effects of sea-level rise, tides, and storm surge on marshes and their capacity to protect shorelines*. (PI Christine Voss, UNC Institute for Marine Science, 2015-2017). This EESLR project combines a marsh transgression model with a marsh wave attenuation model to predict changes in shoreline protection associated with rising sea levels and changes in storm intensity. The project will also identify barriers to up-slope transgression that could be removed to improve marsh resilience in the face of sea level rise, and provide guidance for coastal property owners on the value of marsh habitat in protecting their shoreline properties. By comparing the resilience and ecosystem service capacities of the two structurally different marsh species with different wave attenuation properties, managers can target the best species or mixed species pattern for restoration projects.

- The **NC King Tides** citizen science project is the outreach component of the NC EESLR funded project (above) by Christine Voss of UNC-IMS. The NC King Tides is a regional citizen science effort for the international King Tides project. The project asks community members to take pictures of high water level events during what are known as "King Tide" events; predicted as occurring when the earth, sun, and moon are in alignment. These pictures are then posted to the NC King Tides Flickr website. This project aims to advance awareness of the impacts of sea level rise and coastal inundation in local communities by having people visualize what the normal tide ranges may look like in the future. The NCSSC Coordinator and Outreach Specialist have worked closely with the Voss lab on outreach efforts to connect the NC King Tides project with K-12 educators and other community groups in the Cooperative. The NCSSC is also working collaboratively with Christine Buckel (NOAA National Ocean Service), Voss, and the NWS on the development of the "What's your water level" app, to be released in 2017 by NOAA. People throughout the United States will be able to take and post pictures of high water level events in their community through the app. The data collected will be used by scientists and the NWS in research and outreach efforts.

- The **NC Aquarium at Pine Knoll Shores** partnered with the NCSSC to design interpretive signs to increase the general public's understanding of marsh ecosystems, ecosystem services and the role of marshes in coastal resiliency. NOAA National Centers for Coastal Ocean Science's Center for Coastal Fisheries and Habitat Research and the NC National Estuarine Research Reserve (both NCSSC partners) have collaboratively monitored changes in marsh vegetation and surface elevation over time throughout the Cooperative geography. One of these monitoring locations is at the Aquarium, which has been a monitoring site since 2002. SECART supported NCSSC product development with the funding of this project in 2016. Five signs were installed along the marsh boardwalk adjacent to the Aquarium in October 2016 and are available to the Aquarium's ~ 500,000 annual visitors.

  The Aquarium is again partnering with the NCSSC on a collaborative project in 2017 (more information can be found in *Summary of Outcomes, Completed Action Items,* below*).*

- *"Quantifying and Communicating the Function of Restored Estuarine Habitats"* (PI Mike Piehler, UNC-IMS, 2016-2017). A partnership with the **City of Jacksonville** resulted in a collaborative research project funded by the NC Sea Grant Community Collaborative Research Grant. Jennifer Dorton (NCSSC Coordinator and NC Sea Grant) brought together partners from City of Jacksonville Storm Water Services Division, Marine Corps Base Camp Lejuene, NOAA NCCOS, NC Sea Grant, and UNC-IMS to evaluate the ecosystem services of estuarine restoration projects within Wilson Bay. This diverse group of partners was led by Piehler to quantify the ecosystem services, resilience, and vulnerability of coastal wetlands (restored and natural) in an urbanized, brackish region of Wilson Bay, part of the New River Estuary in the City of Jacksonville (Onslow County, NC). The project team established stations to monitor the effects of storms and sea level rise on natural and restored wetlands. Six Surface Elevation Tables (SETs) were installed, three in the restored marsh and three in the natural marsh. Scientists from NOAA NCCOS taught the staff at City of Jacksonville how to monitor these SETs, which will result in a long-term record of marsh response to sea level rise in Wilson Bay. Results from this project will be shared with over 10,000 K-12 students annually at Sturgeon City. Sturgeon City is the City of Jacksonville's Environmental Education Center. (See *Appendix C* for more project information).

- The **NC Sea Grant Coastwatch** publication highlighted the work of NOAA's five Sentinel Site Cooperatives in the Sentinel Site Program (SSP). The article was published in the Winter 2016 edition of *Coastwatch*, NC Sea Grant's award-winning publication. The goal of the Cooperatives in the SSP is to investigate the impacts of sea level rise in five distinct geographies across the nation (San Francisco Bay, Hawaiian Islands, Chesapeake Bay, the Northern Gulf of Mexico, and North Carolina). The NCSSC and NC Sea Grant spearheaded this effort to feature the activities and accomplishments of the five Cooperatives. NC Sea Grant worked with the five Cooperative Coordinators to write this article that focused on the importance of addressing sea level rise by NOAA and the United States. The finalized article was widely disseminated and received by a diverse

audience, helping spread the word about the collaborative work being conducted within the five Cooperatives.

- *"Develop guidance for incorporating natural infrastructure into efforts to increase coastal resiliency"* (PI Carolyn Currin, NOAA NOS, 2015) and *"Thin layer application of dredged sediment to salt marshes on Marine Corps Base Camp Lejeune to increase coastal resiliency"* (PI Carolyn Currin, NOAA NOS, 2017-2018). A partnership between **Marine Corps Base Camp Lejeune** and **NOAA NCCOS** continues to provide guidance to decision makers. In the most recent project, researchers are conducting and evaluating thin-layer application of dredged material to salt marshes on Marine Corps Base Camp Lejeune. This project utilizes and tests an adaptive management option to improve the long-term sustainability and resiliency of salt marsh habitat by building sediment elevation in fragmented and low-lying marshes adjacent to the Atlantic Intracoastal Water Way. The U.S. Army Corps of Engineers will assist with permitting and regulatory compliance in the planning stages, and will also assist in the second phase of dredge disposal. The proposed sites are near long-term NOAA research sites with nearby water level stations and elevation benchmarks.

- *Evaluating stakeholder perceptions of sea level rise in coastal North Carolina using a social-ecological framework* (Carter Smith, UNC-IMS, 2017-2018). Support for **NCSSC-NC Sea Grant graduate student fellowships** were designated as part of the 2016 NCSSC Coordinator funding provided by NOAA NOS. A panel of NCSSC Core Management Team members selected Carter Smith, a UNC-IMS PhD student in the lab of Charles Peterson, as the 2017 NCSSC-NC Sea Grant Fellow. Smith was selected to study sea level rise and storm events in Carteret, Dare and Brunswick counties and will receive $10,000 to support her project.

  Smith will survey NC homeowners to identify attitudes and perceptions of sea level rise risk in the context of ecosystem services, shoreline hardening, and coastal resiliency. The project will utilize data from a two-year hurricane resiliency field study conducted by Smith from before and after Hurricane Matthew. Smith will use field data and social perceptions to understand the links between risk, socioeconomic data, and observed damage. The overarching goal of the project is to collect data that will help coastal managers inform stakeholders about climate change and coastal resilience adaptation strategies. This fellowship will also contribute to better understanding the socio-economic effects of sea level rise in the NCSSC, a gap noted by Cooperative partners.

  Graduate students applying for this fellowship were asked to conduct hypothesis-based research within one or more of the following sea level rise and inundation focal areas:

  - Impacts on coastal habitats and their associated ecosystem services.
  - Marsh and wetlands sediment supply and distribution.
  - Economic and/or ecological assessments of SLR on human communities and/or coastal ecosystems.
  - Vulnerability of natural and man-made environments to nuisance flooding.
  - Using citizen science based efforts to better understand SLR impacts.

- Development of K-12 pedagogical approaches to climate and SLR education.

MEETING STATEMENT OF PURPOSE

The 2017 NCSSC *Partners Meeting* was hosted by the North Carolina Sentinel Site Cooperative and the NCNERR on 21 February 2017, at the NOAA Laboratory on Pivers Island in Beaufort, North Carolina. There were 51 meeting participants from a diverse background of academic institutions, government agencies, and non-profits.

NCNERR submitted a 2016 Capacity Building Grant with the stated goal to conduct a stakeholder engagement workshop in 2017. The 2017 *Partners Meeting* will build upon the success of the NCSSC's 2013 workshop by re-engaging researchers and expanding stakeholder engagement to include public land managers, natural resource managers, municipalities, and non-governmental organizations to identify and prioritize landscape-scale approaches to understanding and addressing flooding and sea level rise impacts within the geography in a more holistic and efficient manner. The overall goal is to create a team that focuses on sea level rise implications for coastal and estuarine ecosystems. A possible outcome from the 2017 *Partners Meeting* is that the team will submit a grant proposal to the NERRS Science Collaborative in 2017.

Meeting Purpose

The purpose of this meeting is to bring people together to collaboratively enhance the resilience of North Carolina Sentinel Site Cooperative geography to sea level rise and flooding.

Meeting Objectives

The stated objectives of the meeting for participants included:

- Learn about the North Carolina Sentinel Site Cooperative (NCSSC) and its accomplishments;
- Learn about current research and projects conducted by partners within the NCSSC geography;
- Identify needs (e.g. research, monitoring, outreach, tools/products) to promote resilience of the NCSSC geography to sea level rise and flooding;
- Strategize how to best address these needs, including partnership building, collaborative project development, and pursuit of funding opportunities;
- Network with colleagues working on common goals; and
- Learn about ways to participate in the NCSSC.

These objectives were accomplished at the meeting through presentations and facilitated discussions. Presentations from NCSSC partners, showcasing success stories accomplished in the Cooperative geography, were delivered by research scientists and city staff from NOAA NOS, University of North Carolina Chapel Hill's Institute of Marine Sciences (UNC-IMS), and City of Jacksonville, NC. Breakout groups at the meeting discussed the gaps present in sea level rise and coastal resilience research and outreach efforts that were prioritized by partners in the pre-meeting survey. (See *Appendix A* for Pre-meeting Survey, *Appendix B* for Workshop Agenda, *Appendix C* for Workshop Presentation Summaries, and *Appendix E* for a Summary of Breakout

Group Discussions). The first breakout group discussions refined the gaps from the pre-meeting survey and chose these top three priorities for the NCSSC over the next three years; effects of sea level rise on ecosystem health and observations/monitoring, better understanding of localized and socio-economic effects of sea level rise, and communication of sea level rise impacts. Breakout groups then discussed how to work collaboratively to fill these three gaps.

This summary report of the meeting outcomes is expected to support research, education, outreach, and partnership efforts.

This meeting was hosted by the North Carolina Sentinel Site Cooperative and NCNERR, which includes staff from the NCDCM, NCCR/NCNERR, NOAA's National Centers for Environmental Data (NCEI), NOAA's National Centers for Coastal and Ocean Science (NCCOS), and NOAA's National Weather Service. Support for this event was provided a National Estuarine Research Reserve System (NERRS) Science Collaborative Grant.

SUMMARY OF OUTCOMES

Prioritized Gaps Identified in Pre-Meeting Survey

Prior to the meeting, participants filled out a pre-meeting survey. Participants ranked communication products highest when asked how the NCSSC could help their organization use sea level rise data and projected effects in programming and planning, followed by funding, coordination meetings, and trainings. In the survey, participants also identified and ranked gaps related to sea level rise, inundation, and coastal resilience in the NCSSC. Each person was asked to choose 3-5 gaps from the list below that the NCSSC should prioritize. Numbers in parentheses indicate the number of people who chose these as gaps to be prioritized by the Cooperative. These gaps are listed in ascending order as chosen on the survey:

1. Effects of sea level rise on water quality and ecosystem health (26)
2. Better understanding of the economic effects of sea level rise (22)
3. Sea level rise and inundation outreach resources targeting specific audiences (e.g. coastal property owners, local government) (20)
4. Understanding sediment supply and how sediment supply impacts coastal habitat resilience (20)
5. Formal (K-12) and non-formal education materials that incorporate sea level rise science, local data, and localized effects of sea level rise (19)
6. Local scale sea level projects to inform decision-making (18)
7. Stakeholder training on the use of tools and models (e.g. NOAA sea-level rise viewer) to inform decision making related to sea level rise and inundation (13)
8. Identify how land subsidence is impacting the NCSSC geographic area (12)
9. Effects of sea level rise on essential fish habitat (12)
10. Citizen science opportunities related to sea level rise and inundation (10)
11. Better understanding of water level measurements, including identification of local tidal datum and links to sea level rise (8)

During the meeting, participants were placed into breakout groups to discuss these identified gaps. Each breakout group was asked to use this list as a starting point, add any gaps that were not captured on the survey, and further prioritize gaps within the NCSSC. Each breakout group was tasked with identifying the top three to five gaps they felt the Cooperative could address over the next three years. Each breakout group was also asked to identify any additional gaps that could be considered “low-hanging fruit” and easily achievable. Participants were asked to focus on projects that could be accomplished within the timeframe of the next Implementation Plan, with a consideration of the resources, funding and capacity of the Cooperative to address the prioritized gaps. The purpose of this discussion was to identify the broad needs of both the partner organizations and the NCSSC over the next three years, and to also identify easy, short term goals that could be filled by partnerships within the Cooperative.

Discussion across the three breakout groups resulted in the consensus that some of the gaps were similar and could be combined. Participants decided that some gaps used similar wording and concepts and could be combined. A suggestion was made to include the concept “ecosystem services” in the gaps. Some breakout groups found it useful to bin the gaps into specific

categories such as research or outreach. Other gaps were noted as being too broad, with recognition that many of the successes of the NCSSC since 2012 have results from specific actions and partnerships.

The similarities among the gaps prioritized by each breakout group were discussed and synthesized with all participants following the small breakout group discussions. This resulted in three prioritized gaps for the NCSSC to address over the next three years:

1. Effects of sea level rise on ecosystem health and observations/monitoring
2. Better understanding of localized effects of sea level rise, especially socio-economic effects
3. Communication of sea level rise impacts and bridging the communication gap between science and decision makers

Collaborating to Address High Priority Gaps

After prioritizing the top three gaps for the NCSSC, the next breakout discussion had a separate breakout group for each of these three identified gaps. Participants self-selected which of the three gaps to discuss in small breakout group discussions and were encouraged to participate in the topic they were most interested in. Participants discussed what resources are needed and how partners could contribute to filling these gaps, including partnership building, collaborative project development, and pursuit of funding opportunities. Participants were also asked to consider whether the current geographic boundary of the NCSSC was appropriate for the identified gaps and research needs.

1. Effects of sea level rise on ecosystem health, and gaps in observations and monitoring.

Participants self-selected into this group to discuss the effects of sea level rise on ecosystem health and what research gaps exist in sea level rise observations and monitoring. Research gaps noted were sea level rise impacts on submerged aquatic vegetation, more biological monitoring, water level measurements, water quality, water temperature, and bathymetry data. Many topics were discussed as possible collaborative projects among NCSSC partners. These topics included the development of ecosystem health indicators, the availability of data on the appropriate spatial scale, a SET network that is spatially robust in the Cooperative geography, better understanding of the marsh-upland transition, saltwater intrusion, and storm surge.

Participants discussed the feasibility of developing indicators for various habitats, such as marsh, oyster reefs, and submerged aquatic vegetation. Sediment supply and elevation were mentioned as possible indicators of marsh response to sea level rise. Connecting indicators to ecosystem services was suggested, as well as how to help homeowners understand the effect of sea level rise with simple indicators. Participants asked whether communities understand the importance of ecosystem services, and how they are linked to the socio-economic effects of sea level rise. APNEP was identified as a good partner for developing indicators. However, at the end of the discussion, participants in this group recognized that developing indicators is a large effort that requires a lot of resources.

Participants noted that with the number of research institutions in the Cooperative's geography, there are many opportunities to collaborate and share data. A few examples discussed were the NCNERR research and monitoring program, which includes monitoring marsh elevation changes using surface elevation tables, and a long-term water quality monitoring program. The North Carolina Wildlife Resources Committee conducts regular wildlife surveys of shorebirds and wading birds. Research is conducted by UNC-IMS to study the effects of sea level rise on oyster reefs and their growth rates. The Marine Robotics and Remote Sensing program at the Duke University Marine Lab and the use of drones to monitor sea level change was also a topic of discussion.

A suggestion to gain more partnerships in the Cooperative was to link natural habitat research to local communities by focusing research on the resources and issues communities care about and are invested in, and to collect data and information useful for management decisions. Examples included commercial and recreational fisheries, local wildlife, and linking human health to sea level rise impacts. Participants suggested connecting research to biodiversity, wildlife resources and essential fish habitat.

2. Better understanding of localized effects of sea level rise, especially socio-economic effects.

Participants self-selected into this breakout group to discuss the socioeconomic effects of sea level rise in the NCSSC geography. Participants emphasized focusing on the local relevance to coastal communities of the work conducted by the NCSSC, and the need for high resolution data to integrate the impacts of sea level rise on coastal habitats and built environments. Recognizing that communities care about what happens on a local scale (such as coastal flooding) were noted. Examples discussed included understanding the economic effects of flooding and inadequate stormwater drainage systems in the NCSSC, and working with non-traditional audiences (like local businesses) to promote living shorelines and communicate impacts to property owners. Participants also voiced the need to better communicate the socio-economic impacts of sea level rise on coastal communities.

Participants noted it is crucial to understand potential impacts and prepare for both the short and the long-term effects of sea level rise. This breakout group discussed and defined terms such as "impacts", "effects", the "built environment", "localized impacts and changes", "stakeholders" (including local communities and the importance of local buy-in), "vulnerability", and "resilience". They discussed how sea level rise is a driver of impacts, as well as the temporal and spatial scales inherent when examining sea level rise impacts. The group created a problem statement that stated the need to better understand and prepare for both the long and short term socioeconomic impacts caused by the impacts of sea level rise on natural and built communities.

To update the NCSSC Implementation Plan, suggestions were made to include people knowledgeable about social science and resiliency, and to assess what tools and information already exist. Priorities included identifying end users and working with local government staff and elected officials on training initiatives to build a baseline understanding of how sea level rise, storm events, and flooding affect coastal communities. Participants asked what resilience strategies are already being implemented in other areas of North Carolina. Examples of local scale projects reviewed included NOAA pilot resiliency communities in Duck and Edenton.

Participants discussed the possibility of initiating pilot projects in the NCSSC that would be transferable in other areas of North Carolina.

3. *Communication of sea level rise impacts and bridging the communication gap between science and decision makers.*

Participants self-selected into this breakout group to discuss communication and outreach strategies for bridging the gap between science and decision makers. Participants discussed the types of communication content needed as well as the importance of translating research in ways that are understandable and relatable for specific target audiences. Suggestions were made for the NCSSC to host trainings and focus groups to develop communication products. Internally, a need for more exchange between the research community and other partners in the Cooperative, and connecting the end user with the research community was identified. Education staff from the NC Aquarium at Pine Knoll Shores and other town planners at the meeting noted that research is often conducted on or near their properties, but the results are not often shared or discussed. It was recognized that better communication practices would also help to fill the other gaps prioritized for the Cooperative.

Four target audiences were identified by this breakout group; K-12 students, the public, peer-to-peer and coastal decision makers. This breakout group identified the need to customize and focus communication strategies and products for each target audience.

i. *Target audience: K-12*

The absence of sea level rise in NC K-12 education standards is a gap. It was recognized that integrating sea level rise into education standards in North Carolina would be a very large effort, especially due to the current political climate in North Carolina. However, the efforts of lobby groups in the past (the biotech industry, for example) were noted as successful. A more achievable strategy discussed was the development of lesson plans for teachers focused on sea level rise impacts. The Scientific Research and Education Network (SCiREN) events hosted at the NC Aquarium at Pine Knoll Shores is a viable method for disseminating lesson plans. Further, teacher workshops focused exclusively on sea level rise, climate change, and coastal resiliency that could be hosted in the Cooperative's geography was discussed as another way to help fill this gap. The group also identified citizen science efforts, such as the NC King Tides citizen science project, as a way to engage K-12 students.

ii. *Target audience: Public*

A number of existing resources for reaching out to the public and local communities were identified. These resources including living shorelines materials from NCDCM, the NC King Tides project, and a guide to low impact development from the South Carolina NERR. The group identified many platforms and access points as a way to target public audiences and distribute communication products. These included beach access points, wildlife ramps, NC Scenic Byways (NC Department of Transportation), vacation rental agencies, social media, local TV stations, local government websites, utility bills, mailings, local newspapers, press releases, newsletters, Coastal Review Online, community round tables, NC Seafood Festival,

fact sheets, public research presentations, and open houses. The development of outreach materials could be used by Cooperative partners to distribute to the public.

iii. *Target audience: Peer-to-peer*

The peer-to-peer target audience was identified after discussions about the lack of internal communication between researchers and partner organizations. For example, the marsh at the NC Aquarium at Pine Knoll Shores property is utilized by local researchers from NOAA, NCNERR, and UNC-IMS for fieldwork and monitoring, however the staff at the Aquarium are mostly unaware of the results of the research.

In an effort to improve peer-to-peer communication within the Cooperative, the participants in this group discussed two ideas. The first was that the NCSSC could host a "*Science Symposium*" where partners present their research for resource managers, decision makers, education staff, and other interested community members in the Cooperative. The second idea was that the NCSSC could develop and host a "*NOAA Tools Training*", where the participants would learn about how to utilize NOAA tools for making management decisions within the scope of their work.

iv. *Target audience: Coastal Decision Makers*

Coastal decision makers include local government staff and elected officials, coastal businesses, and others. The amount of money saved and the bottom line were emphasized as important messages when targeting this audience. The NCNERR Coastal Training Program (CTP) works with this target audience through workshops and technical assistance, including workshops for realtors and other professionals. The NCSSC and CTP have worked together in the past to reach this audience, and plan to continue hosting joint trainings. Also discussed were possible opportunities to work with risk managers and insurance companies. Another idea was to include living shorelines in Best Management Practice guidelines. Many of the same strategies discussed to communicate with the public were also identified for this audience.

Sustaining Engagement in the NCSSC

A challenge for the NCSSC in the past has been sustaining engagement with partners between sponsored Cooperative activities. During the meeting, the NCSSC displayed a poster summarizing the goals, management issues, and success stories of the Cooperative. The poster also included a list of ways to engage with the Cooperative. These ideas (below) were reiterated to participants at the meeting during presentations and breakout group discussions as ways to stay engaged with the Cooperative:

1. **Become** a NCSSC Core Management Team member.
2. **Subscribe** to the NCSSC Quarterly Newsletter.
3. **Submit** a story for inclusion in the Quarterly.
4. **Provide** feedback for the Cooperative's Implementation Plan at the 2017 NCSSC Partnership Meeting and throughout the year.

5. **Contribute** to the 2017 NERRS Collaborative research proposal.
6. **Collaborate** with a Cooperative Partner on a research proposal/project.
7. **Engage** in citizen science projects in the NCSSC, such as NC King Tides, Sentinels of the Sounds, Community Collaborative Rain, Hail, and Snow network (CoCoRaHS) and become a contributor to the NOAA "What's Your Water Level" app.
8. **Contribute** your research and monitoring project to the NCSSC Clearinghouse.
9. **Attend** a Cooperative sponsored workshop.

NCSSC Geography Expansion

The participants at the 2017 NCSSC *Partners Meeting* were unsure about whether the Cooperative should expand its boundaries. This may be because many of the partners were new to the NCSSC and did not have a strong understanding of the projects and areas where the Cooperative currently works. Initially, the NCSSC chose a small boundary because no new resources were dedicated to the five Cooperatives when they were formed in 2012. The NCSSC decided to start with a small geographic boundary in the central coast of North Carolina, where there is a concentration of resources and partners, and expand the boundaries over time as resources allowed.

Feedback from participants at the meeting was that expansion could be beneficial for involving more partners. However, some also asked about the feasibility of expanding with the current resources. Other feedback included that expansion into the north would be beneficial for learning from communities in the Outer Banks, which are frequently impacted from coastal flooding. Expanding into the Gulf Stream would allow the NCSSC to include offshore bottom habitat in collaborative research. Some participants wondered whether the NCSSC boundary had to be contiguous, or rather could be strategic based on projects occurring outside the Cooperative boundary. Some responded that a non-contiguous boundary could be confusing when discussing the role of the Cooperative. There was also a conversation about the benefits of keeping the boundary small, with opportunities to grow in the current geography. However, it was noted that being able to work strategically with researchers outside the Cooperative would be beneficial.

Next Steps for the NCSSC

The following action items were developed at the workshop as important next steps for the Cooperative:

1. *NOAA Tools Training*
   This training was identified as an action that could be accomplished in 2017. A NOAA Tools training session would educate participants about the availability and use of NOAA tools for local communities and management decisions. Adam Bode (NOAA OCM) and Whitney Jenkins (NCNERR) volunteered to lead the development of this training. This training may also be transferred to other Cooperatives after development.

2. *Communications Plan*
   A communications plan was identified by meeting participants as a high priority need. A central resource for accessing communications information and products was noted as

something that would be useful. A review of what resources are already available is necessary, with the next step to further define the target audiences and specific messages for NCSSC communication strategies. It was noted that the broader partnership group would be willing to help with the content of the messages. The NC Sea Grant communications team volunteered to work with the NCSSC Outreach Specialist to further refine these messages into a coherent communication plan.

3. *NCSSC Science Symposium*
   Participants at the meeting identified that a NCSSC sponsored science symposium would help to fill the gap of communicating research among partners by connecting scientists, decision makers, and educators. Educators, city planners, elected officials, resource managers, and other community members would learn from research scientists about coastal resiliency and sea level rise research and monitoring occurring in the Cooperative. This would also serve as a networking event among partners.

4. *NERRS Science Collaborative*
   Several research gaps were identified during the breakout group sessions, including the marsh upland transition, saltwater intrusion, storm surge, spatial scales, indicators, sediment supply and bathymetry. The discussions provided an initial brainstorming space to talk about a possible science collaborative project among partners, however a feasible research topic was not readily apparent by the end of the meeting. The next step was identified as having the NCSSC Coordinator develop any feasible topics from this discussion into a working group with interested partners that could discuss a NERRS Science Collaborative project.

5. *Determine how to include the socio-economic effects of sea level rise in the update of the NCSSC Implementation Plan*
   The initial focus of the NCSSC when it was formed in 2012 was to assess the impacts of sea level rise on coastal habitats. During both the 2103 and 2017 NCSSC partner meetings, the need to better understand the socio-economic effects of sea level rise in the Cooperative was stated as a high priority. Participants noted that it is crucial for coastal North Carolina to understand and prepare for the long and short term socio-economic impacts of sea level rise. It was noted that the NCSSC may find a niche working at the intersection of coastal habitats and the built environment, and developing resilience strategies that includes protection of ecosystem services.

   The next step is for the NCSSC Core Management Team members to discuss the capacity of the Cooperative to include built environments effectively in the goals of the Cooperative, and in the update of the Implementation Plan. An assessment of what research already exists in the Cooperative may be useful in addressing this priority. Broadening the focus of the Cooperative would most likely result in the involvement of more diverse partnerships. However, the CMT should consider the resources and capacity currently available to the NCSSC when thinking about how to strategically expand the Cooperative's focus.

6. *Annual Meetings*
   The previous meeting that brought together the NCSSC partners was held in 2013. At the 2017 *Partnership Meeting*, the partners noted the need for more regular interactions among the group to sustain engagement. Most agreed that bringing partners together annually would be beneficial, and that annual meetings could have a more targeted focus, such as a science symposium, or some other skills training.

7. *Recruitment of New Core Management Team Members*
   The need to recruit new NCSSC Core Management Team (CMT) members was noted as an important next step during the meeting. Expertise by new and diverse partners would be valuable for the growth of the Cooperative in providing input in updating the Implementation Plan, setting goals, and envisioning next steps for the Cooperative. At the meeting, four people expressed interest in becoming part of the CMT.

Completed Action Items Following the Meeting

Following the 2017 meeting, the Cooperative successfully completed several action items.

- Three new members joined the **Core Management Team in** May 2017; Justin Ridge (Duke University Marine Lab), Nathan Hall (UNC-IMS), and Paula Farnell (Sturgeon City of Jacksonville, NC).

- The NCSSC helped bridge the gap of communicating research among partners by continuing to work with the **NC Aquarium at Pine Knoll Shores**. The NCSSC and Aquarium co-hosted an informal "conservation brown bag" lunch talk in April 2017. Carolyn Currin (NOAA NOS) and Brandon Puckett (NCNERR) were the featured speakers, and presented research results from the marsh monitoring at the Aquarium site. Marsh monitoring has taken place on the Aquarium property since 2002 by researchers from NOAA, NCNERR, and UNC-IMS. Aquarium staff and volunteers in attendance learned about the ecosystem services of marshes and living shorelines, and the research transect sites at the Aquarium.

  The Aquarium is a member of the NOAA Coastal Ecosystem Learning Center Network (CELCN). This event also helped fulfill of the Aquarium's goal as part of the CELCN network to partner with NOAA and other federal agencies to showcase and interpret the latest ocean-related science, data, and discoveries. After the talk, Aquarium staff volunteered to assist with marsh monitoring fieldwork at the Aquarium site in Summer, 2017. The need for two to three general talking points about how to communicate the importance of protecting marsh habitats to visitors, as well as the construction of a possible boardwalk in the marsh were also identified as future action items by participants at the talk.

- The development of a **NOAA Tools Training** workshop was initiated in March 2017 by Adam Bode (NOAA Office for Coastal Management), Jennifer Dorton (NCSSC Coordinator), Whitney Jenkins (NCNERR Coastal Training Program Coordinator), and Sarah Spiegler (NCSSC Outreach Specialist). This training is scheduled to be held for

NCSSC partners in October of 2017, and a pre-meeting survey was sent out in May 2017.

- The NCSSC and the NCNERR Coastal Training Program started planning to host the NOAA Ocean and Coastal Management training entitled **"Adaptation Planning for Coastal Communities"** in winter of 2017. This effort is in response to the need identified at the 2017 Partnership Meeting for education and training for local government staff and elected officials; specifically, the need for training to build baseline understanding of sea level rise for consideration during planning efforts.

- A **Science Symposium** was identified as a possible theme for the 2018 NCSSC Partnership Meeting. At the 2018 meeting, researchers could share their research and monitoring related to sea level rise and coastal resiliency. Coastal decision makers and education professionals in attendance can use this information to inform management decisions and educate the public.

- The NCSSC partnered with the National Weather Service to host a **second North Carolina Water Level Workshop** in April 2017. A plan and methodology for gathering water level information, established by a network of collaborators and volunteers, was shared to build collaboration among groups that may be able to assist with this type of data collection after a storm. This included demonstrating how to find high water marks, and community collaborations, citizen science programs, and tools for recording high water events.

- The NCSSC Outreach Specialist represented the NCSSC at the March 2017 **Sentinel Site Program (SSP) Coordinators meeting** at the NOAA headquarters in Silver Spring, Maryland. Connections were made with personnel at **national level organizations**, including the USNPS, FEMA, USFWS, USACE, National Sea Grant, NOAA CO-OPS, NOAA NWS, NOAA NCEI, NOAA NCCOS, and NOAA OAR, during the meeting. These connections will be used to build upon local and regional partnerships in the NCSSC.

- Sea level rise and climate change impacts at the local scale were taught to 4th and 5th graders at **Bogue Sound Elementary School in Newport, NC** by the Sarah Spiegler, NCSSC Outreach Specialist. Spiegler utilized the NC King Tide lesson plans developed by the Voss lab (UNC-IMS) and the NCSSC for the 2017 Scientific Research and Education Network (SciREN) event.

- The development of a **collaborative workshop focused on surface elevation tables** (SETs) was proposed by the NCSSC. This workshop would review SET locations in the Cooperative, what researchers monitor SETs in the Cooperative's geography, and how to standardize the installation, reading, data, etc. of SETs among partners.

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APPENDICES

APPENDIX A: Meeting Pre-Survey Summary

The purpose of the survey was to engage meeting participants prior to the NC Sentinel Site Cooperative *Partners Meeting* to help determine gaps in sea level rise and coastal resilience research and outreach efforts in the Cooperative's geography, and to foster partner participation in the NCSSC. Participants invited to the meeting were asked to fill out a survey about prioritizing needs in the Cooperative and a strategic expansion of the boundary of the Cooperative.

This pre-meeting survey facilitated discussions at the meeting about gaps that are present and ways in which the Cooperative could work collaboratively to fill these gaps. There were 42 responses to the pre-meeting survey from 28 different local, state, federal government, academic, and non-profit organizations. Results are summarized below.

Survey responses: 42

Affiliation
Carteret County
Carteret County Emergency Services
Carteret County Schools
Carteret County Community College
Chowan University
City of Jacksonville (3)
Duke Marine Lab (2)
East Carolina University/UNC Coastal Studies Institute
Local Governments
NC Aquarium at Pine Knoll Shores
NC Audubon
NC Sea Grant
NC Department of Environmental Quality (2)
NC Department of Natural and Cultural Resources
NC Sentinel Site Cooperative
NC Wildlife Resources Commission
NOAA (4)
NOAA National Centers for Coastal Ocean
NOAA National Ocean Service
NOAA NOS Beaufort Lab
NOAA Office for Coastal Management (OCM) (2)
NOAA/National Weather Service (2)
South Atlantic LCC
Sturgeon City of Jacksonville
The Nature Conservancy
Town of Pine Knoll Shores
UNC-Institute of Marine Sciences (6)
UNCW

Profession

Choices on Survey: Research, Natural resource manager, Local/county government, Emergency management, Outreach/education/training professional, Other management, Other

Federal government (2)
Local/county government (5)
Local/county government, Outreach/education/training professional
Natural resource manager (3)
Other management
Other management, Meteorologist
Outreach/education/training professional (7)
Outreach/education/training professional, Other management
Program Management
Research (15)
Research, federal government
Research, Outreach/education/training professional (2)
Student - With many above interests/experiences
Water Quality Technician

GAPS IDENTIFICATION

The NCSSC and partners have identified the following gaps within the Cooperative's geography. Choose 3 - 5 gaps that you feel the NCSSC should prioritize. Please only select 3 – 5.

12. Effects of sea level rise on water quality and ecosystem health (26)
13. Better understanding of the economic effects of seal level rise (22)
14. Sea level rise and inundation outreach resources targeting specific audiences (e.g. coastal property owners, local government) (20)
15. Understanding sediment supply and how sediment supply impacts coastal habitat resilience (20)
16. Formal (K-12) and non-formal education materials that incorporate sea level rise science, local data, and localized effects of sea level rise (19)
17. Local scale sea level projects to inform decision-making (18)
18. Stakeholder training on the use of tools and models (e.g. NOAA sea-level rise viewer) to inform decision making related to sea level rise and inundation (13)
19. Identify how land subsidence is impacting the NCSSC geographic area (12)
20. Effects of sea level rise on essential fish habitat (12)
21. Citizen science opportunities related to sea level rise and inundation (10)
22. Better understanding of water level measurements, including identification of local tidal datum and links to sea level rise (8)

Other gaps listed:

- Effects of sea level rise and erosion on wildlife communities; monitor available habitat, ecology, numbers and success of water birds (can relate to tourism).
- Effect of sea-level rise on ecosystem function
- Sound/Ocean interactions

- A broader look at coastal resilience, not just sea level rise, is needed. Need research to support difficult decisions and trade-offs made in preserving habitat while maintaining community economy.

NCSSC Focus

As the NCSSC works to increase partner participation in its efforts, is the current Cooperative focus on sea-level rise, inundation, and coastal resilience appropriate for your participation in the NCSSC?

- Yes (39)
- Not Sure (3)

If not sure, on what other climate concern do you feel the NCSSC should focus?

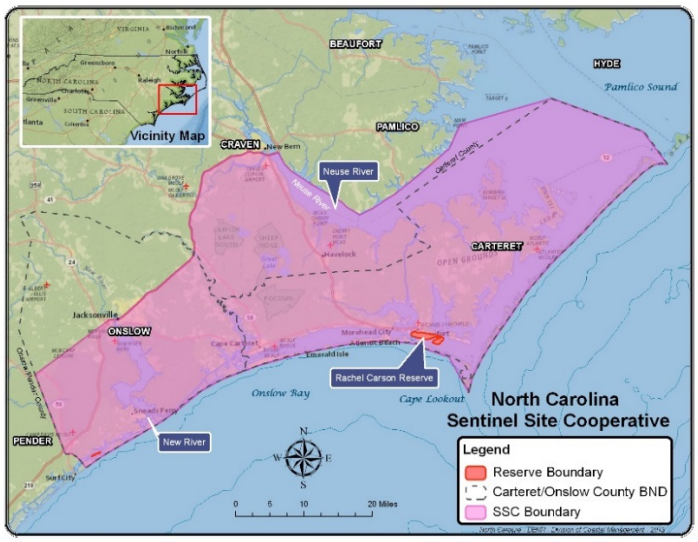
- Ocean acidification
- Pollution such as marine debris and farm/ag run-off.

NCSSC Outputs

From the items below, which one thing can the NCSSC do to best help you/your organization use sea level rise data and projected effects in your programming/planning?

- Communication products (20)
- Funding (8)
- Coordination meetings (7)
- Training (4)
- Other:
    - Habitat management advice and project endorsements
    - Partnering and staff capacity for projects/meetings requiring a lot of participation/breakout groups
    - Recommend appropriate sea level rise data sets for the area to show potential impacts

NCSSC Boundary



The NCSSC boundary was strategically chosen based on the resources within the central coastal region. Now that the NCSSC is more established, we are interested in receiving feedback on potentially expanding our boundary.

Do you think that the NCSSC boundary should be expanded?

- Yes (12)
- No (3)
- Not Sure (27)

What new areas should be incorporated into the boundary and why?

- The entirety of the Outer Banks region (Hyde, Dare and Currituck Counties). These areas have much at stake related to sea level rise and are probably the most fragile in terms of land and infrastructure.
- Coastal Hyde and Dare counties
- Down to SC
- Entire NC coast
- Waters of the state are all connected, everything in that area flows south and hits the southern waters of our state, need a more "global view" water does not start and stop and lines or boundaries.
- Expand to the north to include a little more of southern Pamlico Sound and the mouth of the Tar River.
- All NC coastal areas
- You have included a very small region of Pamlico Sound. This is the 2nd largest estuarine system in the US, yet you are ignoring majority of the system...including inlets, significant benthic habitat, marshes, etc.
- Up to Virginia Boarder - incorporate Currituck Sound shallow fresher ecosystem and low sediment supply. Also proximity to Army Corps research station

- Areas of Pamlico Sound proper at a minimum
- All of coastal NC

Why is the expansion of the NCSSC boundary not appropriate?

- The current boundary includes the area where my education and outreach efforts are focused, so I do not personally feel the boundary needs to be expanded. I could see how other areas could be involved, but do not have specific knowledge past that.
- Being from a regional organization it has been my experience that expansion can quickly splinter the needs/wants of the group. Maybe assisting areas to the north and south to create their own organization in the model of NCSSC would allow each smaller geography to focus on the particular items most concerning to them.
- It is already a large area that extends across gradients in salinity, ocean wave energy, and coastal topographic gradients. It is not clear to me what would be gained, scientifically, from expanding the area. I suppose if it were expanded to the south, the area would extend across a greater tidal gradient and include a large urban setting (Wilmington). Hmm, that might be useful.

APPENDIX B: Agenda

Tuesday, February 21, 2017

8:30 am	Check-in, Coffee, & Breakfast Snacks
9:00 am	Welcome, Introductions, & Meeting Objectives
9:20 am	Overview of the National Sentinel Site Program & North Carolina Sentinel Site Cooperative: Jennifer Dorton (NCSSC Coordinator)
9:50 am	NCSSC Partnership Successes: Caitlin Lauback – UNC Institute of Marine Sciences
10:15 am	Break
10:30 am	NCSSC Partnership Successes Continued: Pat Donovan-Potts – City of Jacksonville & Jenny Davis – NOAA NOS
11:00 am	Review Pre-Workshop Survey – Learn about gaps in research, monitoring, training, products/tools, and outreach related to the resiliency of the NCSSC geography to sea level rise and flooding: Sarah Spiegler (NCSSC Outreach Specialist)
11:25 am	Breakout Groups – Discuss and refine gaps related to the resiliency of the NCSSC geography to sea level rise and flooding
12:30 pm	Lunch (provided)
1:15 pm	Breakout Groups Report Out – Present top 3-5 list of gaps
1:45 pm	Prioritize Gaps & Break
2:00 pm	Breakout Groups – Discuss one high priority gap and begin collaborating to address gap. Consider the following: • In what geographic areas of the state is this a gap? Do you propose working or conducting research in all or a subset of the locations? • Is there a way to include socioeconomic considerations into this effort? • What partners do we need to include? Who do you think will want the information, i.e. who are the end-users of this information? • What is the problem statement? • What resources are currently available to help fill this gap? This may include personnel funding, equipment, technical services (e.g. website hosting), etc. • For this type of effort, what additional resources are required? This may include personnel funding, equipment, technical services (e.g. website hosting), etc. • Would this effort be appropriate for a funding proposal, i.e. NERRS Science Collaborative? • What are the next steps for filling this gap? • Are you willing to commit to this effort beyond today?
3:15 pm	Breakout Groups Report Out
4:00 pm	Discuss Next Steps – How to address high priority gaps under the NCSSC guidance
5:00 pm	Adjourn

APPENDIX C: Meeting Presentation Summaries

Jenny Davis, Ph.D.
NOAA, National Ocean Service (NOS), National Centers for Coastal Ocean Science (NCCOS), Center for Coastal Fisheries and Habitat Research (CCFHR)

Developing Guidance for the Use of Natural Infrastructure to Enhance Coastal Resilience
Widespread use of living shorelines has been limited by uncertainty about the level of erosion protection they can provide in a given setting, and their resilience to sea level rise. To address this uncertainty, we are developing guidance for successful living shoreline implementation. For over a decade CCFHR, in collaboration with the NCNERR, has been monitoring changes in shoreline vegetation and using surface elevation tables (SETs) to track rates of marsh surface elevation change at a number of natural fringing marshes and created living shorelines throughout the NCSSC. Using this data, we evaluated marsh stability with respect to both modeled nearshore wind-wave energy, and estimated boat wake energy, to determine threshold wave energy values under which both fringing marsh and sill-reinforced (hybrid) living shorelines can be considered for shoreline stabilization. To develop spatially explicit map-based guidance products, we modeled values of wind-wave energy and made estimates of boat wake energy along the entire shoreline of the NCSSC at 50 meter intervals. We then used the threshold values determined from our research to indicate shoreline areas that were appropriate for living shoreline installations, including vegetation only and hybrid approaches. Our results indicate that shoreline wave energy is low enough to support living shoreline approaches throughout most of the NCSSC, but that in many regions, rock-sill or similar reinforcement will be required at the shoreline edge. We are currently working with The Nature Conservancy to build these data into a web-based application as part of their Coastal Resilience Explorer (http://maps.coastalresilience.org/northcarolina/).

Caitlin Lauback, M.S. (on behalf of Christine Voss, Ph.D.)
University of North Carolina, Institute of Marine Sciences

Modeling the Wave Attenuation Capacity of Salt Marsh Vegetation
The ability to accurately model the wave attenuation capacity of salt marsh vegetation is a valuable tool as we look at the future of the North Carolina coast. Creating such a model is met with numerous challenges due to the variations in vegetation types, elevation, and slope landward and waterward from the marsh edge. Ten characteristically different marsh sites were selected to provide an adequate representation of the variety found in North Carolina marshes. In order to characterize each marsh site, parameters such as elevation, vegetation, water level, and wave energy were evaluated. A wave attenuation model for individual marsh sites will amalgamate the elevation, vegetation, water level, and wave energy data collected. Following the initial models of the current energy buffering capacity of salt marshes, the next challenge is propagating these models into the future and addressing the concerns of increased energy and marsh transgression from sea level rise.

Extensive field mapping was conducted at each site capturing the marsh surface, the upland transition, and bathymetry up to 20 meters from the edge of marsh. A digital elevation model (DEM) was created in ESRI ArcMap using these data as a surface to create the model. Above-

ground biomass was measured throughout the marsh. Nine samples were collected along a 50 meter transect using a 25cm x 25cm quadrat, parallel to edge of marsh, every 5-10 meters from the upland transition to marsh edge at each site. While the length of every stem in each sample was measured, three samples per transect had additional high precision morphometrics (only on *Spartina alterniflora* and *Juncus Roemerianus*) recording stem/tip/base diameter, number of leaves, leaf length, and leaf width. For these samples of higher precision measurements, 30cm cores were collected to measure below ground biomass as well. Seven water level stations have been established, recording at 6-min intervals throughout the duration of the project. Two of these water level stations (Pine Knoll Shores Aquarium and Cedar Island) were established prior to the project, providing over ten years of data. Pressure sensors were deployed throughout the marsh (transect from 0 meters to 30 meters from edge of marsh) and in front of marsh to record both wave damping within the marsh and the continuous wave energy offshore.

In addition to modeling wave attenuation capacity, the outreach component of this project aims to advance the awareness of the impacts of sea level rise and coastal inundation in our local communities in coastal North Carolina. The North Carolina King Tides Project is a citizen science program that asks community members to take pictures of high water level events during what are known as “King Tide” events; high water levels predicted to occur when the earth, sun and moon are in alignment. The NC chapter is part of the international King Tides citizen science program. The slogan of the international program is “Snap the shore. See the future.” The aim of the project is for people to visualize what the normal tide ranges may be in the future with sea level rise. The project has a Flickr and Facebook site for people to share their photos.

Pat Donovan-Potts
Stormwater Manager, City of Jacksonville

Building Partnerships in an effort to restore Wilson Bay
Coastal restoration offers value through stabilization of shorelines, and provides a range of other functions including fish habitat and nutrient processing. For more than 40 years the City of Jacksonville had discharged its treated wastewater effluent to Wilson Bay. In 1998, the City ceased discharging into Wilson Bay with the completion of a modern and expandable land application plant. The Wilson Bay Water Quality Initiative (WBWQI) was a community – based water quality improvement and habitat restoration effort which began in 1999 and was initiated with Clean Water Management Trust Funds by the City of Jacksonville in cooperation with North Carolina State University. The primary goal of the effort was to “kick-start” the restoration of Wilson Bay and improve water quality by: 1) reducing storm water input into urban streams feeding the bay; 2) planting bivalves, to date- totaling 7.6 million to enhance natural filtration of the water column 3) Adding 3 aeration units to deliver oxygen to an anaerobic bottom and 4) restoring 9 square acres of wetlands adjacent to the Bay.

Coastal restoration is often an ecological engineering exercise because it uses natural systems to provide services often associated with conventional engineering. Assessing coastal restoration in an engineering context requires robust information. After a talk given by Jennifer Dorton (NCSSC Coordinator) at a City of Jacksonville Stormwater Services meeting in 2015, the City of Jacksonville submitted a proposal through the NC Sea Grant Community Collaborative Research Grant Program proposal. This proposal was funded based on the excellent partnerships (City of

Jacksonville, Camp Lejeune, UNC-IMS, and the NCSSC) and educational activities that have been developed in this region through this project. Data collected as a part of this project will be translated into information to assess past restoration and plan future activities, and how living shoreline function and sustainability can be utilized in Wilson Bay. Six surface elevation tables (SETs) were also installed through this project in Wilson Bay. This information gained will also be used to broaden the educational programs that have been highly effective at Sturgeon City (http://www.sturgeoncity.org).

Kathleen Onorevole, M.S. (on behalf of Michael Piehler, Ph.D.)
University of North Carolina, Institute of Marine Sciences

Water Quality & Nitrogen Removal in Wilson Bay
This study was also funded by the NC Sea Grant Community Collaborative Research Grant Program with project partners City of Jacksonville, Camp Lejeune, UNC-IMS, and the NCSSC. One goal of the Wilson Bay restoration was enhanced water quality through increased nitrogen removal. Sources of nitrogen include agricultural, residential, and urban landscapes, but there are few natural nitrogen sinks. As a result, nitrogen loading is a challenge for many estuaries, and it was one of the factors contributing to water quality degradation in the New River Estuary in the 1980s and 1990s. Habitat restoration in Wilson Bay reintroduced salt marshes and oyster reefs, both of which reduce aquatic nitrogen concentrations through denitrification. Rates of denitrification were measured in Wilson Bay nearly two decades after the restoration, thereby evaluating this important aspect of water quality.

In summer and fall 2016, Dr. Michael Piehler led a team in collecting sediment cores from restored and unrestored habitats in Wilson Bay. The sediment cores were incubated at UNC-IMS and their denitrification rates were measured with a membrane inlet mass spectrometer (MIMS). All habitats demonstrated potential to increase nitrogen removal via denitrification. The benefit of the restoration was particularly apparent when excess nitrogen was added to the cores to mimic the impact of stormwater runoff. Under these conditions, the restored marsh exhibited a dramatic increase in denitrification rates compared to other habitats. Overall, denitrification data demonstrate that the Wilson Bay restoration has augmented the system's capacity to remove excess nitrogen, which can maintain water quality and help achieve restoration goals.

APPENDIX D: Meeting Participants and Invitees

Meeting Participant List				
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Invited to Workshop, Unable to Attend				
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APPENDIX E: Breakout Group Summaries

Breakout Groups, Topics

- The first breakout group discussion focused on refining the gaps that were prioritized by partners in the pre-meeting survey.
- The second breakout group discussion focused on the top three gaps prioritized in the first breakout discussion. Three breakout groups discussed one of the following gaps; 1. effects of sea level rise on ecosystem health and observations/monitoring, 2. socioeconomic effects of sea level rise, and 3. communication of sea level rise impacts.

Topic: Gaps in the Cooperative
The first breakout group discussion focused on refining the gaps that were prioritized by partners in the pre-meeting survey.

Group #1 (participants assigned to group)
Facilitator, Jennifer Dorton
Recorder, Sarah Spiegler

Gaps in Communication

- General public is missing in target audiences in the survey
- Combine the similar communication gaps in the survey to create a broader communication themed gap
- Non-formal education connects resources with the general public
- Need more focus on target audiences

K-12 Education

- No formal requirement in North Carolina K-12 education curriculum for teaching sea level rise
- Citizen Science projects is a tool for filling this gap
- Uncertainty in how sea level rise is being taught at the K-12 state level, only aware of individual classroom efforts

Communication Products

- Required sign-in to an online product or program can deter some people in using a product
- Diversity of people represented at this meeting, different levels of experience with the information, who would use the tools?
- Training/focus groups for communication products?
- Coastal Review Online (Coastal Federation) is a good communication tool, highly utilized by Paula Gillikin (NCNERR)

Communication and other Cooperative gaps

- Connect gap in communication with other gaps in the Cooperative, which may be more project focused
- Communication can be tied into most of the high priorities in the Cooperative

Focus on the effects of sea level rise on citizens

- Easily understood products
- How sea level rise affects people
- What people are affected?
- Do not use high-level science to communicate if you are trying to reach the general public
- How sea level rise affects people—also informs decision making
- People relate to birds, animals
- People don’t relate to science of sea level rise as much

- People relate to the fishing economy here in Carteret County
- How animals and wildlife are moving to new locations, how they are changing
- What people can see are the impacts they will understand

How do you change behavior?

- Broader focus on coastal resilience
- What can we do locally to mitigate losses? This should be goals of education/outreach
- Examples from specific municipalities; how they improved their community, what the impacts were, benefits, money that was saved. Showcase these benefits/success stories to others (example City of Jacksonville collaborative project)
- Benefits to fishermen from these projects, effect of sea level rise on essential fish habitat
- Living shorelines versus hardened structures, benefits of living shorelines
- Large scale conservation programs—grants are available

Context of change

- Does science explain change well?
- How to get science to people
- Time/Elevation—can it be presented in a different way? Most people don't care about a specific line in a graph, or graphs in general
- Economic modeler: per acre of shoreline, how much money has washed out to sea?
- Google tool: aerial photography data, see how inlets have changed, new program in 2017
- Water resources: how are these affected by growth?

Target Audiences

- Local Government
    - Make a point about the loss in the tax base when you lose land when trying to engage with local government officials
- Communication products for different audiences
- For example, metric conversions. General public doesn't usually understand mm, cm, so convert it to inches/feet for them in a presentation so it is easily understood.
- Sea level rise viewer tool: visualize SLR—what does that mean for me where I live? Resonates differently with different people. This is a quick visual for people to look at versus analyzing data.

Local relevance

- For local relevant data, need local scale data
- This will help to better inform socio-economic gaps

Socio economic impacts

- How sea level rise affects me, how it affects me on the local scale

University of Maryland—teaches training program in professional communications

- Targeting audiences
- Report Cards on health of ecosystems can resonate with audiences

Communications

- Develop professional quality outreach materials to share
- Simplify the product:
    - for example, a communication product at the PKS Aquarium: easy way to explain marsh ecosystems and marsh monitoring for educators at summer programs

Gap in understanding navigation management and sediment supply

- Engage Army Corps of Engineers
- Understanding dredge spoil areas is important in understanding how to increase coastal resilience, how habitats will move, how/if they can migrate
- Coast Guard area committees: connections with the Port of Morehead City

Top 3 gaps from Group #1 to bring to the large group discussion:

- Need better understanding of socio-economic impacts of SLR, and local scale data to better inform socio-economic data (Gap 2 and 6)
- Effect of sea level rise on ecosystem health: water quality, wildlife community/resources,

Topic: Gaps in the Cooperative
The first breakout group discussion focused on refining the gaps that were prioritized by partners in the pre-meeting survey.

Group #2 (participants assigned to group)
Facilitator, Rebecca Ellin
Recorder, Elise Gilchrist

Overall comments regarding the Cooperative and gaps

- Question: what do the other Cooperatives (Chesapeake Bay, Northern Gulf of Mexico, San Francisco, and Hawaii Cooperatives) work on?
    - All Cooperatives work on sea level rise but with different methods and approaches for each Cooperative
- The gaps listed on the survey are very broad, our successes in NC come from specifics
- A lot of the gaps use similar language (multiple gaps refer to communications), maybe we could combine some of the gaps that are similar
- Suggestion to add a gap that is focused on policy (not necessarily lobbying but reaching out to legislators, educating)
    - NCSSC has not addressed legislation outreach previously because of partner limitations in these activities
- Need to have more stakeholder input as we decide on gaps.
    - Are stakeholders going to use our products?
    - Are we focusing on the right gaps?
    - Need to bring stakeholders in as tools are being developed, make sure the right stakeholders are at the table
- There may be an opportunity in the intersection of business and living shorelines – reaching out to non-traditional audiences (business) to promote living shorelines
- Suggestion to add the term "ecosystem services" to the gaps list

What on the needs/gaps list is resonating with everyone in the breakout group?

- Gap #3: *Sea level rise and inundation outreach resources targeting specific audiences (e.g. coastal property owners, local government*)
    - There is no central resource for communications products or data, good for the NCSSC to internally have all our info/products in the same place
- Question as to why Gap #3 and Gap #5 are not the same
  Gap #3: *Sea level rise and inundation outreach resources targeting specific audiences (e.g. coastal property owners, local government*)
  Gap #5: *Formal (K-12) and non-formal education materials that incorporate sea level rise science, local data, and localized effects of sea level rise*
    - Mixed feelings in group as to whether they should be combined. If combined need to make clear that formal and non-formal educators are separate audiences
- Gap #11 is a great example of a specific gap that fills a specific need
  Gap # 11 *Better understanding of water level measurements, including identification of local tidal datum and links to sea level rise*
- Gap #7 *Stakeholder training on the use of tools and models (e.g. NOAA sea-level rise viewer) to inform decision making raking related to sea level rise and inundation*

    - A call for training, specifically on NOAA products, so that partners understand what tools are available. The developers of the tools could lead trainings
    - Suggestion for two levels of training:
      Training 1: intro to tools available
      Training 2: how these tools are implemented on the ground
- Data gap: need to better understand sediment supply and what effects sediment supply
    - Sediment supply is a research gap on the NC Coastal Reserve Fellowship RFP, may need to better advertise this need to Universities in the area
- Question from NC Wildlife Resources Commission: is there coordination of or a priority for wildlife monitoring (trying to determine how they can fit into the NCSSC)
    - Cooperative has some focus on habitats, at this time not much is wildlife specific

What needs/gaps are missing from the survey?

- The gap referring to bathymetry (from the 2013 NCSSC Workshop); this is a huge effort but the current modeling is not good, this is critical in predicting how sea level rise will change
- Need more categorization among gaps (example. what is outreach, what is research?)
- Major gap is the knowledge and sharing of what research is being done in the Cooperative. Communication gap exists between researchers and other groups (such as local governments or the Aquarium at Pine Knoll Shores)
    - It would be helpful for local governments to know what research is happening so they can reference during policy discussions
    - Need increased coordination between partners, especially relating to data sharing
    - Need research results to be shared in a format that everyone can understand
    - Suggestion to hold community presentations about research
    - Need for increased internal communications to support outreach, especially connecting research to end users
    - Suggestion to include short project descriptions with infographics on the Coastal Atlas
    - Need for a mechanism that bridges gaps between various groups

- The NCSSC previously has been very ecologically focused concerning the impacts of sea level rise, is there a future need to focus on infrastructure and communities?
    - Originally the NCSSC was set up to address the impacts of sea level rise on habitats, but at the NCSSC 2013 workshop the impacts of sea level rise on built environments was identified as a gap for the Cooperative
    - Communities tend to care about what's happening right in front of them, such as coastal flooding
    - Consensus that we should expand to include built environments
    - Need a better understanding of end users, people care about economic drivers so those are key pieces of communications work
    - Does the NCSSC have the capacity to take on a focus on built environments in addition to coastal habitats?
    - Can we draw in more partners with this expanded focus?

Summary of priorities to take back to large group discussion:

- Connecting researchers and results with target audiences (translating research internally)
- A focus on the built environment
- Communications (focusing externally)
- Training (specifically a training about NOAA tools for the NCSSC)
- Bathymetry
- Sediment supply
- Water level

Topic: Gaps in the Cooperative
The first breakout group discussion focused on refining the gaps that were prioritized by partners in the pre-meeting survey.

Group #3 (participants assigned to group)
Facilitator, Whitney Jenkins
Recorder, Whitney Jenkins and Tancred Miller

What happens with septic tanks, high water tables and sea level rise?

- Lack of data on county septic systems, many installed prior to permit records; many inadequate

Economic impacts of flooding and inadequate storm water drainage systems

- Now with higher base flood elevation standards for new buildings, higher buildings are flooding out older lower buildings
- Impacts on sewage and septic lines (utilities)
- Need outreach on all of the above
- Some source tracking of elicit discharges being conducted by the City of Jacksonville to help prevent these discharges and educate residents
- Shellfish Sanitation conducts shoreline surveys to determine where pollution sources are coming from
- Salinity incursion is an issue
    - Research being conducted on Albemarle Peninsula on a restored agriculture site
- Need to include East Carolina University partnerships in Cooperative; considering expanding north to also include Coastal Studies Institute

Effects of sea level rise on fish habitat, including economic impacts

- Economics
- Would shrimp petition (new request to change designation of secondary fish habitat) affect research efforts?
- Is NCSSC still limited to sea level rise? Expand to include other aspects of climate change, e.g. sea surface temperatures, salinity. We generally agreed that might be too much to take on
- Focus on habitat and biodiversity, i.e. oysters, submerged aquatic vegetation (SAV)

NCSSC Boundary

- Move east into Gulf Stream? Monitor sea surface temperatures, thermahaline circulation, animal movement patterns/cycles (sea birds)
- If the boundary doesn't have to be contiguous, why not include offshore hard bottom habitat? What would be the benefit of that? A sentinel community?
- Not sure about boundary expansion, there are benefits to staying small. There are a lot of younger people involved today and opportunities to grow this region.
    - Can still work with other researchers in other areas

NOAA assets

- Role of NCSSC to leverage existing NOAA assets in region.
- Are there sufficient NOAA assets?
- Many in group unsure what is defined to be a NOAA asset
- It would be great for the NOAA Beaufort Lab to have a person completely dedicated to outreach

Economic effects of sea level rise related to coastal communities

- Need outreach on options to improve resilience
- What about permitting agencies providing options? i.e. living shorelines
- Also need to reach elected officials/policy makers
- Museums and aquariums are trusted science sources
- Look regionally at vulnerabilities, where are the biggest problems?
    - Include septic systems, landscaping, ditch maintenance/education, FEMA's Community Rating System (CRS)
    - Tie vulnerabilities to economics

Sediment supply

- Related to marshes or also barrier islands? Mainly marshes
- Controlling sediment off construction sites
- Tidal creeks filling in due to erosion
- Effect of ditching, agriculture, silvaculture

Marine debris

- If, down the road, we begin retreating from the shoreline, what happens to all the buildings and infrastructure?
- Expanding boundary north would help us learn from other communities, specifically on the Outer Banks where houses have fallen into the water

Top 3 priorities/gaps taken back to large group discussion:

- Community vulnerability – related to economics – of sea level rise, flooding, and water quality
- Communication of sea level rise impacts to coastal communities, specifically forging partnerships with local government staff to enhance resilience
- Impacts of sea level rise on biodiversity

Topic: Gaps in the Cooperative, Summary of Report Out
The first meeting breakout group discussion focused on refining the gaps that were prioritized by partners in the pre-meeting survey. This is a summary of the report out after the breakout group discussions.

Group # 1

- Communication (gaps 3 and 12): what is the goal of outreach? Public audience not included in survey
- Effects of sea level rise on environment and ecosystem health (gaps 1 and 9)
- How sea level rise affects people (2 and 6): localized effects, socio-economic effects of sea level rise

Group #2
Process:

- From the meeting pre-survey, some items got lost in the long list of gaps
    - Some gaps had similarities, bin these similar gaps
- Should geography stay the same? Working group would be good to discuss geography

Gaps:

- Built environment (broad focus of Cooperative needs to include this)
- Translate the science of sea level rise into communication products to use by stakeholders (public educators, contractors, planners)
- Communication in general: who are the audiences, what products does each audience need?
- Training on NOAA tools
- Observations: data gaps in water levels, sediment supply, bathymetry

Group #3

- Vulnerability related to economics of sea level rise, flooding
    - Septic systems, agriculture are relatable to general public
- Communication of impact of sea level rise to coastal communities: relationships and partnerships with local governance staff
- Impacts of sea level rise on biodiversity (water, temperature, salinity)

Similarities across Groups 1, 2, and 3:

- **Communication:**
    - Bridge the gap between science and decision makers
    - Stakeholders: internal vs. external
    - Targeted audiences: professional audiences (decision makers), general public, K-12, peer to peer
    - Content of communication
    - Translate science based on targeted audience

- **Ecosystem health**
    - Sea level rise effect on ecosystem health

    - Ecosystem health/biodiversity, wildlife resources, essential fish habitat

- **Observations/monitoring**
    - Good science: how can it have an impact
    - Be specific about data needs
    - Water level, sediment bathymetry, water quality, water temperature

- **Socioeconomic effects**
    - Better understanding of localized sea level rise, especially socio-economic effects
    - Local scale, high resolution data
    - Human interface, built environments
    - Resilience strategies

Vision statements related to science

- How to incorporate into outreach products
- May come out later in the discussion

Geography

1. Interested in working with the Core Management Team to discuss Cooperative geography: Robby Fearn, Paula Farnell, David Glenn

Topic: Collaborating to Address High Priority Gaps
The second breakout group discussion focused on the top three gaps prioritized in the first breakout discussion. Three breakout groups discussed one of the following gaps;

1. Effects of sea level rise on ecosystem health and observations/monitoring
2. Better understanding of localized effects of sea level rise, especially socio-economic effects
3. Communication of sea level rise impacts and bridging the communication gap between science and decision makers.

Effects of sea level rise on ecosystem health and observations/monitoring

Group #1 (participants self-selected into group)
Facilitator, Jennifer Dorton
Recorder, Sarah Spiegler

Current Work

- NCNERR: research and monitoring, Surface Elevation Tables (SETs), vegetative transects, water quality, water level, weather station (Beaufort airport), monitoring at the NC Rachel Carson Reserve, how marshes respond to sea level rise
- NC Wildlife Resources Commission: routine wildlife surveys of shorebirds, wading birds (New Dump Island)
- Use NCSSC Clearinghouse to identify research, monitoring efforts
- Sea level rise effects on oyster reefs and growth rates
- LIDAR used in the past, more accurate elevation data using updated LIDAR
- Possible drone usage for sea level rise monitoring
- NOS/NCCOS work
- Academic work

Gaps?

- Use gaps that people care about: commercial fisheries, recreational fisheries, wildlife
- Research questions?
- Stakeholders?
- Research opportunities?
- Prioritizations?

Indicators

- Link health to sea level rise (animals, etc.?): this should be a priority
- Marsh specific: sediment supply, elevation, rate of sea level rise at your site
    - Resilience to sea level rise
- Ecosystem indicators: oyster reefs, seagrass habitats, submerged aquatic vegetation (SAV)
    - Relate back to fisheries, wildlife, things people care about
    - Tie in socioeconomics

    - CHPP to prioritize habitat types (Coastal Habitat Protection Plan in the NC Division of Marine Fisheries)
    - NCDMF, NCDCM, NC Wildlife Resource Commission, APNEP, NCNERR
- SETs, LIDAR, drones
- Gap: Develop indicators for other habitats
    - Oysters, SAV
    - Turbidity, temperature, salinity
- APNEP is monitoring sea grass beds, SAV is an indicator for ecosystem health. APNEP would be a good resource for developing indicators
- Gap: sea level rise impacts on SAV
- Gap: biological monitoring

Develop indicators

- Citizen Science: USDA, Stream Visual Assessment Protocol
- Can we create something like this for sea level rise? A visual assessment? Help homeowners understand the effects of SLR? Clear indicators that don't need a lot of equipment
- Ecosystem health indicators. Different habitat types: indicators for each habitat types.
    - Effect of sea level rise on these habitat types?
- CHPP: Coastal Habitat Protection Plan (Division of Marine Fisheries)
- Why are these indicators important? Can indicators translate back to ecosystem services? Tie back to community? Science transfer grant. Transfer results back to other NERRS.
- Will most likely need to tie socio-economics back into grant.
- What do communities think is important? Do the communities understand what the ecosystem services are?
- Indicators, threshold, values
- Big effort and many resources may be required to develop indicators

Spatial Scale

- Is SET network spatially robust enough to determine marsh response to sea level rise?
- Rick Luettich (UNC-IMS): can work help inform models?
- Gap: estuarine water levels
- Gap: bathometry, shoreline interface
- Duke University Marine Lab-high resolution data through drone lab. Pre and post storm events
- More accurate elevation LIDAR available, using updated LIDAR
- Marsh resilience to sea level rise: very local results from research

Marsh/upland transition

- What is occurring at this transition?
- Losing edge of marsh. Is marsh narrowing, or is the marsh migrating backwards?
- Impacts to built environments, marshes, wildlife

- Can’t speed up sea level rise research. How to examine how sea level will impact different ecosystems
- Salt and freshwater changes (e.g. CFR)
- High resolution satellite imagery
- APNEP, NC Wildlife Resources Commission, NC Division of Coastal Management, SALCC, Chowan University
- Interested participants: Windy, Gloria, Justin, Robby, Tom Allen’s work

Saltwater intrusion

- Freshwater/groundwater
- Ties into built environments, local municipalities
- Hyde County agricultural context (APNEP)
- Possible Partners: municipalities, NCDCM, Department of Agriculture, USGS (SE regional project, projections based on previous data), CISA, NIDIS, NC Aquarium at PKS
- East Carolina University (Manda) monitoring wells on Bogue Banks

Storm surge

- Storm surge on top of sea level rise will have big impacts
- All things connected to sea level rise (storm surge, salinity changes): chain effects, indirect effects

NERRS Science Collaborative

- Wide variety of partners
- What does the science mean?
- How does data relate?

Topic: Collaborating to Address High Priority Gaps
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1. Effects of sea level rise on ecosystem health and observations/monitoring
2. Better understanding of localized effects of sea level rise, especially socio-economic effects
3. Communication of sea level rise impacts and bridging the communication gap between science and decision makers.

Better understanding of localized effects of sea level rise, especially socio-economic effects

Group #2 (participants self-selected into group)
Facilitator, Rebecca Ellin
Recorder, Anna Hilting

Problem statement/terminology discussion

- **Impacts** depend on person (impact on a rich person may be less than an impact on a poor person).
- **Effects** happen universally.
- We talked about temporal and spatial scales of effects and impacts.
- **Built environment** includes infrastructure interspersed with natural environment. Infrastructure includes fisheries, agriculture, economic and diverse aspects.
- **Localized** – implies that communication depends on the audience. It is "relatable" and at a scale of what is achievable, project specific.
- Within sentinel site area, realized importance of local communities for education and buy in.
- **Stakeholders** – local communities
- **Vulnerabilities (localized changes).**
- **Resilience** is a proactive step, such as fostering a storm ready community, ability of ecosystems to bounce back from surges, strategies to maintain ecosystem services, (not included in discussion – it also can mean adaptation.)
- The **Driver** is SLR.

Draft Problem statements

- Understanding and preparing for the long- and short-term socioeconomic impacts caused by the effects of sea level rise on natural and built communities. (or replace natural with ecosystem services).
- Assessing the long- and short-term socio-economic vulnerabilities of the effects of SLR on communities to develop resilience strategies that also protect ecosystem services.

Resilience strategies

- Connect strategies to FEMA Community Rating Service
- Build on what has been done in other areas.

Geography for application:

- ID best places for conservation
- Break pieces of puzzle for communication strategies
- Local research
- Transferable - Extract lessons to other parts of coast
- Pick strategic areas for project foux
- Small scale so we have appropriate data
- Understand differences in different area of state
- Combine habitat work with built areas.

Down East communities with need (as an example of potential local scale project):

- Poor drainage system, poorly maintained septic system, high water tables, frequent flooding, frequent flood claims, not enough funds to raise houses, new houses build up elevation which exasperates flooding to neighboring properties, flood insurance costs unaffordable, sedimentation from drainage ditches eroding properties. Tie the impacts on ecosystem services to homeowner impacts. Implement a project to lesson impacts on natural systems, homeowners, and reduce flood insurance costs by improving the FEMA CRS rating. Make this a pilot project that is transferable.

How to bridge gap from focus on natural to a focus on built areas- through the next generation of the Implementation Plan?

- Expert members
- Vulnerability assessments
- Existing tools/strategies
- Interested communities
- Extrapolate natural impacts to property owner impacts.

Process

- Work with local government representatives
- Foster understanding then approach resilience.
- Work with legislature to push for reductions in insurance costs.
- Educate local government staff (who have a more permanent influence that elected officials)
- Need for new partners.
- Include social scientists

Resources/examples

- South Atlantic Cooperative Landscape- members bring diverse input
- Town of Beaufort is working with NC Coastal Federation (NCCF) to preserve water quality and help property owners
- NOAA creating resilient communities –
    - NCNERR intern, Coastal Ecosystem Learning Centers (CELC) network through NOAA Office of Education.

- NOAA pilot resiliency communities – Duck and Edenton. A precedent has been set in Long Beach , CA.
- Climate Community of practice – meeting in Charleston in April
- Socio-economic impacts on tourism – Jess Whitehead/East Carolina University?
- Jess Whitehead/Tom Allen – impacts of sea level rise on storm water management systems and healthcare facilities (Coastal and Ocean Climate Applications- COCA grant)
- League of Municipalities
- NOAA Socio-economic work in NJ – being scaled to rural setting in Chesapeake.
- Tom Allen –maps of high and low marsh in SE.
- Jess Whitehead of NC Seagrant – vulnerability assessments

Topic: Collaborating to Address High Priority Gaps
The second breakout group discussion focused on the top three gaps prioritized in the first breakout discussion. Three breakout groups discussed one of the following gaps;

1. Effects of sea level rise on ecosystem health and observations/monitoring
2. Better understanding of localized effects of sea level rise, especially socio-economic effects
3. Communication of sea level rise impacts and bridging the communication gap between science and decision makers.

Communication of sea level rise impacts and bridging the communication gap between science and decision makers

Group #3 (participants self-selected into group)
Facilitator, Whitney Jenkins
Recorder, Elise Gilchrist

Participants:
- David Glenn
- Scott Sherrill
- Jeff Harms
- Paula Farwell
- Shannon Myers
- Adam Bode
- Miriam Sutton

Identified target audiences:
- K-12
- Public
- Decision makers
- Peer to peer

K-12
- Suggestion to get an education standard related to sea level rise (SLR)
    - Biotech industry has been successful in driving the curriculum
    - Maybe approach through the habitat health side
- Discussion of how to integrate SLR concepts into existing curriculum standards
    - Miriam Sutton (Carteret County Schools) integrates SLR with hydrosphere curriculum in 8th grade and through weather and climate curriculum in 7th grade
    - Could discuss king tides and moon phases, tie SLR into discussion of storms
    - Create lesson plans and teach those in teacher workshops
    - NOAA has ready made products
    - The Scientific Research and Education Network (SCiREN) hosted at the Aquarium at Pine Knoll Shores, and other locations throughout the state
- Tough to surpass the political boundary

Public

- Increase Living Shorelines outreach – ask homeowners "have you considered a living shoreline"
    - NC Division of Coastal Management (NCDCM) involved with this
- South Carolina National Estuarine Research Reserve (SCNERR) has a great guide to Low Impact Development (LID)
- NC King Tides Initiative
- Promote living shorelines coast share options
- Add signage with SLR information to beach access, wildlife ramps
- Utilize local TV stations
- Put publications on local government websites or include info in utility bills and other mailings
- Connect with local newspapers, put out press releases
- Coastal Review Online
- Newsletter
- Social media campaigns
- Round table community discussions
- Seafood festival?
- Create a fact sheet that everyone could disperse
- Public presentations about research (especially about research happening within community boundaries)
- Citizens Academy in Jacksonville
- Open houses

Decision Makers

- NERR Coastal Training Program does trainings and workshops for realtors and other professionals
    - LID, barrier island development, living shorelines
    - Marine contractors targeted through "Dinner and a Movie" events focused on living shorelines
- Can we incorporate living shorelines into Best Management Practice (BMP) guidance?
- Work with risk managers and insurance companies
- Use some of the same tactics as would be used for the public (see above)
- Always translate messages into dollars! Focus on the economic values
- By educating the public you create your own spokespeople

Peer to peer

- Aquarium doesn't know what research is going on at their site, they have never seen any of the results, need better communication
    - Idea: research symposium
- Above reiterated by local governments, saying they want to know what research is happening within their municipality
- Could create science updates
- NOAA tools training – first have an overview of all the tools, then follow up to see which tools need more training

- Need for a central point for everyone's data

General ideas

- If NCSSC designed social media content and other outreach materials, they could send those to the partners to share
- Jacksonville hosts round tables and would love speakers
- NC Biways – good way to get information out to decision makers
- Hard to reach renters/beach people – add information to rental agencies

People interested in helping with tools training:

- Adam (NOAA Office of Coastal Management, Charleston, SC)
- Whitney (NCNERR Coastal Training Program Coordinator)
- David (NOAA NWS)

People interested in helping with communications:

- Everyone in this breakout

Topic: Collaborating to Address High Priority Gaps, Summary of Report Out
The second breakout group discussion focused on the top three gaps prioritized in the first breakout discussion. Three breakout groups discussed one of the following gaps;

4. Effects of sea level rise on ecosystem health and observations/monitoring
5. Better understanding of localized effects of sea level rise, especially socio-economic effects
6. Communication of sea level rise impacts and bridging the communication gap between science and decision makers.

This is a summary of the report out after the breakout group discussions.

Group #1
Effects of sea level rise on ecosystem health and observations/monitoring

- Observations
    - What observing is currently occurring?
    - Local organizations, agencies, Clearinghouse

- Marsh transitioning possible research project
    - Next steps: Robert Fearn, Justin Ridge, Tom Allen work, Chowan University, APNEP?

- PKS Aquarium has done citizen science work on saltwater intrusion

Group # 2
Communication of sea level rise impacts and bridging the communication gap between science and decision makers.

- K-12 Education
    - best way to get sea level rise into standards? lobby into education system?
    - biotech industry has been able to create standards
    - lesson plans
    - marsh habitat angle
    - 8th grade hydrosphere focus, paleoclimatology
    - 7th grade weather/climate
    - keeling curve: CO2 animals
    - moon, tides, king tides, increasing height
    - hopeful messages, citizen science
    - SCiREN

- Public
    - Resources already available
    - NCDCM, low impact guidebook for NC, SC

    - King Tides
    - Messaging
    - Social media
    - SLR info at Beach accesses and boat ramps
    - Government TV stations
    - Partnering with local government websites, utility mailings, community newspapers
    - Fact Sheets for outreach events
    - CRO
    - Social Media Campaign NRR page (Sarah Spiegler)?
    - Easy opportunities, fact sheets, aquarium, music festivals
    - Local National Weather Service representative will come talk to your group
    - Rental agencies: get info out to those coming for vacation. Local Tourism Authority?
    - UNC TV spot that can be used by the schools

- Peer to Peer
    - Science symposium, to learn about what science is being done
    - NOAA tool training: tailor it to audience
    - Focus groups: determine training needs
    - NC Science Now: What information the group needs

- Decision makers
    - Living shorelines part of Water Quality Best Management Credit?
    - Risk managers and insurance companies
    - Living shorelines and Community Rating System (CRS)
    - Policy probably won't change: focus on education
    - Relate sea level rise to money
    - Fisherman
    - NC BIWAYS

- Communication: can be woven into any research project

- Tool Training before the end of 2017: Adam Bode, David Glenn, Whitney Jenkins

- Group participants interested in these efforts: Miriam Sutton, Jeff Harms, Shannon Myers, Paula Farnell, Scott Sherrill, David Glenn

- NC King Tides, What's your Water Level App: City of Jacksonville, Miriam Sutton, Rich Bandy would like to be further involved

Group #3
Better understanding of localized sea level rise, especially socio-economic effects

- Bridging gaps between natural habitats and built communities
- Understand and prepare for long and short term
- Community resilience
- Keeping things local
- Vulnerabilities—research products geared toward specific communities
- How transferrable can product be to other parts of the state
- Interested communities
- What is needed?
    - Education
    - Training
    - Communicate what we already to know to local communities
- Resources
    - NOAA CELC (Coastal Ecosystem Learning Center): Network utilizing aquariums. Community resilience is current focus
    - Jess Whitehead
    - John Whitehead
    - Dumas
    - Pilot resilient communities: NE part of NC. Can we make a Council of Governments, league of municipalities?
    - CRS: Community Rating System. Reduce flood insurance if your community is more resilient
- Priorities
    - Local government staff—needs training to build baseline understanding so elected staff would consider taking this work on
    - *Edu and Training for local government staff
- CELC network
- Volunteers from breakout group
    - Pat Donovan-Potts, Louise Vaughn, Wade Keller, Anna Hilting, Nathan Hall, Patrick Flanagan, Scott Sherril
    - Partners: DEM, FEMA
    - Robbie Fearn: connections to partners
    - Windy Arey-kent: for PKS/Aquarium specific roles
    - Mark Monaco: resiliency contact

- Don’t recreate what has already been done: assessment of what is already being done.
- Identify partners based on needs
- New partners needed based on new/expansion of Cooperative focus

Next Steps for the Cooperative:

1. **Tools Training 2017**
    - What tools are available, use of tools for specific communities
    - Transferability to other Cooperatives?
    - Interested partners: Adam Bode, Whitney Jenkins, David Glenn, Sarah Spiegler, Jennifer Dorton, Chris Taylor (?)
    - Lead: Adam and Whitney

2. **Communications Plan**
    - Central resource for communications products, access to info/products in the same place
    - What resources are already available?
    - What are the messages (broader partnership group can help with content), who are the target audiences?
    - Sea Grant communications team can work with Sarah Spiegler to develop messages
    - Interested partners: Miriam Sutton, Jeff Harms, Shannon Myers, Paula Fearn, Scott Sherril, David Glenn
    - Lead: Sarah

3. **NCSSC Science Symposium**
    - Help fill the gap of science communication by connecting science, decision makers, educators. Possible focus for 2018 NCSSC Partners Meeting?
    - Researchers explain their projects to educators, city planners, local governments, resource managers. Encourage partners to communicate, share data at the symposium.
    - Spring 2017: Spring 2017 meeting with scientists from NOAA/NCNERR and educators from PKS Aquarium educators. Topic: how to educate aquarium visitors about marsh monitoring and ecosystem services.
    - Lead: Sarah and Windy (Spring 2017 meeting)

4. **Science Collaborative**
    - Topics that were discussed: marsh/upland transition, saltwater intrusion, storm surge, spatial scales, indicators
    - Other possible gaps: sediment supply, bathometry
    - Interested partners: Justin Ridge, Robby, Tom Allen, Wildlife, APNEP, Gloria Putnam (ecosystem health), Windy (community outreach), SALCC
    - Lead: Jennifer Dorton

5. **How to include socio-economic effects in the IP**
    - CMT conversation needed: what needs we want to fill. In the past focus has been on ecosystem habitats and science, so this would be a transition. May be a longer-term focus

- Understand and prepare for the long- and short-term socioeconomic impacts caused by the effects of sea level rise
- Assessment of what research in the Cooperative already exists. Monica (NCDCM) has done a lot of information gathering
- How to develop resilience strategies and products for vulnerable communities while also protecting ecosystem services
- Volunteers could help update IP with these ideas
- Lead: CMT

6. **Annual meetings**
    - Focus of annual meetings could be more targeted
    - Yes, bringing partners together annually is beneficial

7. **Recruitment of new Core Management Team members**
    - Core Management Team: meet quarterly
    - Input by new partners would be valuable
    - Recruited three possible new CMT members

Other priorities noted from breakout groups:

- Education and Training for local government staff: need training to build baseline understanding so elected staff would consider taking this work on related to sea level rise
- Lack of data on county septic systems
- Navigation management and understanding of sediment supply is a gap. Army Corps of Engineers is not engaged with the Cooperative.
- Possible resources/partners for sea level rise effects on built environments: DEM, FEMA (Community Rating System)
- Education resource: NOAA CELC (Coastal Ecosystem Learning Center) is a network utilizing aquariums
- Don’t recreate what has already been done. Assess what already exists
- The gaps in the survey were broad, keep in mind that Cooperative’s successes are specific achievements

APPENDIX F: NOAA Tools

Meeting participants were asked to write down NOAA tools they have used in past work or research related to sea level rise. In breakout group discussions, many people stated that they were not informed about what NOAA tools were available, or how to use specific tools. This resulted in an action item for the NCSSC to host a NOAA tools training session by the end of 2017 in partnership with the NCNERR and NOAA Office of Coastal Management. Below are the tools noted by meeting participants, with the number of people who checked use of the tool in parenthesis.

- NERRs CDMO data viewer (2)
  http://cdmo.baruch.sc.edu/
- Habitat Restoration Atlas
  https://restoration.atlas.noaa.gov/src/html/index.html
- SLR Viewer (4)
  https://coast.noaa.gov/digitalcoast/tools/slr
- Ocean Explorer
  http://oceanexplorer.noaa.gov/
- National Marine Sanctuaries (2)
  http://sanctuaries.noaa.gov/
- National Ocean Service, Weather Service (Forecast Map, Area Forecast Discussion) (3)
  http://www.weather.gov/forecastmaps
- Tides/Currents (5)
  https://tidesandcurrents.noaa.gov/
- Sea Level Trends (2)
  https://tidesandcurrents.noaa.gov/sltrends/slrmap.htm
- Climate.gov (2)
  https://www.climate.gov/
- The U.S. Integrated Ocean Observing System (IOOS) (2)
  https://ioos.noaa.gov/
    - Southeast Coastal Ocean Observing Regional Association (SECOORA):
      ioos.noaa.gov/regions/secoora/
    - Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS)
      https://ioos.noaa.gov/regions/maracoos/
    - Northwest Association of Networked Ocean Observing Systems (NANOOS)
      http://www.nanoos.org/
- Geostationary Operational Environmental Satellite system (GOES) (2)
  http://www.goes.noaa.gov/
- Teacher at Sea
  http://teacheratsea.noaa.gov
- Infographics (2)
  http://www.noaa.gov/multimedia/infographics

- Marine Debris (+ app) (2)
  https://marinedebris.noaa.gov/partnerships/marine-debris-tracker
- Coral Reef
  http://coralreef.noaa.gov/
- NGIS Precipitation Data/Storm predictions, e.g. 100 year relevant (2)
  https://www.weather.gov/gis/
  http://www.spc.noaa.gov/gis/svrgis/

APPENDIX G: Post-Meeting Evaluation

There were 51 people in attendance, and 31 responses to the post-meeting evaluation. People who completed the post-meeting evaluation were from local, state, and federal government, academic institutions, and non-profits. All respondents (100%) agreed or strongly agreed that the workshop was a good use of time. Most respondents (71% yes, 26% maybe) said that they would apply what they learned in future work and/or decisions. Most respondents (93% yes, 7% maybe) said they planned to engage or continue to engage with the NC Sentinel Site Cooperative after this meeting.

The survey questions, scores, and written comments are noted below.

1. What would best describe your current position (check the most appropriate)?

	Response %	Response Count
• County Elected/Appointed Official	0%	0
• County Government Staff	3.23%	1
• Municipal Elected/Appointed Official	0%	0
• Municipal Government Staff	16.13%	5
• State Agency Staff	19.35%	6
• Federal Agency Staff	25.81%	8
• University/College	22.58%	7
• Non-Profit Organization	6.45%	2
• Business/Consulting	0%	0
• Other (please specify)	6.45%	2
o K-12 Education, Partnership		

2. Participating in this meeting was a good use of my time.

	Response %	Response Count
• Strongly Agree	58.06%	18
• Agree	41.94%	13
• Neutral	0%	0
• Disagree	0%	0
• Strongly Disagree	0%	0

3. How much did this workshop increase your understanding of the NC Sentinel Site Cooperative; the benefits of being involved in the Cooperative; and the needs related to the resilience of the Cooperative's geography to sea-level rise and flooding?

	Response %	Response Count
• A Great Deal	38.71%	12
• A Lot	38.71%	12
• Some	19.35%	6

• A Little	3.23%	1
• Not At All	0%	0

4. If you chose a ‘A Little’ or ‘Not at All’ above, why did you make this choice?

	Response %	Response Count
• I already know a lot about these topics	75%	3
• The workshop was too basic	0%	0
• The workshop was too advanced	25%	1
• The workshop was not effective	0%	0
• Other (please specify)	0%	0

5. Did you learn something new at the meeting that you will apply in your work or future decisions?

	Response %	Response Count
• Yes	70.97%	22
• No	0%	0
• Maybe	25.81%	8
• Prefer not to answer/Not Applicable	3.23%	1

If you answered yes above, where would we look in the future to see evidence of that application?

- Will be working to add SET data to NOAA Data Archives for easier access (Federal agency staff)
- I am looking forward to using the portal sites to find out more about the research being done in the area. I am hoping to be able to talk more about sea level rise to guests here at the aquarium as well (State agency staff)
- Networking ability at this workshop was excellent and will allow my agency to leverage common goals to further fulfill our mission (Federal agency staff)
- In outreach materials for the Wilson Bay project, which will hopefully now be more reflective of NCSSC's role in that effort and, conversely, the contributions ongoing monitoring at Wilson Bay can make to NCSSC (University/College)
- I learned about new projects and people working on sea level rise related topics and hope to be involved with crafting a project investigating in more detail what is happening at the marsh and upland transition zone, and the ecological, social and economic implications of those changes (University/College)
- By attending, I was personally able to better understand the issues being addressed within the Cooperative boundary and gather information, training, and tool needs from attendees that will feed into a NOAA Tools Training that will occur by the end of this calendar year. The networking was invaluable (Federal Agency Staff)
- More from the perspective of steering other folks I work with towards the Cooperative when it makes sense (Federal agency staff)

- That scientist and researchers are willing to used already collected data to help the socio-economic effects of sea level rise and work with other stakeholders that develop policy and regulations (Municipal Government Staff)
- Currituck Marshes (Non-Profit Organization)
- I am hoping to incorporate some information from the NC Coastal Atlas into our lesson plans. While we do not have specific "publicity" on our educational programs, it may be visible through social media posts (Non-Profit Organization)
- Classroom instruction using information/research presented during meeting. (Possibly posts to Science by the Sea Facebook Page) (K-12 Education)
- Lots more folks involved in NCSSC than I realized! (University/College)
- The South Atlantic LCC would like to be a listed partner and we would like to review some of the good work that is being generated in this area to see if it could help us improve our Blueprint (Partnership)
- For now my main take away will be internal uses of data that has been created or compiled by the Cooperative so it probably won't be seen anywhere (County Government Staff)
- NOS coastal vulnerability and resiliency studies (Federal agency staff)
- Future meetings I host will have those excellent sparkling waters. That was an easy way to class up the meeting (University/College)
- Definitely looking for ways to incorporate some of the tools I learned about into our information for developers (Municipal Government Staff)
- I enjoyed learning about local government partners. I am excited about the marsh wave energy/water level project that Caitlyn and Chris Voss are managing (Federal Agency Staff)

6. Please rate the following aspects of this workshop on their overall quality and usefulness:

	Very Satisfied % (count)	**Satisfied** % (count)	**Neither Satisfied nor Dissatisfied** % (count)	**Dissatisfied** % (count)	**Very Dissatisfied** % (count)	**Not Applicable** % (count)
Meeting Facilitation	77.42% (24)	22.58% (7)	0% (0)	0% (0)	0% (0)	0% (0)
Meeting Content	54.84% (17)	45.16% (14)	0% (0)	0% (0)	0% (0)	0% (0)
Meeting Format	51.61% (16)	41.94% (13)	6.45% (2)	0% (0)	0% (0)	0% (0)

Organization of Meeting	70.97% (22)	25.81% (8)	3.23% (1)	0% (0)	0% (0)	0% (0)
Networking Opportunities	74.19% (23)	22.58% (7)	3.23% (1)	0% (0)	0% (0)	0% (0)

7. What is the most valuable thing you gained from the meeting?

- Learning who all was involved and what route they are taking in the future. How to help.
- A recognition of just how important the NCSSC is (or can be) to connecting science to community in the region.
- A better understanding of the NC Sentinel Site Cooperative
- I learned a lot about the Cooperative as this was my first time at the meeting. It was very cool hearing about the successes of the Cooperative.
- A better understanding of the program and who is involved.
- Meeting people across a wide range of employment, learning about tools available to various interests and projects
- I learned more about the research and outreach going on in our own backyard, and how we can help others through the cooperative.
- Hearing perspectives from representatives of different organizations (towns, counties, state, federal, NGO). Also the desire of group to see the Cooperative move into adaptation.
- Learning more about NCSSC and better understanding the stakeholders involved. I had a fuzzy idea of the network going into the meeting and this definitely helped resolve it.
- Learning the success stories of the cooperative
- If I have to choose one, is making new connections with people working at the coast.
- Better understand the needs and topical issues being addressed by and through the Cooperative. Networking and meeting others face-to-face was invaluable.
- The update on the Cooperative's progress and direction.
- Networking with various agencies and people.
- Insight into some science possibilities
- Ideas for future projects.
- I made some great connections with other organizations and hope to keep learning more about sentinel site projects.
- A better understanding of the Cooperative mission.
- Networking opportunities
- A better understanding of the NCSSC successes and challenges facing its future.
- Contacts
- Meeting a wide diverse array of people and learning more about the Cooperative
- Data sets and contacts

- Contacts and the success stories of the program
- Met new partners
- Better understanding for local research and what efforts have been underway
- An increased understanding of the basic data needs for supporting decision making at the town/local scale. There does seem to be a disconnect between many of these resource managers and the research that is going on within their jurisdictions. I think the Cooperative could play a strong role in making these connections.

8. What changes would you make to this meeting?

- It was hard to decide where to go from here... in that amount of time... needed more time.
- Perhaps have more of a singular focus (e.g., consideration of a single idea or priority). And make the meeting a half day (e.g., breakfast meeting) as part of a regular quarterly face-to-face.
- Information on how we can inform our legislature about the Cooperatives initiative and how they can make changes to improve our coastal environment (ie: tighten up those CAMA regs!)
- None, I liked it
- More demonstration of tools currently available to assist various interests (local government, non-profit, state, etc.)
- Perhaps a brief training session on some of the available tools (e.g. Sea Level Rise Viewer) to help those tasked with educating others on sea level rise and coastal resilience.
- More networking time. More time on what folks are doing.
- More breakfast snacks? :) Otherwise everything was A++! I especially liked the breakout groups; they were more focused and productive than at other meetings.
- I would have liked more time to network but that would have required an extended day or additional half day of time.
- Slightly longer breaks (~20-30) to allow for more networking.
- I would have some more specific frameworks that the working groups work within. The leadership should provide more or an overarching direction.
- N/A
- None
- More focus on available "tools"
- The meeting was a bit long, but I felt that breakout sessions helped to keep the flow going. Perhaps a bit less "thought intensive" conversation.
- ?
- More opportunities to see what others are doing as part of NCSSC
- I was coming in with little to no background on the Cooperative so an orientation would have been very helpful.
- Discussion on marketing and communication materials focused on educating NOAA leadership on program to influence secure future funding.

- Table notepads for people to jot down ideas that they may not want to share in front of the group
- I thought it was fine.
- It was too long..I felt drained at the end.

9. Do you plan to engage or continue to engage with the NC Sentinel Site Cooperative after this meeting?

	Response %	Response Count
• Yes	93.55%	29
• No	0%	0
• Unsure	6.45%	2

If yes, in what way? If no or unsure, why not?

- Bringing the information back to the municipality.
- I'm part of the Cooperative Core Management Team.
- I would like to help with the education component in educating the public about the research being done.
- Attend future meetings, become more involved in projects at a local government level
- Make connection to climate community of practice. Continue support to NCSSC.
- Continuing to work on the Wilson Bay project
- Hope to be involved with crafting a project investigating in more detail what is happening at the marsh and upland transition zone, and the ecological, social and economic implications of those changes.
- Working closely with Jennifer, Whitney, and Rebecca on a NOAA Tools and Information training that will hopefully increase members of the Cooperative understanding of the information resources that already exist that could help them address their issues or topics of focus.
- Serving as a volunteer.
- Assist with committee
- I hope to attend future gatherings and perhaps even work more with the core management team. I am particularly interested in helping out with communication efforts.
- As a resource or in a support capacity.
- I'm happy to assist in the translation of the science to the general public and classroom.
- Work with others in the cooperative to do research
- First, I would like to get an orientation and then I am willing to be involved in the action items discused yesterday.
- NOS scientific investigations contributing to NCSSC needs.