Principal Investigator Abstract Table of Contents

Marine Operations

North Carolina and South Carolina Moorings – University of North Carolina Wilmington

UNCW's Coastal Ocean Research and Monitoring Program: Optimization & Enhancement of Observing Elements in the Carolinas

***Principal Investigator**: Lynn Leonard and Chris LaClair, University of North Carolina Wilmington*

In partnership with the US Army Corps of Engineers (USACE), UCSD Coastal Data Information Program (CDIP), Florida Atlantic University Harbor Branch Oceanographic Institute, and Second Creek Consulting, UNCW's Coastal Ocean Research and Monitoring Program (CORMP) operates 13 real-time coastal offshore moorings in North and South Carolina that provide hourly reports of core meteorological and oceanographic parameters (www.cormp.org). CORMP also supports seven coastal stations that provide weather, water level and/or water quality observations, two additional wave buoys, and one non-real time instrumented frame that measures water column currents, water depth, and near bottom temperature and salinity. CORMP implements QARTOD for real-time data QA/QC and uses an interactive QA/QC reporting tool to flag suspect or failed data. All data, including QARTOD flags, are archived on CORMP servers and provided to SECOORA. Real time data are made available as soon as they are received and processed and used by stakeholders such as USACE's Research and Development Center's Coastal and Hydraulics Laboratory (Wave Information Study, hurricane model validation), NOAA's National Weather Service (coastal waters & rip current forecasts, marine hazard warnings), SECOORA's Marine Weather Portal, Wrightsville Beach Ocean Rescue, harbor pilots, fishing websites (e.g. saltwatercentral.com) and the public. By providing observations in the Carolinas portion of the SECOORA footprint, CORMP fills what would otherwise be large observational gaps, including areas not covered by existing HF Radar or federal assets in the region. The UNCW observing program supports SECOORA goals in the areas of Marine Operations; Coastal Hazards; and Living Marine Ecosystems.

Key accomplishments in Year 3 include deployment of a new Sofar Spotter buoy at FRP2 in partnership with the Fripp Island Sea Rescue (FISR). FISR supports CORMP by providing regular buoy servicing, thereby ensuring continuous operation for the past year. CORMP also partnered with the Cape Fear Pilots Association to verify tidal lag times in the shipping channel and correlate predictions with pilot observations. These contributions address data coverage gaps within the SECOORA domain and provide critical marine traffic safety information for ships being moved into and out of the Port of Wilmington. CORMP also upgraded the cormp.org website to include real-time camera images and new real-time water level data provided by UNCW and NSCU researchers and added NCEP wave forecasts and storm spaghetti model map layers to its landing page. In Year 4, CORMP will focus on repairing and replacing damaged infrastructure, upgrading sensors to improve resilience and redundancy, and increasing stakeholder engagement in hopes of reducing vessel strikes and platform outages/down-time.

West Florida Shelf Moorings and Modeling – University of South Florida

Coordinated Observing and Modeling for the West Florida Shelf and Applications in Matters of Societal Concern

***Principal Investigators:** Yonggang Liu, Robert H. Weisberg, Jing Chen, Sebin John, Jay Law, Alexander Nickerson, Luis Sorinas, Kaili Qiao, College of Marine Science, University of South Florida*

The University of South Florida (USF) Ocean Circulation Lab maintains a coordinated coastal ocean observing and modeling program on the West Florida Continental Shelf (WFS), with observations consisting of instrumented moorings for surface meteorology and in-water physical oceanography sensors and high-resolution 3D coastal ocean circulation models that downscale from the deep ocean, across the continental shelf and into the estuaries. The objectives continue to be to describe and understand the WFS circulation and the role that the circulation plays in shelf ecology and other matters of societal concern, such as HABs, fisheries, storm surges, SAROPS, and pollutant tracking.

Twenty-five years of moored current velocity time series from the USF's Coastal Ocean Monitoring and Prediction System (COMPS) program are used to update the long-term mean currents on the WFS and their seasonal variation. The long-term surface meteorological and oceanographic data sampled from surface buoys are used to study the seasonal and interannual variations of ocean–atmosphere heat exchange and its influence on WFS water temperature and stratification. It is found that both the spring and fall transition onsets, February and August, respectively, occur when the sign of the net heat flux changes. The water column begins to stratify in March, peaking in June–July and lagging the surface heating by one or two months, then decreasing through September and October. Stratification is also modified by persistent upwelling when the Gulf of Mexico Loop Current interacts with the WFS slope at its southwest corner near the Dry Tortugas. By using the automated West Florida Coastal Ocean Model (WFCOM) and Tampa Bay Coastal Ocean Model (TBCOM) nowcast/forecast systems, the USF lab developed a short-term trajectory forecast tool to help federal, state, and local end users monitor and manage red tides. Observed *Karenia brevis* cell count data provided by FWC/FWRI are uploaded daily into the models to generate 3.5-day forecasts of the bloom trajectories both on the shelf and in the estuaries. During the 2023 spring break season, the online HAB product was accessed by more than 4,000 users each day during the peak days, with more than 200 users in an hour every morning. The TBCOM was also used to set up a tracer model nowcast/forecast, providing important guidance to state and local agencies in rapid response to the emergency discharge of the untreated wastewater from the defunct Piney Point fertilizer plant in 2021.

Other funding resources (e.g., NOAA COMIT, NOAA ECOHAB, Florida DEP) have been heavily leveraged for our observing and modeling work. Note that some of those resources are lost (e.g., NASEM). Steady funding are required to sustain the critical SECOORA assets and to retain highly skilled and dedicated scientists that are difficult to recruit.

North Carolina High Frequency Radar – ECU Coastal Studies Institute and UNC Chapel Hill

North Carolina long-range high-frequency radar system

Principal Investigators: *H. Seim, University of North Carolina at Chapel Hill and M. Muglia, Coastal Studies Institute / East Carolina University*

During Year 3, the 4 NC long-range high-frequency radar (HFR) sites (CORE, OCRA, HATY and JENN) have generally performed well, though not without some issues. At the end of Year 2 the HATY and JENN sites had been augmented with twin transmit antennas in support of the NASA Surface Water Ocean Topography (SWOT) satellite mission, which was in its calibrations/validation phase through mid-July, 2023. Among accomplishments during the last year were the relocation of the DUCK site to JENN, the successful operation of the twin antenna systems at HATY and JENN in support of the SWOT calibration/validation (calval) period, and the rehabilitation of the OCRA site. The latter was found to have a failed transmit antenna, which was replaced in mid-September, 2023, and which has largely addressed issues with the site over the past year or so. Among challenges during the last year, the JENN site has experienced large, intermittent noise problems; we are still working to identify the source, in hopes of implementing some form of mitigation. There

have also been issues with communications to the site, as we navigate security mandates associated with state agencies and our institutions.

With NSF support we have also been re-processing existing data collected offshore of NC, seeking to establish a time history of Gulf Stream properties since 2005. That work suggests some subtle changes in GS orientation and distance offshore of NC, most notably starting in late 2018 and lasting until late 2022. We are also in the midst of evaluating the impact of using twin transmitters at HATY and JENN, and whether those systems should be sustained. We continue to seek ways to maximize uptime and coverage. Preliminary findings are that the HATY site range is indeed enhanced but that alongshore coverage is reduced, and there may be some gaps in coverage (along certain bearings).

Harvey Seim presented HFR analysis as a member of the SWOT Adopt a Crossover campaign at the OSM 2024. ECU Post Doctoral Scholar Caroline Lowcher presented a poster about our NSF sponsored HFR analysis at the OSM 2024.

South Carolina High Frequency Radar Network – University of South Carolina

University of South Carolina HF Radar Operation and Maintenance

Principal Investigators: *George Voulgaris, William (Jeff) Jefferson and Douglas Cahl, University of South Carolina*

During this period the University of South Carolina continued the operation and maintenance of three WERA HFR systems that provide coverage over the coastal ocean area extending from Wilmington NC to Georgetown SC (Long Bay). The three stations are in Georgetown, SC (GTN), Fort Caswell, NC (CSW) and at Myrtle Beach State Park, SC (MBSP). All stations operate at the oceanographic radar FCC-approved frequencies of 13.5 MHz and 5.26 MHz for MBSP and CSW/GTN, respectively. As reported before the 5.26MHz frequency is more susceptible to noise and interference than the frequency of 8.3MHz used in the past.

All three stations have been serviced through routine maintenance and emergency repair visits ranging from 3-4 per year for CSW and MBSP to over 11 for GTN. The maintenance requirements are a function of aging equipment and installation location vulnerability. CSW has continued to be the most reliable site; its down time this past year was due to failure of the cellular WAN hardware (Cradlepoint) that provides remote control / communication to the site. The device has reached its end of life and is not supported anymore. Down time at MBSP was due to failure of the computer controlling data acquisition. A new one was configured and installed, but this event led to an outage that lasted 21 days. On the other hand, GTN continues to show the effects of prior storm degradation that has affected both system parts and local infrastructure. Repairs are constant in an effort to keep the site operating; a complete overhaul is required and planned for when funds become available. Due to climate change the site is susceptible to inundation and damage under any spring/king tide, northeast storm and/or hurricane; these conditions can easily overwash the Rx and Tx arrays and cause enough damage to bring the site down. There was also wild life (coyote) trapping operations at that site that caused significant damage to one antenna cable. Despite all these challenges over the last year we managed to remain operational for 95%, 93% and 90% of the time, for CSW, GTN and MBSP, respectively.

Pending funding and hardware availability we are planning to continue maintenance and operations for year 4 and hope to increase the reliability of the system through several actions. CSW planned maintenance includes infrastructure (trailer) refurbishments and antenna array hardening. For GTN the plan is to overhaul most of the system due to damage from Hurricane Ian including replacing the trailer floor and all RX and TX antennas. New updated cellular WAN communications hardware will be installed at MBSP and GTN.

In the area of data processing, the assessment of the performance of three different algorithms for estimating surface ocean currents from two linear array HF radar systems (like CSW and GTN) was published (Cahl et al, 2023). The results indicated that under certain conditions, Beamscan and MUSIC can outperform the traditional beamforming method. This was found to offer significant

improvement when one or more antennas in the linear array fail or perform poorly (i.e., badly tuned, slightly damaged, etc.). The codes are available in the public domain (Cahl and Voulgaris, 2022) for use experimentally but not yet operationally, as this would require additional investment.
We used data from the same systems to study the effect Stokes' drift has on the phase speed of Bragg waves. Currently the measurement method utilized by HF radars assumes negligible or no effect; we hypothesized that during periods of high wave activity this is not the case. As part of his PhD Thesis, Cahl (2023) compared HF radar derived radial velocities with in-situ ADCP Eulerian velocities (see Cahl, 2023, Chapter 2). Due to lack of near surface in-situ data the results were not conclusive, but qualitatively it can be argued that using the filtered or effective Stokes drift formulations is more appealing than using half surface Stokes. This finding contributes to more accurately converting radar velocities to Eulerian, if that is desired. As part of the same analysis, the application of neural network methods was examined. Bragg peak amplitudes recorded from 2 HF radar sites can be used in Machine Learning to predict the filtered Stokes drift term with a relatively high accuracy. This approach explained 60-70% of the difference between the radar and in-situ current measurements; it has the potential to allow radars to self-correct the current estimates without the need for (external or inverted) wave information.

In addition, during this period improvements were made in the publicly released code developed by Douglas Cahl for eddy identification for HF radar data sets using the Winding Angle method using Matlab®. The code is publicly available at github (https://github.com/dougcahl/eddy_identification_winding).
On May 2023 PhD student Douglas Cahl graduated from the University of South Carolina. His work was partially supported by this project and relied on HF data collected as part of this project.

Cahl, D., 2023. HF Radar: Shining a Light on Ocean Currents. (Doctoral dissertation). Retrieved from https://scholarcommons.sc.edu/etd/7434

Cahl, D., G. Voulgaris, and L. Leonard, 2023: A Comparison of Beamforming and Direction Finding Algorithms (Beamscan and MUSIC) on a Linear Array HF Radar in a Medium to Low Wave Energy Environment. J. Atmos. Oceanic Technol., 40, 191–218, https://doi.org/10.1175/JTECH-D-22-0005.1.
Cahl, D. and G. Voulgaris, 2022: HFcur_BBM: A MATLAB package for calculating surface currents from HF radars using Beamforming, Beamscan (direction finding using beamforming) and MUSIC for a linear array (v0.0aa). Zenodo. https://doi.org/10.5281/zenodo.7231459

Georgia and Florida High Frequency Radar – Skidaway Institute of Oceanography

Georgia and Florida Radar Networks

Principal Investigators: *Catherine R. Edwards, Drew Vincent, Frank McQuarrie, James Bird, Karen Dreger, Dana Savidge, Skidaway Institute of Oceanography, University of Georgia*

Skidaway Institute of Oceanography operates two pairs of WERA HF-radar sites on the Georgia and Florida coasts. Along the Georgia coast, radars sited at Jekyll Island and St. Catherine's Islands combine for coverage of surface velocity measurements extending approximately 100 miles alongshelf and 100 miles out to sea. The Jekyll Island installation has required significant hands-on troubleshooting of multiple hardware failures during this project year due to the age of the instruments, including replacement of components of the power amplifier, troubleshooting system issues through disassembly and testing of the frequency control rack (FCR), scavenging spares from failed equipment, and regular replacement of exterior components (antennas, coils, power splitter). The system is currently offline due to a suspected hardware/corrosion issue in the FCR. In the prior project year, a wildfire on St. Catherine's Island resulted in the total loss of the radar installation there. University-provided insurance covered replacement of the 5 MHz equipment rack delivered in Spring 2024; we are seeking funds to cover cost of reinstallation (antennas, cables, shed, air conditioning, restoration of services to the remote site, personnel time). Once restored, a

dense grid of measurements at ~3.5mile spacing will be updated every half hour, and are used for model verification (R. He, NCSU), assist in glider navigation (C. Edwards, SkIO) and support continuing scientific analysis of shelf circulation and Gulf Stream variability.

The Florida installation consists of a pair of 13.5 MHz radars north of Cape Canaveral. The first system, at Canaveral National Seashore, has maintained excellent performance despite significant corrosion since its installation in December 2021; replacement of components is ongoing as spares allow, and work is planned for Fall 2024 to replace several antennas that are near failure, as well as all wooden poles. Construction of the second site at Kennedy Space Center is complete, test broadcasts have been conducted and approved by KSC frequency space managers, and the site is expected to go live during late Spring 2024 once some final equipment issues are resolved. This achievement follows delays of over 6 years that arose due to COVID, extended efforts to develop and finalize federal/federal agreements, resiting the array after an erosion event, and updating the land use agreement in coordination with NASA KSC site managers and NOAA program office support. IOOS HFR coordinator B. Zelenke has provided invaluable assistance coordinating the re-siting of the array.

Operational challenges include maintaining uptime with the ongoing issues troubleshooting and repairing aging systems and balancing financial burden (time, hardware/repair costs, and travel) of operating aging equipment and installing new sites with a limited budget.

East Florida High Frequency Radar – Florida Institute of Technology

Treasure Shores and Hightower Beach Florida HFR

Principal Investigator: *Dr. Steven Lazarus, Florida Institute of Technology*

A shed was purchased and installed on-site at Hightower in April 2023, retrofit with insulation and the transmit/received cables were laid shortly thereafter. Since then, there were a number of hurdles that had to be overcome including a lightning strike that fried one of the receive antennas (the cable and coil were replaced); the radar PC failed to boot due to a bad lithium battery and was brought in for repair); and the new AC would not start. As a result of the lightning strike, we installed additional equipment grounding for the radar server rack (ground rods and copper conductors to the server rack equipment and lightning arrestor). These problems delayed the install and also led to corrosion related issues with the coils – each of which had to be removed and brushed clean. We also added a thin slice of UV resistant rubber adhesive between the aluminum poll and the stainless-steel clamps (Helzel has since addressed these issues in an addendum to their radar manual). Although the AC unit was replaced free of charge, both of the single hose units (at Treasure Shores and Hightower) have since been removed and placed with dual-hose cooling systems due to negative inside pressures and subsequent salt build-up on the radar rack. The Hightower radar (Satellite Beach) is now up and running as of late February and the remaining firewall issues have been resolved (the data are flowing to the Florida Tech campus server). The data will soon be made available to both Axiom and the HFRNet.

We recently (March 2024) met with James Bird (SKIO) to help answer some of their questions associated with the Canaveral radar installation. My PhD student (Marcus Cote) will be attending the ROWG-13 workshop in May. With the exception of the data transfer, Hightower is fully operational. Over the next 6 months we will refocus on Treasure Shores to 1) inspect and repair damaged cable (due to the recent beach renourishment project); 2) replace/repair damaged coils and add rubber interface between the clamps and antenna poles; 3) retune all new and/or refurbished coils; and 4) install heat shrink, self-sealing tape and nylon washers to all of the antennas.

South Florida High Frequency Radar Network – University of Miami RSMAS

South Florida High Frequency Radar Network

Principal Investigators: *L. K. (Nick) Shay, J. Martinez Pedraja, B. Jaimes de la Cruz, S. Akin and D, Voss Department of Ocean Sciences, Rosenstiel School, University of Miami*

As part of the US IOOS/SECOORA priority Wellen Radar (WERA), we continue to operate and maintain to the extent possible high frequency (HF) radar sites at Crandon Park (CP), Virginia Key (VK), Dania Beach (DB) and North Key Largo (NKL). Hourly (subsampled to 2.2 km) data from these sites are sent to SECOORA and the IOOS National High Frequency Radar Network at Scripps Institution of Oceanography for integration, display and dissemination. These data are also on the UM's Rosenstiel School web site. Our targeted "up time" is 85% for these sites, however, there have challenges to maintain this up time given that we do have to comply with requests from the county, state and federal government to turn the radars off at certain times on a not-to-interfere basis.

All four radar have been operational over the past year: CDN-99%, NKL-93%, STF-91% and VIR-89%. The VIR site is particularly important since it oversees the port of Miami where larger cruise industry ships line up to get into Government Cut for safe harboring for passengers disembarking and embarking ships. However we do have intermittent outages are primarily due to King Tides at VIR (October-November), occasional requests at STF by the Navy while they test their equipment and over the past two months we have had significant interference at CDN (13.5 MHz-approved ITU Band). This interference is located about 30 km offshore and we have not been able to pinpoint the source. The IOOS program office is well aware of the problem and CORDC has been told not to use the radials from CDN.

We continue to work with the Navy facility integrating an X-Band radar measurement with WERA measurements for currents and waves. In addition, we collaborate with organizations such as CESU program (consortium of the National Park Service Department of the Interior, Southeast Marine Fisheries, Army Corps of Engineers, Fish and Wildlife, Coast and Geodetic Survey, Bureau of Indian Affairs, and the University of Miami). Fiscal challenges remain with respect to our day-to-day HF radar operations given rising fuel and electricity costs, increases in the rent for the beach hut at Virginia Key, beach maintenance around the sites damaging equipment as well as cost-of-living salary increases for technical personnel.

West Florida High Frequency Radar Network – University of South Florida

West Florida High Frequency Radar (HFR) Network – University of South Florida
Maintaining West Florida High Frequency Radar Network

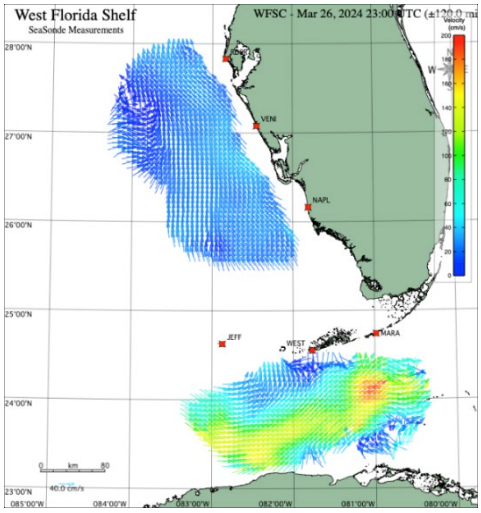
Principal Investigator: *Dr. Clifford R. Merz, University of South Florida, College of Marine Science (USF/CMS)*

The USF/COMPS/Ocean Circulation Group operates and maintains eight (8) HFR systems along the West Florida Coast and Lower Florida Keys. Real-time (RT) hourly HFR data from each remote site is pulled/pushed via scripting to a central processing station located at USF/CMS and provided to SECOORA, NOAA NDBC, and the IOOS National HFR CORDC Network (HFRNet) for integration, display, and dissemination. Data plots displayed on the USF/CMS Coastal Ocean Monitoring and Prediction System (COMPS) (http://comps.marine.usf.edu) web site.

- Specifics to report during this annual reporting period include:

✓ Redington Shores (CODAR: Frequency: 5.263 MHz) - **Operational: 98.3% Up time.**

- ✓ Ft. De Soto (WERA: Frequency: 13.500 MHz) - **Operational: 97.9% RT Up time**.
- ✓ Venice (CODAR: Frequency: 5.263 MHz and WERA: Frequency: 13.500 MHz) - **Status: Both Sites Operational: 98.3%, 99.7% RT Up time, respectively**. The Venice site sustained damage during Hurricane Ian in 2022 resulting in several beach dune washout areas exposing portions of previously buried cable carrying conduit. A sand replacement effort was completed, replacing 5 truckloads of suitably sourced sand after requesting and receiving approvals from numerous governmental agencies including: USCG, FDEP, USACE, NOAA IOOS NEPA and the City of Venice.
- ✓ Naples (CODAR: Frequency: 5.263 MHz) - **Status: Operational: 77.6% RT Up time since installation (SI)**. The Naples site sustained damage during Hurricane Ian and was returned to operation in December of 2023. Restored with system sparing along with a recently developed Transmit/Receive (TR) antenna that serves as both the transmit and receive antenna.
- ✓ Marathon (CODAR: Frequency: 5.263 MHz) - **Status: Operational: 98.9% RT Up time**.
- ✓ Key West (CODAR: Center Frequency: 5.263 MHz) - **Status: Operational: 92.6% RT Up time**.
- ✓ Ft. Jefferson, Dry Tortugas National Park (CODAR: Center Frequency: 5.263 MHz) - **Status: Operational: 91.6% RT Up time SI**. The Ft Jefferson low power site came online in March of 2024 using the same CODAR single TR antenna design in use at both the Naples and Key West HFR sites along with Starlink satellite communications.



- Frequent correspondence and on-site meetings with USCG and Eglin AFB personnel regarding facility building changes at the Venice USCG Auxiliary Station where the USF CODAR/WERA HFR systems are located.

Coastal Hazards and Climate Variability

Water Level Team – American Shore & Beach Preservation Association and Hohonu, Inc.

Water Level Network Team | Nicole Elko and Brian Glazer

Principal Investigators: *Nicole Elko, ASBPA (American Shore & Beach Preservation Association); Brian Glazer, Kevin Mukai, Hohonu, Inc.*

Accomplishments

Maintained and surveyed 34 of 34 sensors in North and South Carolina and Florida in collaboration with SECOORA. Upgraded most of our 41 SECOORA water level sensors (including mini-OBX project) to new LTE versions with improved telemetry and onboard data logging, resulting in nearly 100% uptime.

Collaborated with CO-OPS to refine QA/QC and tidal calculations to be consistent with their standards. Launched a user-friendly mobile app (Figure 1). Began developing prototypes of flood reporting as well as early-warning flood systems.

Engaged with stakeholders to gather feedback and ensure that our efforts are aligned with the needs and priorities of the communities.

Next Year's Objectives
Finalize upgrade to improved LTE sensors and test/deploy radar and new "over land" sensor types.
Continue outreach to other IOOS Regional Associations, fostering broader collaboration and data integration.
Develop a prototype of an early-warning flood system, leveraging cutting-edge technology to enhance community preparedness.

Figure 1. Example of real-time water level data mobile app focusing on data from Isle of Palms, SC. It also includes Hohonu predictions, over 1,500 NOAA stations across the U.S., and weather conditions.

Water Level Team Update – Florida International University

Integrated coastal flood observation network for citizen engagement and improved data, modeling and projections

Principal Investigators: *Tiffany Troxler, Jayantha Obeysekera, Michael Sukop, Emily Standen, and Rachel Stovall, Florida International University; Amy Clement, University of Miami; Greg Dusek, NOAA/National Ocean Service; Carlos Genatios Sequera, Miami-Dade College; Alexander Nunez, Digital E Consulting*

Overview: The goals of our project are to develop a multi-sensor network of integrated coastal flood observation sites that combine approaches of crowd-sourced, citizen flood measurements, in-situ measurements of depth and salinity, web cam monitoring and drone surveys, and coordinate with SECOORA partners to develop a regional scale enterprise. The information from the network is highly responsive to stakeholder challenges and societal needs, and fundamentally supports SECOORA's priorities for contributing to our improved understanding, management, and stewardship of valued coastal ocean resources. Value-added products and services include improved flood modeling and projections, flood warning systems with location specific thresholds, and improve flood metrics to support decision-making. In particular, we seek to integrate and leverage: 1) relevant existing observing assets, data management and communications, modeling, products and education and outreach activities and 2) identified SECOORA investment opportunities to support end-users and broader group of stakeholders charged with coastal flood risk preparedness.
Our objectives are to: 1) establish eight integrated coastal flood observation stations in Florida, with a subset including extreme high tide citizen science flood reporting and drone flights, real-time water and salinity gauges, and web cam monitoring; 2) coordinate with other SECOORA water level network project teams to extend integrated observation stations and data; and 3) coordinate transfer of citizen science flood reporting programming and tools.

2023-2024 Accomplishments: We continue to maintain 8 *In-situ* water level pressure sensors. In its 8th year, we conducted a Fall king tide citizen science flood monitoring sampling event, and we established a flood monitoring web cam. These data are being leveraged to develop local flood thresholds verified with spatially-distributed, on-site flood measurements in low-lying neighborhoods, and spatially-expanded applying high density LiDAR data for 2 neighborhoods in Miami-Dade and Monroe Counties.

Next Year's Objectives: We are working to develop integrated products based on the different types and scales of flood information being collected. These include neighborhood flood maps and flood projections based on integration of local data. Once the method is refined, we intend to expand drone surveys to 2 additional neighborhoods. We are also applying these data along with local

temperature and humidity measurements to assess distribution of multiple climate-related hazards. Finally, we will convene the 9th Annual Sea Level Solutions Day citizen science sampling.

Water Level Team Update – Georgia Institute of Technology

Smart Sensor Networks for Coastal Flooding in Georgia
Principal Investigator: *Russell Clark, Georgia Institute of Technology*

The goal of this work is to partner with stakeholders, decision-makers, and residents to co-design and co-deploy a network of internet-enabled smart flooding sensors along the Georgia coast at the scales required for the decision-support tools of coastal communities.

Leveraging existing collaborations with a diverse stakeholder and outreach network in Georgia's coastal counties, this project will provide real-time high-resolution and high-frequency flood data that coastal communities can use to **(1)** plan for and respond to flood emergencies (e.g. flooding, hurricanes, storms) and **(2)** design resilience and adaptation strategies for the long-term effects of sea level rise and the projected increase in flooding. The data produced in this project will also be integrated in ongoing high-resolution modeling efforts to advance our understanding of coastal system dynamics and prediction capabilities at 10 meter spatial resolution.

The project team deployed five new water level monitoring stations in Coastal Georgia. These were deployed in conjunction with community partners to address flooding concerns in their communities.

The project team worked with the M&C survey crew to identify and establish elevation surveys for sixteen monitoring stations.

The project team worked across the previously deployed stations to perform maintenance and repair. In the process, twenty-two of the stations were converted from battery to solar power. New signage was developed and deployed at publicly accessible locations.

In year 4, the team will deploy additional monitoring stations in Glynn, McIntosh, Liberty, and Bryan counties. The design and deployment of the sensor network involves close collaboration with existing City and County partners along Georgia's coast. Ultimately, our shared goal is to transfer the ownership and maintenance of these sensor network to the community at the end of the project. This will include plans for maintaining stations to established SECOORA SOPs for low cost monitoring stations.

The team continued to work through a transition in cellular service providers for the LoRa gateways and replaced two gateways that had failed due to lightning strikes.

Water Level Team Update – Coastal Carolina University and Florida Atlantic University

SEA Econet- Integrated Coastal Sensing and Modeling Across the Marine-Terrestrial Boundary: Water Level Sensing Contribution through SECCORA
Principal Investigators: *Luu Tuan Linh Dang [1], Paul Gayes [2], Jason Hallstrom [1], Len Pietrafesa [2], Preston O'Brien-Gayes [2], Rebecca Smail [2], [1]Coastal Carolina University, [2]Florida Atlantic University*

The Coastal Carolina and Florida Atlantic University team has been focused on integrated observing through the coastal zone supporting direct public applications for various stakeholders and an overarching coast of better spatial reporting of environmental parameters supporting research, education, and extension. The primary technical goal is to further advance, validate and

long-term assimilate data near real time into interactively coupled ocean-atmosphere-hydrologic mode system towards better predictive capacity for driving pressures in the coastal zone. The overall program is funded and partnered with various programs and interests historically focused on parts of the complex transition across the coastal zone (e.g. weather, water level, wave/currents etc.). SECOORA funding is helping greatly expand the water level sensor network across, initially, northeastern SC and southeastern Florida.
SECOORA supported water level station installations thus far include:
In Florida: water level sensors have been co-located with weather or water quality stations (supported from other sources) have been installed at: the Florida panhandle (4 plus 1 standalone water level sensor), Cocoa Beach and Port Canaveral (4), Matanzas River in Flagler County (4), Jacksonville (1), at the three 3 FAU campuses in Boca Raton, Dania Beach and Fort Piece (2 with 5 single water level stations), NAVSEA in Fort Lauderdale (1), Pompano Beach (2) and the SECOORA test bed at Fernandina Beach Harbor Marina (1).
In South Carolina: water level sensors have been co-located with weather or water quality stations in: Georgetown County (1), Charleston County (1), Horry County (6), St Phillips Island State Park in Beaufort County (1). Stations are under construction in Williamsburg County (2) and Florence County (2). Two nearshore sites have tested water level measurements from Spotter buoys 3-4 miles offshore of northeastern SC and being installed in Port Royal Sound in Beaufort.
Note weather, water quality nearshore buoy stations are supported from other projects support by Fed, State and local partners but part of the integrated program being pursued.

Long term, we seek to continue to build out the onshore water level network as part of the larger observing system with increasing focus on the coastal ocean where three nearshore stations have been established and sustained (intermittently) from other funding sources off northern, central, and southern SC.

The range of stakeholders and partners include federal and state agencies, local county, municipalities, other universities, and private (corporate and individual) interests. We continue to work with this range of partners towards leveraging interests and resources to co-locate diversified sensing system were possible. Some partners are seeking internal sources to help sustain (e.g. telemetry or some recurring component replacement/maintenance costs) at their properties. Cooperative efforts with university and private sector tech companies continue to seek capable and cost-effective sensing solution to affect better special coverage, again focused on the transition from coastal ocean into the watershed. Strong partnerships have evolved in both states with public and private interests who have bought into the integrated model and importance of focusing across the marine – watershed boundary where heightened environmental and economic concerns and pressures continue to mount.

Expanding the Southeast Water Level Project – Southeast US Sea Grants

Regional Coordination of the Southeast Water Level Network

Principal Investigators: *Susan Lovelace, Ph.D., Executive Director, S.C. Sea Grant Consortium And Katie Finegan, PE, S.C. Sea Grant Consortium and Coastal Carolina University*
Partner: *Jeffrey Steinmetz, Ph.D. Francis Marion University*
Staff: *Ke'Ziyah Williamson, S.C. Sea Grant Consortium in partnership with Francis Marion University*

Water level sensors are being installed across the Southeast, as part of this effort, engagement with communities helps connect users to the data so local flooding impacts can be understood and planned for. The community engagement is led by Sea Grant programs in North Carolina, South Carolina, Georgia, and Florida. From 2023 to 2024, each state was able to complete at least one installment of a water level sensor. Each Sea Grant program is also working with SECOORA on

regional coordination meetings every other month to determine how to make data more accessible and useful to communities and ways to increase awareness and communication of the work.
North Carolina Sea Grant (NCSG), currently led by Cayla Cothron, built a foundation for establishing sites by developing a living document with a matrix of potential communities. This document was presented to local and regional partners for feedback, to help NCSG prioritize and focus initial engagement efforts. Two successful water level sensor installations occurred in March 2024 in Beaufort County and in the Town of Belhaven. In the next year, NCSG plans to continue to engage with Beaufort County to discuss engagement needs and the most effective uses of data. Additional partnerships are being formed to continue to engage new communities and the living matrix will be updated.
South Carolina Sea Grant Consortium (SCSGC), led by Ke'Ziyah Williamson, has developed products to increase awareness in communities before and after sensor installations. This includes a rack card with general information about water level sensors and a business card that includes QR codes to the website with data and tutorials on accessing and downloading data. One sensor was installed in Marion County in September 2023 and engagement has continued with Marlboro County and the Town of McClellanville for their sensors. SCSGC is working to establish critical flooding thresholds at two sensor locations and install additional sensors in the next year.
UGA Marine Extension and Georgia Sea Grant, led by Jessica Brown, collaborated with partners at Georgia Tech (CEAR Hub) to install sensors in four new communities, with a special focus on a sensor in the City of Brunswick. There have also been regular meetings with municipal staff in Brunswick regarding how to use data and how this data can be relevant to other projects related to water resources management throughout the City. These meetings will continue into the next year. Community engagement opportunities will also continue to be leveraged to increase awareness of the work.
Florida Sea Grant (FSG), led by Mary Gutierrez and Laura Tiu, began a program to install 20 water level sensors throughout seven counties in the Florida panhandle, including: Escambia, Santa Rosa, Okaloosa, Walton, Bay, Gulf, and Franklin Counties. FSG is collaborating with city and county officials, estuary programs, and others to select sites. Two sites were installed as a part of a pilot test in Okaloosa and Walton Counties. Throughout 2024, six additional sensors were installed across Okaloosa and Walton Counties. In the next year, FSG is planning additional installations, starting with four sensors across Bay and Gulf Counties, and community engagement events with stakeholders.

Glider Operations – Georgia Tech, Skidaway Institute of Oceanography, University of South Florida

SECOORA Glider Observatory

Principal Investigators: *Catherine R. Edwards, Karen Dreger, Frank McQuarrie, James Bird, Xavier Giomi, Garrison Hefner, Drew Vincent, Ben Hefner, Skidaway Institute of Oceanography, University of Georgia*
Chad Lembke, Alex Silverman, Heather Broadbent, Sean Beckwith and Garrett Miller, College of Marine Science, University of South Florida
Harvey E. Seim, Tony Whipple, Lu Han, and Yubeen Jeong, University of North Carolina at Chapel Hill
Fumin Zhang, Ruochu Yang, and Klimka Szwaykowska, Georgia Institute of Technology

The SECOORA regional glider observatory is a collective effort among the glider groups at SkIO, UNC, USF, and GT. Project PIs cooperate to support shelf-wide glider surveys through at least 4 glider deployments in the South Atlantic Bight (SAB), with joint deployments/recoveries, piloting, and data management, pooling resources to take advantage of complementary assets (instruments, personnel, and ship access).

In year 3, observatory partners conducted 4 observatory-funded missions in the SAB for a total of 114 glider-days, providing data visualization, logistics, deployment/recovery, piloting, and/or coordination support among the group. This tight coordination of resources and operations is facilitated by a glider coordinator who serves on SkIO and USF teams, as well as cross-training of lab personnel for glider preparation and piloting. SkIO also supported deployment, piloting, and recovery of 2 Navy gliders made available through a Navy/NOAA partnership and OMAO funding. SkIO deployed and led recovery for 2 deep Navy gliders that sampled for approximately 5 months (300 glider-days combined) in the Sargasso Sea before crossing the Gulf Stream for recovery off Cape Hatteras.

The observatory provided data submission and observatory structural resources to one privately-funded mission for right whale monitoring off the Georgia coast that produced the first confirmed passive acoustic detection of the critically endangered North Atlantic right whale south of Virginia. A second mission off Georgia and South Carolina with partner E. Meyer-Gutbrod was jointly supported by the Tides Foundation and SECOORA. These missions were conducted in coordination with the Florida and Georgia Early Warning Systems' aerial surveys, and have established the ability for glider detections to be broadcast via a notice to mariners by NOAA in near real-time.

Two observatory missions were piloted with support from the Glider Environment Network Information System (GENIoS), which integrates smart piloting strategies into waypoint generation and monitoring for flight anomalies, and was ported from MATLAB to Python, with its first real-time operational test of the anomaly detection algorithms in Fall 2023. Post-deployment, data from deployments has been used to post-process CTD observations as a science product, integrating an independent model of glider flight to adjust for measurement dependence on variable vehicle speed.

Coordination of observatory operations, resources, and planning occurs through monthly all-hands calls, and a monthly "Tech Talk" series for deep dives into technical and/or scientific topics of interest; in 2023, 4 "Tech Talk" sessions were presented on technical (2) and scientific (2) aspects of glider operations. Two observatory personnel represented their institutions and the SECOORA glider observatory at the MTS OCEANS Meeting in Biloxi, MS, presenting 2 posters, giving 2 talks, and leading a panel group.

The glider observatory has been awarded significant external funding to supplement baseline operations, including $675k to purchase a new glider and fund 3 deployments per year in the 2023 and 2024 seasons. The new SECOORA glider, unit_1091 (name pending) successfully executed two back-to-back missions during hurricane season, in which data download and battery recharge in the lab was conducted without opening the glider to reduce turnaround time and risk associated with opening the vehicle. The glider was rapidly turned around in preparation for an October mission, but extended bad weathe prevented its redeployment before the end of hurricane season. Data from Year 3 deployments during hurricane season were assimilated into Navy and NOAA models, including RTOFS, the operational ocean model used by NOAA coupled with meteorological models for tropical storm predictions.

PI Edwards participates in a continuing collaboration with NOAA AOML/PMEL scientists to coordinate gliders with 5 Saildrones during hurricane season, including 2 Saildrones in the South Atlantic Bight near the Gulf Stream, where air-sea interaction can be significant. Edwards assisted with design and implementation of the Saildrone sampling in the SAB and GoM, including coordination of Saildrones with gliders, multiple NDBC and CDIP buoys, and experiential learning cruises aboard the R/V Savannah. This work received significant press, and has thus far resulted in 2 publications (BAMS, Oceanography) and 13 presentations at national meetings (AMS Tropical, AMS annual meeting, Ocean Sciences, MTS/OCEANS). Efforts are underway for 2024 operations,

which will include development and testing of feature-based strategies for coordinated glider/saildrone operations, as well as analysis of impact of observations through data assimilation into NOAA models.

Operational challenges include equipment loss and damage sustained while offshore: the loss of a USF G3 glider during Hurricane Idalia, multiple shark strikes, and remora strikes. Multiple G3 gliders owned by SkIO, USF, and SECOORA are 5+ year old and due for hardware upgrades to bring them up to the capability of the new G3S models, and as of late 2023, Teledyne Webb Research will no longer do even routine maintenance on G1 gliders that, while declared obsolete for 10+ years, comprise half of the SkIO/USF fleet. Lastly, operational and personnel costs continue to rise, and it is becoming harder to complete mission observatory goals without further leveraging of baseline operations with external funding.

Southeast and Caribbean Disaster Resilience Partnership

Southeast and Caribbean Disaster Resilience Partnership (SCDRP)
Principal Investigator: *Heather P. McCarthy, Southeast and Caribbean Disaster Resilience Partnership*

The Southeast and Caribbean Disaster Resilience Partnership (SCDRP) is the trusted network for hundreds of professionals in emergency management, climate adaptation, resilience, and disaster preparedness, response, and recovery specifically in the U.S. Southeast (NC, SC, GA, and FL) and Caribbean (PR and USVI). SCDRP is an incubator network of SECOORA, led by a 15-member Advisory Board, and staffed by a full-time Executive Director and a part-time Program Coordinator.

During the last year, SCDRP engaged in a multi-faceted strategic planning process culminating in the 2024-2027 SCDRP Strategic Plan containing a new vision, mission, core values, and 3-year strategic objectives. The Partnership conducted its second official Advisory Board Election and first official Officer election. SCDRP submitted its first major grant proposal to the NOAA Climate Resilience Regional Challenge. If funded, the project will include 33 collaborators from 8 different institutions working to reduce risks in vulnerable communities in FL, SC, and USVI.

Designed by a 24-member Steering Committee and supported by 18 sponsors, the SCDRP 8th Annual Meeting brought together 127 attendees in Savannah, GA. The theme of this flagship event was *"Moving the Needle Toward Equitable Community Resilience to Natural Hazards."* Opening remarks were provided by Savannah Mayor Van Johnson and the Keynote Speaker was civil rights/environmental justice champion, Rev. Dr. Gerald Durley. Attendees enjoyed guided tours of Tybee Island Resilience Sites and Chatham Emergency Operations Center, live graphic recording, an app-based Resilience Sites Scavenger Hunt through Savannah, and an interactive Data Tools & Technology Exhibition. Speakers highlighted case studies and successful climate resilience initiatives, innovative public-private partnerships, and strategies to address inequities and effective community engagement. In collaboration with SCDRP, the Duke Nicholas Institute for Energy, Environment & Sustainability hosted the "*Insurance, Innovation & Climate Change"* Roundtable to explore innovations in the insurance industry designed to fit the current risk landscape posed by climate change.

During the coming year, the newly elected Advisory Board Officers will oversee a full-day Advisory Board Summit and refine the Budget and Staffing Plan. The Governance Committee will write new Policies & Procedures for Committees and discuss adding Advisory Board seats to enhance diversity. The Partnership Committee will initiate a "Partner Picks" Summer Speaker Series, identify and fill membership gaps, conduct a Fall Group Membership Drive, and initiate a Mentorship Program. The Development Committee will establish a Tiered Membership Model, pursue

philanthropic and corporate support, and seek grant funding to address regional resilience challenges. With time, SCDRP aims to become an autonomous, durable, and member-supported organization to better serve our members, communities, and region.

Drones in the Coastal Zone - SECOORA

Support and expand the existing Drone in the Coastal Zone Community of Practice (DITCZ CoP)

***Principal Investigator**: Troy Walton, University of North Carolina*

The Drones in the Coastal Zone (DITCZ) Community of Practice (CoP) connects all sectors with common interests in coastal and ocean research and management to share resources, strategies, and innovations. Our goal is to support the transmission and expansion of knowledge and expertise for leaders, learners and professionals across the U.S. Southeast and Caribbean.

The CoP hosts quarterly virtual meetings to support its goal. In February 2024, the CoP met in-person for the first time, as the original in-person meeting plans were thwarted in 2020 due to the pandemic. The three-day meeting, held in Beaufort, NC, was in partnership with SECOORA, Duke University's Marine Robotics and Remote Sensing Lab (MaRRS), and the N.C. Coastal Reserve & National Estuarine Research Reserve. It was also supported by technology vendors Geo Owl, Duncan Parnell, and Frontier Precision. The meeting objectives included networking with colleagues with common interests in using unoccupied aircraft systems (UAS), or drones, for coastal and ocean research and management; discussing and troubleshooting the use of drones; interacting with drone technology through equipment tables; and discussing the future of the CoP.

Approximately 75 participants attended the meeting. Small group discussions focused on using drones for monitoring habitat change and water quality; legal challenges including land permission, Remote Identification requirements, and adhering to the National Defense Authorization Act (NDAA); and best practices for flight planning and imagery processing. Unfortunately, the drone air show was canceled due to gale force winds, but participants were able to connect with drone vendors and their equipment during technology table time. The future of the CoP was discussed and included future meetings, improvements to communications platforms such as the website and listserv, and developing mechanisms for data sharing within the group. Optional trainings were offered on Day 3 - mapping and photogrammetry were led by the MaRRS lab and a National Institute of Standards and Technology drone pilot training was led by Atollo LLC.

Looking forward, the CoP will continue to foster collaboration around the use of drones for coastal and ocean research and management through virtual collaborative meetings and a biennial in-person meeting. If you are working with drones in the U.S. Southeast or Caribbean, join our community by sending an email to ditcz@secoora.org.

WebCOOS – SECOORA

WebCOOS: Webcam Coastal Observation System

***Principal Investigators:** Theo Jass & Debra Hernandez, SECOORA; Joe Long, University of North Carolina Wilmington; Greg Dusek, NOAA; Dwayne Porter, Jeremy Cothran, & Louisa Schandera, University of South Carolina; Alex Pang, Akila de Silva, & Fahim Khan, University of California Santa Cruz; Rob Bochenek, Lauren Showalter, & Josh Rhoades, Axiom Data Sciences.*

SECOORA and our team at University of South Carolina, University of North Carolina Wilmington, University of California Santa Cruz, NOAA CO-OPS, and Axiom Data Science have worked together to develop WebCOOS (Webcam Coastal Observation System), an operational webcam coastal

observing network. Starting in 2017 as the WebCAT pilot project with a small number of sites in the SECOORA region, this project has grown to include 20 sites not only in the southeast but also in other coastal states.

Over the past year, the project team has integrated 7 new cameras in the SECOORA region and beyond. Algorithms for a number of coastal applications, including rip current detection, beach erosion and shoreline change, beach usage and object detection, and flood monitoring, are being integrated into camera streams to create products in near real time.

The newest phase of the project will expand this network across the IOOS Regional Associations and add 60 cameras over three years across the country in locations and applications of interest. We also plan to continue to build collaborations with coastal scientific and management organizations from the federal (including NOAA & USGS) to the local level.

Ecosystem: Water Quality & Living Marine Resources

Regional Surface Elevation Table (SET) Coordination – SECOORA

Regional SET Coordination
Principal Investigator: *Nisse Goldberg, Jacksonville University*

The goal of the SECOORA Surface Elevation Table (SET) project and forthcoming Community of Practice (CoP) is to foster regional collaboration for coordinated SET management. This initiative unites stakeholders to deepen our understanding of coastal resilience in the face of rising sea levels. SETs are instrumental in measuring wetland elevation changes, particularly in coastal marshes. A webpage dedicated to the SET Network has been developed: Surface Elevation Table Community of Practice - SECOORA).

The SET Coordinator and assistants have identified have created an inventory of existing active and inactive SET stations located from North Carolina to Florida that are managed by members of government agencies that include the US Fish and Wildlife Service, US Geological Survey, South Carolina Department of Natural Resources, National Park Service, and Florida Department of Environmental Protection. Additionally, scientists from universities are actively involved in utilizing SETs. A list of SET-related publications is included on the webpage, as well as links to data visualization and other SET resources. Soon, a map of active and inactive stations along with the number of publications per state will be uploaded to the webpage.
A listening session was held to identify the data visualization needs of stakeholders who may use SET-derived trends. It was apparent that more educational outreach of the value of SET patterns is critical to bridge the gap between the scientists collecting the data and end users.

Current and future directions for the SET project are to develop the data visualization platform, build on progress made for the regional CoP, identify SET stations to either install and/or maintain, and create materials that showcase applications of SET-derived trends for stakeholders in the SECOORA region.

The FACT Network and DaVIT – The Fact Network

Let's get together: the FACT Network
Principal Investigator: *Joy Young, PhD*

The Fast FACTs

Long-term animal movement observations are a key component in understanding the impacts of changing oceans and implementation of effective management controls to conserve our natural resources. Acoustic telemetry studies have increased over time, surpassing satellite telemetry studies due to several factors, including cost. However, as opposed to satellite telemetry, acoustic telemetry requires the collaboration of scientists to match tag metadata with observation data to create a complete movement track. The FACT Network was formed in 2007 to meet that need. The FACT Network is dedicated to improving the conservation and management of aquatic animals by facilitating data sharing amongst researchers using acoustic telemetry technology, providing a community for scientists, and building stakeholder partnerships. Covering much of the southeast US and into the eastern Gulf of Mexico and Bahamas, it is spatially one of the largest networks in the world. In 2016, an online data sharing system was implemented that is capable of exchanging information with other compatible systems designed by the Ocean Tracking Network. The FACT database currently houses over 316 million detections and metadata from over 10,000 tags deployed on or in 132 species of fish and aquatic reptiles. Environmental data collected as part of collocated sensors or specialized detection equipment are formatted and published in our IOOS regional association, SECOORA. To overcome issues of archiving acoustic telemetry datasets with incorrect data points, FACT is currently working on a project to better quality control detection data and establish guidelines for publication in OBIS.

DaViT: Bridging the Gap to Open Data

***Principal Investigators**: Joy Young, Bonnie Ahr, The FACT Network; Beth Bowers, Smithsonian Environmental Research Center; Robert Ellis, Danielle Morley, FWRI/FWCC; Jon Pye, Ocean Tracking Network*

In recent years, the U.S government has made strides in implementing or reinforcing mandates for open data on supported grants and contracts, including biological observations. Two primary stakeholders in open data initiatives are scientists and the public. Whereas scientists can leverage raw or moderately summarized data, the general public often lacks the technical expertise to navigate and interpret these data. Visualization serves a crucial role in bridging this gap, transforming complex telemetry datasets into visually engaging representations that enhance understanding and accessibility. The FACT Network has amassed a vast repository of animal observation data, encompassing numerous species of fish, aquatic reptiles, and mollusks. In 2022, we launched the FACT DaViT (Data Visualization Tool), an online interactive web map designed to display acoustically tagged species range and density within compatible acoustic networks. This platform strikes a balance between scientists' need for data privacy and the broader expectation of open data, presenting sensitive data as highly summarized and visually intuitive information. Development was supported through grants from federally associated institutions. By leveraging the FACT data processing system, we are able to provide valuable information to stakeholders long before traditional scientific publications, with minimal effort required from scientists. The DaViT not only facilitates public engagement but also caters to the needs of resource managers by offering easy discovery and access to projects and contacts. Moving forward, we aim to enhance transparency and collaboration by making the DaViT code publicly accessible on GitHub, allowing for broader adaptation and adoption by animal movement networks.

BioTracks – University of Miami

Towards a MBON-ATN acoustic telemetry data project to map and monitor marine biodiversity hotspots

***Principal Investigators**: Neil Hammerschlag[1,2] and Thiago B. A. Cout[2],*
[1]Shark Research Foundation Inc., [2]Lancaster University

The overall goal of this project is to integrate historical and newly acquired acoustic animal tracking data into biodiversity monitoring, and ultimately generate data visualizations of marine biodiversity

hotspots that will be useful for conservation and natural resource management. These multi-species hotspots will be analyzed with respect to essential ocean variables to identify the key environmental and biological drivers behind them. Current and projected hotspots and migration corridors will be overlayed with place-based management zones to highlight areas vulnerable to exploitation. This is focused on the Gulf of Mexico, Caribbean and Western North Atlantic. This collaborative A-BioTrack project, is a joint initiative of the Animal Telemetry Network (ATN) and of the Marine Biodiversity Observation Network (MBON). After concluding the data acquisition process that includes more than 39 million detections of 71 species from 3,509 unique receiver locations, the full dataset was combined and went through a systematic process of standardization and quality control. Over the past year, we then undertook and completed a set of Integrated spatial occupancy models combining acoustic telemetry data and the open-access database from Ocean Biodiversity Information System (OBIS). Our predictions, based on a set of spatial and environmental variables, produced distribution maps with 10-km resolution (hexagonal grid cells) for 68 species with sufficient data. By overlapping latent occurrence parameters from outputs generated for all the species were able to generate a wide range of spatially explicit biodiversity indicators to highlight biodiversity hotspots within the study area (e.g. species richness, weighted-area species number). We have also been able to generate visualizations of these data. Challenges have included computational ability to analyze large volumes of data. Within the next year, we aim to (1) refine and validate our species distribution models to generate final data products of biodiversity hotspots; (2) overlay these aggregated biodiversity hotspots with place-based management zones to highlight and map areas protected from and vulnerable to exploitation; (3) create and disseminate map visualizations of these protected and vulnerable biodiversity hotspots; and (4) preparation of a peer-reviewed scientific paper for submission.

South Carolina Soundscape Observatory – University of South Carolina Beaufort

The Estuarine Soundscape Observatory Network in the Southeast (ESONS)

Principal Investigators: *Eric W. Montie and Alyssa Marian, Department of Natural Sciences, University of South Carolina Beaufort, SC*

The Estuarine Soundscape Observatory Network in the Southeast (ESONS) monitors underwater sounds and noise in four estuaries of South Carolina (SC) including the May River (9M, 14M, and 37M stations; 2013 - present), Chechessee Creek and Colleton River (CC4 and CR1 stations; 2019 - present), Charleston Harbor (B, C, and D stations; 2017 - present), and North Inlet-Winyah Bay (NI-WB) NERRS (NIWB station; 2020 - 2023). The soundscape approach allows the ability to 'eavesdrop' on key behaviors of marine animals (from snapping shrimp to fish to marine mammals) that can change rapidly or gradually in response to environmental changes and human impacts, thus providing a measure of resilience or shifting baselines for economically important or protected species. Passive acoustic platforms provide sound files at a high temporal resolution of two minutes every hour. Acoustic records from this network assist in tracking: (i) received root mean square (rms) sound pressure levels (SPLs) over various bandwidths; (ii) courtship sounds and spawning potential of soniferous fish; (iii) vocalizations of bottlenose dolphins; and (iv) anthropogenic noise detections.

During Year 3, we serviced all nine recorders and made monumental progress in data analysis. We determined rms SPLs of each two-minute sound file at stations 9M, 14M, and 37M to 1/24/24; stations CC4 and CR1 to 2/26/24; stations B, C, and D to 2/15/24; and station NIWB to 6/29/23. We manually reviewed 69,498 wav files and identified/quantified fish calls, bottlenose dolphin vocalizations, and noise detections at stations 9M, 14M, and 37M to 1/24/24; stations CC4 and CR1 to 11/20/23; stations B and C to 11/8/23; station D to 2/15/24; and station NIWB to 6/29/23. Unfortunately, due to aging infrastructure and other challenges, we lost data at station 9M (4/20/23 to 7/14/23), station 37M (4/20/23 to 7/14/23), station D (4/12/23 to 7/24/23; 8/5/23 to 11/8/23), and station NIWB (6/29/23 to present). Using ESONS data, we published a manuscript in *Aquatic Mammals* that investigated how dolphin abundance from SC Aquarium surveys, prey availability from SCDNR fishery-independent sampling, and noise influenced dolphin vocalization

patterns in Charleston Harbor from December 2017 to June 2019. Vocalizations varied spatially and temporally, peaking in fall and winter months coinciding with decreases in water temperature and daylight hours, following patterns previously reported in other SC estuaries. Dolphin prey and total fish abundance decreased with water temperature, which may indicate that dolphin's echolocate and whistle more frequently in the winter months when prey are scarce and sound-producing species are less soniferous. Dolphin sightings and vocalizations were highly correlated. Dolphin occurrence was highest in the areas surrounding the confluence of the Cooper and Wando Rivers, along the shipping channel, where vessel and sound-producing fish detections were greatest. When vessel noise occurred, dolphins increased their vocalizations, which suggests that this population may be modifying its acoustic repertoire in response to increased noise levels.

During year 4, our objectives are to (i) continue servicing ESONS recorders, (ii) complete soundscape endpoints through 2024, (iii) incorporate data into Research Workspace, (iv) archive data with Axiom, and (v) compare soundscape endpoints across estuaries in SC.

Water Quality Decision Support Tools – University of South Carolina

Integrated Decision Support and Management Tools for Adaptive Public Health Practices: An Early Advisement and Reporting System for Recreational and Shellfish Harvesting Waters of the Southeast

***Principal Investigators**: D.E. Porter[1], D. Ramage[1], A. Fries[2], H. Kelsey[2], N. Miller[2], N. Nelson[3], A. Cook[4] and K. Claridge[4]*
University of South Carolina[1], University of Maryland Center for Environmental Science[2], North Carolina State University[3], Mote Marine Laboratory & Aquarium[4]

The goal of our five-year SECOORA project is to integrate, enhance, and expand our respective How's the Beach (HTB; howsthebeach.org), ShellCast (https://ncsu-shellcast.appspot.com/) and Beach Conditions Reporting System (BCRS; https://visitbeaches.org/map) initiatives. Working with public health officials, resource managers, municipalities, tourism and chamber of commerce officials, the public and other identified end users we are:

- providing access to relevant data and information on water quality and safety to support improved decision making at scales ranging from individuals to agencies;
- continuing geographic expansion of the HTB and ShellCast nowcasting / forecasting efforts in recreational waters and shellfish harvesting waters; and
- supporting the integration of the BCRS to allow for citizen reporting of beach and recreational waters conditions.

Highlighted Year 3 accomplishments include:

- Expansion of the HTB nowcasts in NC, SC and working with the Institute for Water and Health at Georgia Southern University to expand the HTB into GA.
- Restructured the ShellCast app's architecture and expanded into SC and FL.
- Executed a Data Sharing Agreement (DSA) between USC and the FL Department of Health to allow for pushing of enterococci bacteria monitoring data from the FL Healthy Beaches Program for ingest into the HTB nowcasts.
- Implemented technical plans to integrate the BCRS into the HTB decision-support tool, and HTB nowcasts into the BCRS via external links.
- Implemented, and documented via a tutorial, the BCRS DataFetch API (https://datafetch.visitbeaches.org) facilitating data retrievals.

Year 4 objectives include working with EPA partners to assess their 'Virtual Beach' modeling toolset and engage beach managers and regulators in the identification of analyses, modeling and information dissemination needs; ShellCast initiative will engage regulators in FL to receive feedback on the expansion to FL, and make changes in response to their input; continue implementation of technical plans for further integration of HTB, the BCRS and ShellCast to support

geographical and thematic expansion of the decision-support tools; investigate the expansion of the BCRS into freshwater recreational waters; and develop and disseminate educational and outreach materials to provide broader exposure to the SECOORA-supported tools and applications.

Gray's Reef Mooring – University of Georgia

Ocean acidification time-series mooring at Gray's Reef National Marine Sanctuary
***Principal Investigators**: Scott Noakes, Ph.D., The University of Georgia*

Operation of the Grays Reef time-series mooring has been a multi-organization effort which has successfully collected high-resolution data since 2006. The mooring is located in the South Atlantic Bight offshore Georgia, USA and within the boundaries of Gray's Reef National Marine Sanctuary. It sits along the divide between the inner and middle shelf with water depths of 20 m. Water chemistry is primarily controlled by the middle shelf oceanic dynamics, but during heavy rain events, it can be affected by freshwater plumes coming from the numerous rivers along the Georgia and South Carolina coast. Temperature also plays a major role in the partial pressure of carbon dioxide (pCO_2) variability with seasonal changes being apparent. During summer months, GRNMS acts as a CO_2 source to the atmosphere while during winter months it is a CO_2 sink. The benthic community at GRNMS has proven to be hardy enduring large seasonal swings of seawater CO_2 and pH.

As with any research station located approximately 20 nautical miles offshore, biofouling, sea state, marine life and yes, humans have often made it difficult to keep the Gray's Reef monitoring station operational. It is not uncommon to find fishing hooks and line tangled in the data cables and tubing associated with the CO2 monitoring system. Hungry fish often bite the submerged cables and floating debris slam into the sensors mounted under the buoy. However, given all these challenges, the system has managed to operate with little down time.

In addition to the surface monitoring effort offshore, NOAA OAP has requested an expanded effort to include seafloor water quality monitoring and identifying *Oculina arbuscula* monitoring stations inside and outside the sanctuary. The new coral monitoring stations will be aimed at determining how the organisms currently residing at Gray's Reef cope with the seasonal changes and how they will adapt to rising seawater CO_2 over time. Without the CO_2 data generated by the surface and seafloor monitoring stations, these studies would not be possible.

Southeast Ocean and Coastal Acidification Network

Update on the Southeast Ocean and Coastal Acidification Network
***Principal Investigators**: Emily R. Hall, Mote Marine Laboratory and Janet Reimer, Mid-Atlantic Regional Council on the Ocean*

The Southeast Ocean and Coastal Acidification Network (SOCAN) was established in February of 2015 through a partnership with the Southeast Coastal Ocean Observing Regional Association (SECOORA) and NOAA's Ocean Acidification Program (OAP). The Acidification Networks are charged with catalyzing partnerships and leveraging resources to move regional acidification network efforts forward. SOCAN has significantly increased NOAA OAP's regional capacity-building efforts by tailoring messaging to the unique societal climate of the US Southeast and working with stakeholders to build awareness and prioritize monitoring efforts for understanding acidification in this region. SOCAN has taken a leadership role in synthesizing and applying available science in addition to serving in funding proposal coordination roles throughout the Southeast since its inception. SOCAN continues its core commitments to advance acidification knowledge and communicate research findings to stakeholders and decision makers, as well as work to assess research and monitoring gaps, societal, economic, and vulnerability needs in the Southeast.

This past year, SOCAN Partnered with the Gulf of Mexico CAN (GCAN) to assess research and monitoring gaps as well as overall social and economic vulnerabilities in the US Southeast and Gulf of Mexico. A final report was submitted to NOAA's Ocean Acidification Program office. Over the next funding cycle (FY24-27), SOCAN and GCAN will continue to collaborate to turn the report into a peer-reviewed paper. This project was advised by the Coastal and Heartland National Estuary Program and was a featured project at their Climate Summit during FY23-24.
SOCAN completed a two-year project with Coastal Carolina University, funded by South Carolina Sea Grant to assess acidification in Long Bay and Murrell's Inlet, SC. This project also assessed the accuracy pH measurements taken by a citizen science program. The results of the project were compiled into a Master's Thesis that was presented in March 2024. Over the current funding cycle, SOCAN will partner with CCU researchers to publish one to two peer-reviewed papers based on this project. In summary, the results show that there was excellent agreement between citizen science collected data and "professionally" collected data. There is also evidence that low pH conditions in the estuary sites may be long enough and intense enough to create detrimental conditions for biota.
SOCAN lead a workshop attached to the ACE Basin Teachers On The Estuary workshop in July 2023. This workshop introduced the basic concepts of acidification to middle and high school teachers from across SC and provided hands-on lessons to teachers to use in their classrooms.
In June SOCAN will deploy a SeapHOx instrument (funds through SECOORA's IIJA funding) to monitor pH and dissolved oxygen on the seafloor at Looe Key, FL. The project will produce directly measured climate-quality pH and other carbonate chemistry data products to establish a unique time series in the lower Florida Keys. This will also provide support for OA monitoring, end-user engagement, increased spatial monitoring coverage for OA monitoring; all of which will ultimately support future spatio-temporal modeling for the Florida Keys and the South Atlantic Bight.

Sargassum Forecasting – University of South Florida

Monitoring and forecasting pelagic Sargassum in the South Atlantic Bight
***Principal Investigator**: Chuanmin Hu, University of South Florida*
***Project team:** Brian Barnes, Yuyuan Xie, Ruoying He, University of South Florida*

Background and objectives:
Large scale inundations of pelagic *Sargassum* in nearshore environments can have severe negative consequences for sensitive coastal ecosystems and the communities that rely on them. Coarse resolution satellite data can dependably be used to identify and track *Sargassum* offshore, but provide unreliable results in nearshore waters, necessitating new approaches to identify coastal *Sargassum* aggregations and determine their hazard potential. Furthermore, distribution of these products in a timely manner is critical to informing inundation event response. As such, the overarching goal is to develop and operate Web-based system to monitor and forecast pelagic *Sargassum* in several coastal zones of the Florida Keys and South Atlantic Bight. Objectives of this project are to (1) develop and validate algorithms suitable for high-resolution satellite data to map and quantify *Sargassum* distribution and abundance; (2) generate prototype high-resolution imagery products to map and quantify *Sargassum* distribution and abundance; and (3) test and evaluate these high-resolution algorithms in selected regions, possibly through the use of citizen science data.

Accomplishments (Years 1-3):
To date, we have developed a machine learning (ML) algorithm to detect *Sargassum* from daily coarse-resolution images (e.g., MODIS) (Hu et al., 2023). This will make it possible to fill some of the data gaps in the nearshore environments (10 – 30 km from shore). To further fill these gaps and enable *Sargassum* monitoring in nearshore environments, we also developed a ML algorithm to detect *Sargassum* on beaches and in nearshore waters from commercial high-resolution (3-4 m) satellite imagery (Zhang et al., 2022). A similar ML algorithm for *Sargassum* detection using Sentinel-2 MSI (10-30m resolution) data is currently under development, with results presented at the Ocean Science meeting in New Orleans, February 2024. Toward dissemination of these

products to stakeholders in near-real time, we have also implemented infrastructure for automatic download and processing of Sentinel-2 data for selected areas (e.g., Florida Bay, south Indian River Lagoon).

Challenges and plans for next year:
Prior to fully automatic and operational production, more algorithm improvement and evaluation is needed to ensure delivery of reliable and robust data products. In the coming year, we plan to supplement traditional image-based validation with citizen science data, which has been somewhat limited in the past. Also, numerous technical challenges must be overcome prior to near real-time satellite data stream from the commercial data provider (e.g., Planet), including completion of computer programs for automatic satellite data downloading and processing. Finally, we will begin integration of derived *Sargassum* products with numerical models toward improved forecasting capabilities in the South Atlantic Bight.

Harmful Algal Bloom Monitoring in Georgia – University of Georgia

Insights from High-resolution monitoring of Akashiwo sanguinea in Coastal Georgia
Principal Investigators: *Mallory Mintz[1], Elizabeth Harvey[2], Katie Higgins[3], and Natalie Cohen[1]*
1. University of Georgia, Skidaway Institute of Oceanography; 2. University of New Hampshire; 3. University of Georgia, Marine Extension and Georgia Sea Grant

In Georgia, marine and estuarine HABs are largely unreported and uncharacterized, despite potential impacts to coastal communities and economies. Notably, elevated abundances of the HAB-forming species, *Akashiwo sanguinea*, have been seasonally observed in the Skidaway River Estuary (SRE), near Savannah, GA. *Akashiwo* blooms have coincided with multiple larval oyster stock failures at the UGA Shellfish Research Laboratory (SRL), which draws sea water from the SRE. Uncertainty about *Akashiwo* bloom timing and triggers leaves fisheries vulnerable to HABs and their byproducts.

We present findings from ongoing high-resolution monitoring efforts conducted in the SRE to understand the factors driving *Akashiwo sanguinea* blooms. Since January 2023, we have conducted weekly measurements of phytoplankton community assemblages, physicochemical parameters, and nutrient concentrations. Sampling frequency increased to daily during summer, aligning with historical observations of *Akashiwo* blooms. Collected data complement the existing multi-year, qualitative dataset from the NOAA-led Phytoplankton Monitoring Network citizen science initiative.

Results reveal a seasonal pattern of *Akashiwo* abundance, surging from undetectable levels in June to a peak bloom density of 150 cells/mL in late August, positively correlating with warm, salty, nutrient-poor conditions. Peak *Akashiwo* density in the estuary coincided with another observed larval oyster mortality event at the SRL. Metatranscriptomic analysis of samples taken before, during, and after the bloom event is underway and will offer insights into the potential molecular underpinnings of HABs and changes in ecosystem function during these events. In the upcoming summer, we will resume daily sampling to determine if observed seasonal patterns hold true across multiple years of sampling, improving our understanding of long-term HAB dynamics.

In addition to our research efforts, we conduct public outreach to raise awareness of local HABs. We share *Akashiwo* abundances in near real-time, providing stakeholders with timely updates on estuarine conditions. We collaborated with journalists to disseminate our findings in local publications, and have hosted HAB workshops for students, further enhancing our engagement with the community. In part due to this work in public outreach, Mallory Mintz was awarded a Research Traineeship Fellowship through the University of Georgia's Marine Extension and Georgia Sea Grant. In February 2024, we presented our findings at the Ocean Sciences Meeting in New Orleans, LA, contributing to the scientific discourse on harmful algal species.

Harmful Algal Bloom Monitoring in Southwest Florida – Florida Gulf Coast University

Expansion of the Ester Bay HAB Water Quality Monitoring Network

Principal Investigators: *Kayla Hughes, Dr. Michael Parsons, Adam Catasus, Florida Gulf Coast University*

The expanding presence and capabilities of real-time (remote sensing) platforms are improving the study of coastal environmental conditions, including harmful algal blooms (HABs) and water quality. Southwest Florida is a highly dynamic and heavily impacted region with water quality impairments and frequent HAB events in the coastal zone (i.e. freshwater discharges, hurricanes, cyanobacteria and Florida red tide [*Karenia brevis*]). These events and their long-term impacts can be better understood, managed, and potentially predicted from additional investment in cutting edge monitoring systems. Here, we propose to expand and augment the Estero Bay HAB Water Quality Monitoring Network with additional sensor systems to improve monitoring capabilities. In this project, we deployed four fixed data collection stations with YSI EXO2 datasondes, located at the Florida Gulf Coast University's Vester Field Station, New Pass bridge in Estero Bay, Gulf Star Marina at Fort Myers Beach, and City of Sanibel Island dock, which are all located in the state of Florida. A fifth station will be deployed in the future at Mound House on Fort Myers Beach. Along with the datasondes, two YSI EMM25 buoy platforms provide a mobile capability to the network. The two new mobile systems will provide flexibility and rapid response capacity to our network (i.e., deployed in the vicinity of bloom events, high discharge events, accidental spills of fuel, gray water, etc.). Two YSI Prosample P auto samplers are deployed once a month at each site to capture a 24-hour cycle of water quality conditions. A McLane Imaging FlowCytoBot (IFCB) will be added to the project to create a catalog of phytoplankton species throughout Estero Bay, FL. Water quality data collected by the datasondes is currently live streaming on the WQ Data Live portal, which can be accessed by the general public, resource managers, and policy makers to determine best management practices for the southwest Florida region.

Southeast US Marine Biodiversity Observation Network (MBON) – SECOORA

Climate Change Indicators Across the National Marine Sanctuaries System

Principal Investigators: *Frank Muller-Karger, University of South Florida (USF); Jennifer Dorton, SECOORA; Chris Simoniello, GCOOS; Joshua Kilborn, USF; Rebecca Zarger, USF*

The Marine Biodiversity Observation Network (MBON) Southeast team is led by Dr. Frank Muller-Karger, University of South Florida (USF). The team is engaged in two research projects: 1) The Southeast US MBON: Toward Operational Marine Life Data for Conservation and Sustainability; and 2) Climate Change Indicators Across the National Marine Sanctuaries System. Both projects address how climate-induced changes in the physical and biogeochemical characteristics of Earth's systems are affecting marine life and ecosystem services. The project team is co-developing operational data products for the NOAA National Marine Sanctuary (NMS) System based on historical and ongoing physical and biogeochemical datasets. The team is comprised of Investigators and Collaborators from USF, SECOORA, GCOOS, Florida Keys NMS, NOAA Atlantic Oceanographic and Meteorological Laboratory, NOAA CoastWatch and Flower Garden Banks NMS. SECOORA and GCOOS are co-leading the stakeholder engagement process. During Year 1, the team conducted front-end assessments that included interviews and virtual meetings with the four NMS in the SE US (Monitor, Gray's Reef, Florida Keys and Flower Garden Banks) to identify essential ocean variables, climate threshold data and product needs required for NMS Condition Reports.

As a starting point, the project team is working with Gray's Reef NMS staff to iteratively develop data products that support overall Sanctuary management. The stakeholder engagement team is working closely with the USF data manager and product developer to incorporate data sources relevant to the South Atlantic Bight (SAB) identified as needed for decision support by the Sanctuary staff. These range from nearshore data such as NERRS water quality to offshore satellite products such as chlorophyll and sea surface temperature. Most recently, discussions have focused on adding layers of biological data such as benthic coverage and fish distributions. Sanctuary management staff need to characterize the physical and biogeochemical processes within the SAB to understand how Gray's Reef functions within the larger ecosystem. A draft dashboard has been co-developed and beta tested with a small team from the Gray's Reef NMS, who are now helping to refine with their full team prior to rollout.
Products co-developed with NMS staff and other partners will be transitioned to operations working with Integrated Ocean Observing System partners including the Marine Biodiversity Observation Network (IOOS, MBON), the NOAA Science Council's Ecosystems Indicator Working Group (National Marine Ecosystem Status or NAMES), the NOAA Climate Program, regional Integrated Ecosystem Assessment (IEA) programs, and others as appropriate.

These projects were funded through NOAA-OAR-CPO-2022-2006799 and NOAA-NOS-IOOS-2022-2007005.

Data Management, Data Visualization, and Modeling

Artificial Intelligence: Annotation, Data Standards, and Applications – Florida Fish and Wildlife Conservation Commission

Augmenting Ocean Observing through Artificial Intelligence: Annotation, Data Standards, and Applications

Principal Investigators: *Luke McEachron[1], David Kochan[1], Lauren Showalter[2], Steven Olthoff[2], Enrique Montes[3], Frank Muller-Karger[4], Dan Otis[4]*
[1]Florida Fish and Wildlife Conservation Commission, [2]Axiom Data Science, [3]University of Miami, [4]University of South Florida

We developed a beta-version of our interactive web portal based on requirements scoped in previous years. The portal, which we are now referring to as a gateway, summarizes AI standards, resources, and workflows and provides a place for end-users to share, host, and collaborate on worked examples. Importantly, Axiom Data Science hired a web developer to support this effort. The beta gateway now includes an interactive decision tree to guide users to different AI resources; a portfolio of imagery, video, and acoustic use cases; and a community hub for end-users to share related resources and worked examples. We continued our outreach efforts by presenting on the project at Ocean Sciences in a session on open data and by promoting the product at the GEOBON conference. Several related initiatives are underway in other institutions and communities that complement this project. Several modifications are required such as how to control end-user access and how to link directly to existing repos, which, in addition to testing, is the focus of the upcoming year.

Fisheries Data Access – South Carolina Department of Natural Resources

Enhancing the Capabilities of the SEAMAP-SA Biological Surveys Integrated into the SECOORA Data Portal

Principal Investigators: *Tracey Smart, South Carolina Department of Natural Resources (SCDNR); C. Michelle Willis, SCDNR*

The Southeast Area Monitoring and Assessment Program, South Atlantic (SEAMAP-SA) fully or partially supports a variety of long-term, living marine resource surveys in waters of the Atlantic coast off the Southeast United States. Surveys are conducted by North Carolina Department of Environmental and Natural Resources, South Carolina Department of Natural Resources, and the Georgia Department of Natural Resources. These biological surveys provide essential data for state and federally managed species in this region, including finfish, sharks, turtles, and invertebrates. SEAMAP-SA is migrating its online database into the SECOORA data portal. To complete this migration, we have tackled with Axiom Data Science increasing the number of data and code tables and increasing the ability of data users to visualize and summarize data in the SECOORA portal, capabilities not available in the current SEAMAP-SA system. DarwinCore mapping and migration has been completed. Database structure has been streamlined. Tests of the Administrative tools have been conducted. Training videos and protocols are under development to better allow users to make the transition to the new system.

Data Management and Communications – Axiom Data Science

SECOORA Data Management and Communications Services

Principal Investigators: *Lauren Showalter, Axiom Data Science*

As a member of IOOS, SECOORA has a mandate to collect, organize, and provide access to regional oceanographic data. These data need to be quality reviewed, understandable, discoverable, electronically accessible, and well organized to allow researchers, policy makers, industry, and the public to make well-informed decisions. To satisfy this mandate, SECOORA supports a web-based data portal for the region providing ocean, coastal, and watershed environmental data and information products.

The goals of the SECOORA data management system are to: i) curate multiple data streams from the sensors and models supported by SECOORA as well as from independent data providers, ii) document data using IOOS-approved metadata standards, iii) provide data to users via standard services and data products, and iv) archive data in long-term archives. The SECOORA Data System is based on a service-oriented architecture that employs interoperable systems to enable data discoverability via web services and catalogs. The vision of SECOORA is to be recognized in the ocean observation community as a trusted leader in FAIR data.

SECOORA partners with Axiom Data Science to provide a standards-based lifecycle data management framework that maximizes the discoverability, accessibility, and usability of data and information products and ensures their sustained use. SECOORA leverages Axiom's data systems that also support AOOS, CeNCOOS, IOOS Environmental Sensor Map, and the Animal Telemetry Network DAC to use common infrastructure which enables the dedication of more funds to system advancements and innovation than would otherwise be possible. The relationship between SECOORA and Axiom is a partnership designed not only to serve the needs of SECOORA, but also to allow for greater contributions to the larger IOOS community. SECOORA works closely with Axiom to develop and update data management plans, statements of work, facilitate the flow of data, and ensure a coordinated end-to-end system.

Key DMAC accomplishments during FY23 include:

- Planning and requirements gathering for next generation data portal
- Transition from V1 to V2 sensor system
- Support and data ingestion for the water level team
- Ingestion and visualization of HAB data
- Glider team support

- Support and tool development for WebCOOS
- Support data management, ingest, and visualization of data from various PIs
- Improvements to portal search and speed
- CNAPS model data available through THREDDS
- Ingestion of NOAA coastal relief model layers

DMAC objectives FY24 include:

- SEAMAP data visualization
- Data ingestion and tool development for all SECOORA projects and PIs
- Next generation portal development

The Southeast Marine Mapping Tool – The Nature Conservancy

Southeast Marine Mapping Tool: *Increasing access to regional ecological and management data to help inform offshore wind use decisions.*
Principal Investigator: *Mary Conley, The Nature Conservancy*

The nearshore ocean across the United States is facing a growth in marine uses, including wind energy development. Informed siting of these uses can help mitigate the impact on marine ecosystems and other uses already existing in the area. However, access to regional ecological data to provide context when making decisions on offshore development is either limited or not centralized which can limit stakeholders' ability to participate in the siting process. The Southeast Marine Mapping Tool (https://maps.tnc.org/marinemap) was developed to help fill that gap, allowing users to access and summarize an array of information available for a given ocean space.

With funding through the Southeast Coastal Ocean Observing Regional Association (SECOORA), The Nature Conservancy continues to work with potential users to refine the online tool. Areas of focus, based on project steering committee review of the existing tool, include:

(1) Increasing transparency and trust
(2) Improving management and human use information
(3) Improving data exploration
(4) Increasing functionality and stability
(5) Enhancing user communication and engagement

Over the past six months, the project team has focused on engaging the steering committee to in update the management and human use information available through the tool. This includes changes in how marine management areas and vessel information are summarized and displayed. Additional we are updating the tool with new habitat and species data and working on overall functionality. The updates are scheduled to be ready for beta testing in the late summer with outreach This presentation will provide a brief overview of the tool and highlight changes underway.

CNAPS Model – North Carolina State University & Fathom Science

Partnering to meet the needs of coastal communities for actionable information to protect lives and property
Principal Investigator: *Ruoying He, North Carolina State University & Jennifer Warrillow Fathom Science*

The primary goal of our project is to support all three SECOORA theme areas by developing state-of-the-art prediction capabilities and near-real-time nowcast/forecast for regional-scale marine environmental conditions. The resulting capability to model and predict the transport of heat, salt, organisms, nutrients, and pollutants materially impacts SECOORA's ability to address all important scientific and societal issues related to: i) Coastal Hazards and Climate Variability, ii) Ecosystems (both living marine resources and water quality), and iii) Safe and Efficient Marine Operations.

In Year 3, we have continued working on a series of peer-reviewed reports and papers analyzing the 30-year, 4 km resolution, 50 vertical layer CNAPS-2 ocean reanalysis product that our team has generated. We have generated regional ocean circulation climatology from which climate change impacts and its variability, including Loop Current Eddy Shedding (Chaichitehrani and He, 2023) Gulf Stream variability (Mao et al., 2023 a, b), marine heatwaves (Wu and He, submitted), and sea level variability (Wu and He, submitted) have been quantitatively assessed.

Based on the 30-year hydrodynamic reanalysis, we have also worked on the generation of DriftCast (https://driftcast.fathomscience.com/), which provides a user-friendly interface to see how virtual particles (such as fish larvae, harmful algal blooms, oil spills, seaweed, etc.) were transported at different times and years over the last 30 years. This web application provides a powerful way to illustrate the inter-annual variability of ocean circulation and its impact on marine property distribution.

In Year 4, we expect there will be many opportunities to collaborate with other research teams and stakeholders to derive additional ocean analyses and products. Based on the 30-year hydrodynamic reanalysis, we will continue to work on the generation of marine biogeochemistry (BGC) reanalysis for the same period. We will refine the offline BGC model, couple it with the CNAPS-2 ocean hydrodynamic reanalysis, and generate 4-dimensional (x, y, z, t) daily outputs of key state variables (e.g., NO_3, Chl a, DIC, pCO_2, DO) in the marine nitrogen and carbon cycles.

Additionally, we will continue 1) conducting routine operations of the CNAPS system to deliver critical nowcast and forecast information (sea surface height, sea surface temperature, sea surface salinity, and surface velocity) to support SECOORA efforts in addressing coastal hazards (e.g., storms), water quality (e.g., oil spills, harmful algal blooms), and marine operations (e.g., navigation, fisheries); and 2) continuing routine operation of CNAPS-1 and its data delivery in the AWS cloud computing environment.

Model Evaluation: New York Harbor – University of South Florida

NOAA Model Evaluation: New York Harbor – Cook Inlet

Principal Investigators: *Yonggang Liu, Sebin John, College of Marine Science, University of South Florida*

The University of South Florida (USF) Ocean Circulation Lab was selected to participate in a project of coastal ocean model software evaluation that was organized by NOAA Unified Forecast System (UFS) Coastal Application Team (CAT). The lab works as one of the testers to configure the unstructured grid Finite Volume Community Model (FVCOM) for the New York Harbor/ Cook Inlet region. Model performance was evaluated quantitatively against tide gauge and moored current velocity data available in the region. The model testers are required to provide skill assessment documentation and evaluate the model performance in the context of operations (stability, code management, ease of operation, etc.)

Phase I of the project has been completed: setting up a barotropic ocean model application (tides) using the latest FVCOM software, and evaluating the model performance against available water level observations for two time periods of three months. Phase II of the project is ongoing: configure an FVCOM application for the New York Harbor/ Cook Inlet region for 3D wind-driven circulation simulation, and evaluation against available observations. The work by the USF lab is on track and ahead of the other groups in terms of the anticipated progress.

There are some uncertainties and challenges in this project. Most of the testers do not have the needed modeling expertise, thus may need a lot of guidance from more experienced labs and from

the model developers. However, this is one of the main purposes of the project – to train next generation of coastal ocean modelers and model users.