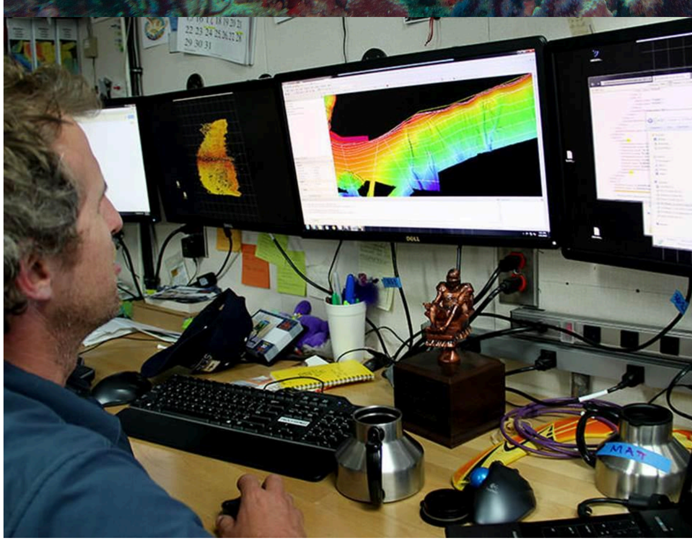
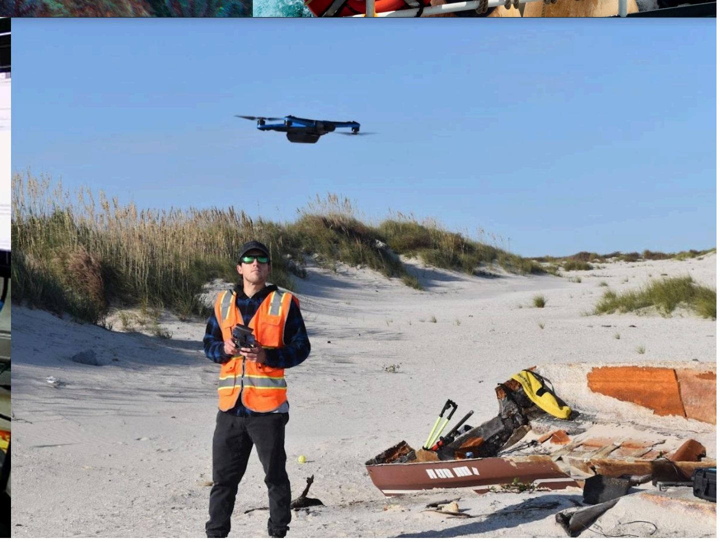
NCCOS Annual Science Review:
Habitat Mapping and Characterization

Silver Spring, Maryland
22 - 23 October, 2024

Briefing Book and Meeting Materials



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NCCOS Annual Science Review:
Habitat Mapping Program
AGENDA
Silver Spring, MD
October 22-23, 2024

Location: Silver Spring Civic Center at Veterans Plaza
1 Veterans Place, Silver Spring, MD 20910
Spring Room

Please Note: Mobile phone devices' GPS may show the following address:
8525 Fenton Street, Silver Spring, MD 20910

Virtual link to full day (same link for Tues and Wed):
Video call link: https://meet.google.com/pop-nzia-scj
Or dial: (US) +1 901-646-1331 PIN: 109 267 630#

Objectives
1. Evaluate NCCOS' role as a federal entity to provide applied habitat mapping and characterization products, including the mix of projects, funding, staffing, infrastructure, and assess the program's ability to engage stakeholders.
2. Offer observations and make recommendations to better position NCCOS for improving its habitat mapping and characterizations portfolio.

DAY 1 (Tuesday, October 22)

8:30	Assemble
9:00	Welcome, Introductions, Purpose, and Charge - *Sean Corson, NCCOS Director*
9:10	Organizational Context, History, and Ethos - *John Christensen, MSE Division Chief*
9:30	Overview of Feedback from 2019 Biogeography Review - *Tim Battista, SEA Branch Chief*
9:50	Program Review Structure, Schedule, and Roles- *Terry McTigue, MSE Ecologist*
10:00	Session Presentation 1 *(Mapping Coordination and Spatial Prioritizations)*
10:40	BREAK ~10mins
10:50	Session Presentation 2 *(Remote Sensing and Signal Processing)*

11:30	Session Presentation 3 (*Predictive Habitat Modeling)*
12:10 - 1:30	LUNCH
1:30	Session Presentation 4 *(Uncrewed Systems for Mapping)*
2:10	Session Presentation 5 *(Image Analysis, Artificial Intelligence, and Deep Learning)*
2:50	BREAK ~10mins
3:00	Session Presentation 6 *(Data Management, Visualization and Applications)*
3:40	Question/Answer
4:00	Executive session (Panel Only)- *Facilitated by Review Chair - time for reviewers to discuss and share thoughts*
5:30	Adjourn
6:00	Dinner with panel @ Copper Canyon Grill

DAY 2 (Wednesday, October 23)

8:30	Assemble
9:00	Welcome Back and Review Day 2 Agenda - *Terry McTigue, MSE Ecologist*
9:15	Reflections and Outstanding Questions from Day 1- *John Christensen, MSE Division Chief*
9:30	Habitat Mapping "By the Numbers"- *Tim Battista, SEA Branch Chief*
10:00	Species Predictive Modeling & Climate- *Matt Poti*
10:20	BREAK ~10mins
10:30	Partner Attestation | Informing Decisions *(Closed Session)*
12:00 - 1:00	LUNCH

1:00	Overview of report format & submission process- *Margo Schulze-Haugen, NCCOS Deputy Director*
1:30	Executive session - *Facilitated by Review Chair- Deliberations and Initial Recommendation Development*
3:20	BREAK ~10mins
3:30	Panel Presentation & Summary to Program Leadership- *Panel Chair*
4:00	Thanks and final remarks - *Sean Corson, NCCOS Director*
4:15	Adjourn
4:30	Panel Reception @ McGinty's Public House
7:00	Dinner on own

Review Information

Review Panel

Members of the review panel include technical experts in different fields, program directors, and users of information. We have tried to balance the composition of the review panel, considering affiliation (Federal and non-Federal), scientific expertise, and stakeholders. We do not expect each panel member to have command over the entire spectrum of the NCCOS habitat mapping & characterization portfolio. We will provide adequate time each day for the panel members to discuss and deliberate on the information provided and come up with their own judgment and conclusions.

The Review Panel consists of the following:

<u>**Chair**</u>**:** ***Brandon Krumwiede***: Physical Scientist, NOAA National Ocean Service

Jason Fahy: Associate Director, Ocean Exploration Cooperative Institute

Dave Bernstein: Program Manager, NV5

Pete Esselman: Research Fishery Biologist, U.S. Geological Survey

Ashley Chappell: U.S. Committee on the Marine Transportation System

Partner Attestation

Members of the Partner Attestation include technical experts in different fields, program directors, and users of information. We have tried to balance the composition of the Stakeholder Panel, considering affiliation, scientific expertise, and users of information. The Partner Attestation provides an opportunity for reviewers to ground truth information shared in sessions, to gain additional insights from stakeholders (users group and partners), and discuss efforts to meet stakeholder needs (i.e., coordinating with folks on the ground and making sure NOAA made/makes informed science decisions based on what is relevant and useful to the stakeholder.

Steering Committee

The following individuals are members of the Steering Committee for this review. As with the Review Panel, they represent a variety of areas of expertise and affiliations within NCCOS. The committee includes:

John Christensen, Division Chief, Marine Spatial Ecology Division, NCCOS

Tim Battista, Branch Chief, Seascape Ecology and Analytics Branch, NCCOS

Josie Galloway, Review Coordinator, Program Coordination and Communication, NCCOS

Terry McTigue, Ecologist, Marine Spatial Ecology Division, NCCOS

Max Brown, Knauss Fellow, Program Coordination and Communication, NCCOS

Purpose of the Review

NOAA requires external, peer-reviews of its research and development programs on a periodic basis. Such reviews can play a key role in program planning, management and oversight by providing feedback on both program design and execution. NCCOS is further interested in evaluation of its informational products and their delivery to users, and engagement with stakeholders. For the habitat mapping portfolio review, we anticipate the review panel to:

1. Appraise the size and direction of the portfolio, including the mix of projects, funding, staffing, and infrastructure.
2. Assess NCCOS' role as a federal entity to provide applied habitat mapping and characterization products. Are we leveraging the appropriate scope and quantity of external capabilities to enhance and support the portfolio?
3. Evaluate NCCOS' role in delivering relevant and usable research products, data and information, and engaging stakeholders.
4. Offer observations and make recommendations to better position NCCOS for improving its habitat mapping and characterizations.

Scope of Review

NCCOS will focus the 2024 Annual Science Review on the internally- and externally-funded science activities within the habitat mapping portfolio. NCCOS has instituted a multi-faceted approach to habitat mapping which incorporates key, inter-connected mapping activities and product development steps. This approach positions NCCOS as a unique, experienced, and technically advanced provider of science-based products to support resource managers and fill information gaps within coastal and marine ecosystems. The habitat mapping portfolio concentrates on six cutting-edge focal areas which include: 1) mapping coordination and spatial prioritizations, 2) remote sensing and signal processing, 3) uncrewed systems for mapping, 4) image analysis, artificial intelligence, and deep learning, 5) predictive habitat modeling, and 6) data management, visualizations and applications. To see a full list of relevant publications from 2019-2024, see Appendix B.

Program Evaluation Criteria

NOAA, through an Administrative Order (NAO 216-115A, dated October 3, 2016, and its previous editions), has adopted Quality, Relevance and Performance as core evaluation criteria. The NAO also calls for a periodic evaluation of research, development and transition activities as well as outreach efforts and stakeholder engagement. Criteria are outlined and defined in NOAA Administrative Order 216-115B Handbook and the NOS Program Evaluation Framework.

Reviewer's Responsibility

NCCOS will present data and information relevant to its habitat mapping and characterization portfolio during the course of the review, primarily as lecture presentations and in the briefing book. Each member of the Review Panel will use that information and any ensuing discussion to come up with independent observations, evaluation, and recommendations on different aspects of the portfolio (reviewers are encouraged to use the attached format). We have formulated the following questions to guide your review and to conform to the three core evaluation criteria, previously described in the "Program Evaluation Criteria" section above. The Tabular Report Template for Reviewers that can be used to take notes or organize recommendations can be found in Appendix A.

Quality is a measure of soundness, accuracy, and reproducibility of a specific body of research. It is the most widely and traditionally used criterion evaluated by peer review committees. In general, it refers to the merits of research and development (R&D) within the scientific community – research publications, awards, innovations, and patents – and implies adherence to values of objectivity, fairness, and accountability. It also requires evidence of established procedures for competitive, merit-based research funding and assuring scientific Integrity.

Questions to consider:

1. How well are NCCOS scientists and program managers recognized as leaders in their scientific disciplines for the quality of their contributions (e.g., authors of peer-reviewed publications; congressional briefings; invited lectures; awards and recognition; and national and international leadership positions in the scientific community)?
2. How effective are NCCOS studies in developing (a) new and validated analytical methods and technologies in wide use, and (b) advanced tools and techniques to map, validate, deploy and distribute geospatial products (e.g., predictive models, new sensors and acquisition vehicles, and map services)?

Relevance refers to the value and significance of the NCCOS habitat mapping portfolio to NOAA's mission, and the benefits of related products and services to stakeholders and broader society. OMB refers to relevance as "impact" of a program, i.e., measurable analysis of how NCCOS products and services accrued societal benefits, and who uses the products and how. In essence, relevance asks, "What would not have happened if NCCOS did not exist, and how much would society have missed?" During a review, program personnel identify public benefits of the program, including added benefits beyond those of any similar effort that has been by others. Benefits include increasingly more skillful and reliable program output, technology, or methodology that satisfies legal mandates and user needs, and provides effective expert counsel and technology transfer, as well as new options for the future.

Questions to consider:

1. How well has the portfolio supported noteworthy achievements in improving coastal and ocean mapping?
2. How effective have NCCOS mapping products been in informing Federal guidance and decision making?

3. Have NCCOS tools, services, or research been effectively used by federal, local, state, tribal, and regional governments to improve their preparedness, management and/or response to various events and issues?
4. How effective is the NCCOS habitat mapping portfolio in assisting federal partners meet statutory requirements (e.g., Essential Fish Habitat, Endangered Species Act, the National Marine Sanctuaries Act, Coral Reef Conservation Act, Federal Partners' mandates, etc.)?

Performance refers to an ability to manage in a manner that produces identifiable results effectively (achieving desired results) and efficiently (with maximum productivity and minimum wasted effort or money). This is evaluated by program management structures that produce the desired results, guidance, or framework for tracking progress toward agency's strategic goals and objectives, flexibility to address events or changing priorities, interaction with stakeholders, and extramural collaboration.
Questions to consider:

1. How does NCCOS assure – and does it have procedures for – funding preeminent research and impactful science?
2. How well does NCCOS execute its research and related studies in an efficient and effective manner given appropriated resources?
3. How effectively does NCCOS utilize collaboration and partnerships to achieve desired outcomes?
4. How effective are NCCOS roles in working with end-users and partners to ensure that data outputs and tools align with external priorities and applications?

Given the scope of planned presentations as well as anticipated use of the panel's recommendations, the "Relevance" criterion is the most important one. Prior to the review, the reviewers may suggest additional criteria, and at the review, each reviewer will be free to ask additional questions as appropriate.

Anticipated Review Products

Each member of the review panel will use her / his scientific expertise and professional judgment to provide independent observations, evaluation, and recommendations on different aspects of the NCCOS habitat mapping portfolio, including product value and utilization.

Each member of the review panel will also prepare notes on his/her observations, comments and recommendations that, at a minimum, address the three core evaluation criteria: Quality, Relevance, and Performance. For convenience, a tabular format is provided for recording comments on different aspects of the review (see attached).

Panel members will present their preliminary finds to NCCOS and NOS leadership (Day 2 of the review). Individual written reports, following the format of the 2019 Report (see attached), will be due within 60 days after the review. ***While no consensus report is required,*** the review panel chair may choose to summarize important or common findings from the review in a written report (due within 60 days after the review).

NOAA procedures allow for "evaluation ratings" with a bipolar construct for program components, e.g., Exceeds Highest Expectations, Exceeds Expectations, etc. However, we are not requiring the panel members to do that. Also, note that answering the question merely by "yes" or "no" will not be sufficient in conveying your observations, assessment and recommendations and should be avoided.

Review Report

Individual reviewer reports will be compiled in a document for use by the NCCOS director and/or program managers. The document will be used for planning of future science and related activities and improving the performance of current and near-term projects. Individual review reports will not be made public, and will only be used by NCCOS as background for the final report. Internal distribution of the individual reports will be limited.

NCCOS Overview

Overview

NCCOS sits within NOAA's National Ocean Service. The NOS provides data, tools, and services that support coastal economies and their contribution to the nation. The mission of NOS is to provide science-based solutions through collaborative partnerships to address evolving economic, environmental, and social pressures on our ocean and coasts. The National Centers for Coastal Ocean Science (NCCOS) is the research, monitoring and assessment organization within NOS. NCCOS delivers ecosystem science solutions: a) for the stewardship of ocean and coastal resources; and b) to support thriving coastal communities and economies.

NCCOS was formed in 1999 as the focal point for NOAA's coastal ocean science efforts to meet its coastal stewardship and resource management responsibilities. The office conducts nationwide, multidisciplinary research that integrates a broad spectrum of physical, biological, chemical, and social sciences to inform and guide resource and community managers, while seeking a balance among resource use, economic development, restoration, conservation, and human health. NCCOS works closely with coastal managers and other stakeholders to determine research needs and ensure we are delivering valuable, relevant, timely, and actionable products and tools to inform decisions. Stakeholders are often engaged in project planning and execution and provide guidance throughout the research process. NCCOS science is guided by NOAA's legislative mandates, executive orders, and NOS priorities, as well as stakeholder engagement. By providing science products and tools, NCCOS helps communities plan for, adapt to, and reduce risks from the multiple challenges facing coastal communities.

Facilities

NCCOS leadership, scientists, program managers, and staff work in several facilities across the country. They are described below.

NCCOS Headquarters Silver Spring

Silver Spring is the location of NCCOS headquarters, the Competitive Research Program, as well as scientific expertise in biogeography, habitat mapping, HAB forecasting and monitoring and bioeffects of chemical contaminants.

NOAA Beaufort Laboratory
NCCOS staff in Beaufort conduct research on harmful algal blooms, habitat mapping, aquaculture siting and impacts, ecology of marshes and coral reefs, and coastal resilience and restoration. Facility infrastructure includes seawater/culture facilities, analytical laboratories, scientific diving and small boats programs, and NCCOS business management functions.

Cooperative Oxford Laboratory (COL)
COL is a partnership between NOAA, the Maryland Department of Natural Resources and the USCG Station Oxford. COL partners combine science, response, and management capabilities to meet respective missions and collaborate to address science and management challenges. The lab is a branch of NCCOS' Marine Spatial Ecology Division. COL scientific capabilities are diverse and include expertise in research to enhance preparedness and recovery in the face of coastal change, and research of novel methods to improve restoration and resilience practices.

Kasitsna Bay Laboratory
The Kasitsna Bay Laboratory has been the Alaska field station for both NCCOS and the National Marine Fisheries Service since the late 1950s. NCCOS partners with the University of Alaska Fairbanks on lab operations and research. The Kasitsna Bay Laboratory is a part of NCCOS's Marine Spatial Ecology Division and conducts research on coastal impacts of climate change, ocean acidification, harmful algal blooms, and oil spills and hosts Federal, state, tribal, and university researchers.

Hollings Marine Laboratory (HML)
HML is a NOAA-owned facility operated by NCCOS as a fully collaborative enterprise, governed by the five partner organizations through a Joint Project Agreement. HML partners consist of NOAA, the National Institute of Standards and Technology, the South Carolina Department of Natural Resources, the College of Charleston, and the Medical University of South Carolina. Scientists from all partner institutions work side-by-side in the laboratory, taking advantage of each other's special expertise.

The NCCOS organizational chart and additional background can be found in Appendix C.

NCCOS Priorities and Strategic Plan
NCCOS Strategic Science Priorities for 2017-2021 which partially encompasses the review period, are outlined in the FY 2017-2021 Strategic Plan: Advancing Coastal Science and listed below.

1. **Marine Spatial Ecology**
2. Stressor Impacts and Mitigation
3. Coastal Change: Vulnerability, Mitigation, and Restoration
4. Social Sciences

Note this program review focuses on science that falls within the Marine Spatial Ecology priority, specially under the sub-priority area of Habitat Mapping.

Relevant sections of the 2017-2021 Advancing Coastal Science relating to the Habitat Mapping Program can be found in Appendix D.

In 2021, NCCOS released its FY 2022-2026 Strategic Plan: Science Service Coastal Communities, which encompasses the later half of this review period and outlines the following six science and organizational priorities:

1. **Advancing Ecosystem Science for Conservation and Sustainable Use**
2. **Developing and Implementing Advanced Observation Technologies and Ecological Forecasts**
3. Facilitating Resilience and Adaptation to Inundation and Climate Impacts
4. Detecting, Monitoring, and Mitigating Impacts of Chemical and Biological Stressors
5. Advancing Social, Economic, and Behavioral Approaches to Coastal Stewardship
6. **Investing in our People and Achieving Organizational Excellence**

We also mention FY 2022-2026 Strategic Plan to provide reviewers context for the direction NCCOS is heading. The Habitat Mapping portfolio is primarily captured under the "Advancing Ecosystem Science for Conservation and Sustainable Use" priority, highlighted above, with substantial contributing work from the "Developing and Implementing Advanced Observation Technologies and Ecological Forecasts" and "Investing in our People and Achieving Organizational Excellence" priorities, also highlighted.

Relevant sections of the FY 2020-2026 Strategic Plan relating to the Habitat Mapping Program can be found in Appendix D.

Habitat Mapping Programmatic Plan

NCCOS Habitat Mapping Portfolio Goal

We aim to provide cutting-edge, high-quality, and relevant science-based habitat mapping products on the geology and seafloor habitats, and associated marine life for place-based ecosystem management so customers and partners can make smart management and business decisions to address evolving economic, environmental, and social pressures on our ocean and coasts.

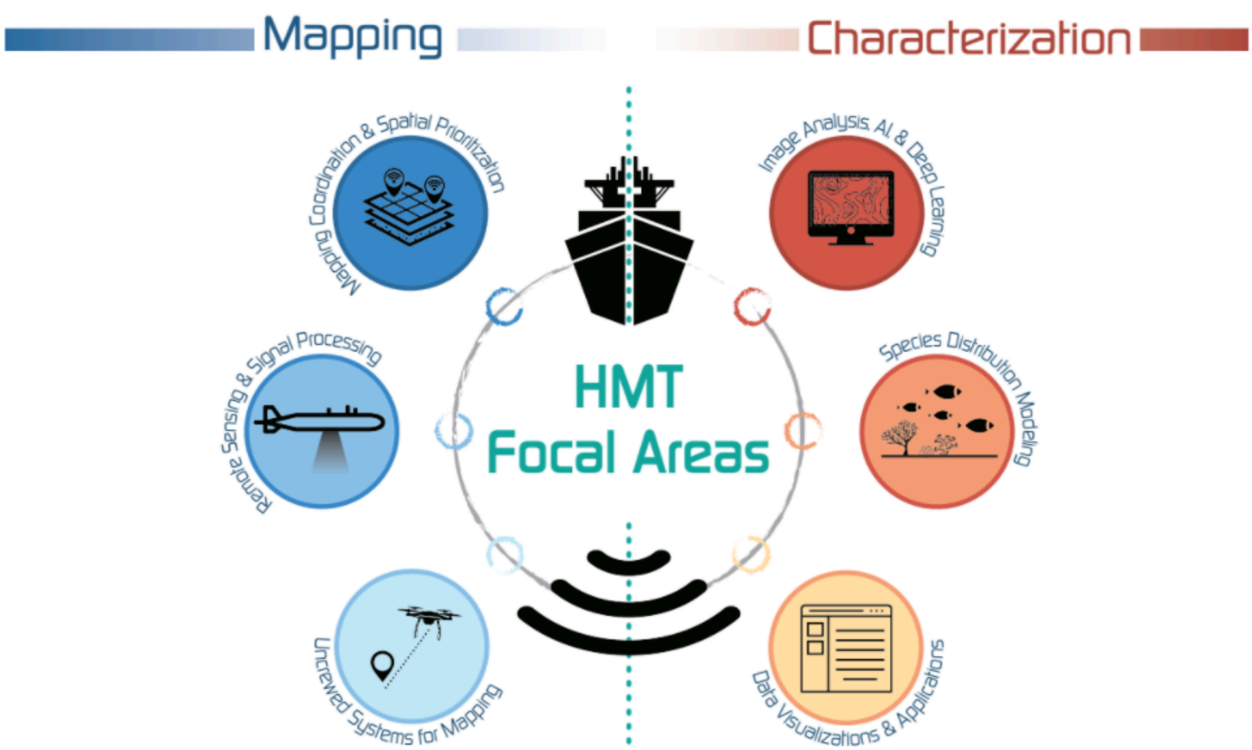
Benthic habitat maps describe the spatial distribution and qualities of the seabed or lakebed physical structure (e.g., reef, sand, rock) and biological cover (e.g., live coral, seagrass, algae). NCCOS has a long history of developing benthic habitat maps using a variety of technologies, software programs, and map making techniques. The primary uses of these habitat maps are to inform marine management decisions, ranging from marine protected area design to offshore energy development.

NCCOS has instituted a multi-faceted approach to habitat mapping which incorporates key, inter-connected mapping activities and data visualization steps. This approach positions NCCOS as a unique, experienced, and technically advanced provider of science-based products to connect knowledge and fill information gaps within coastal and marine ecosystems. NCCOS concentrates on six focal areas, which enable the habitat mapping program to provide cutting-edge planning, data collection, data processing, modeling, and visualizations to inform coastal and marine management decision-making.

These focal areas contribute to the habitat mapping program's approach for habitat mapping and characterization. The Habitat Mapping and Habitat Characterization themes describe an end-to-end (i.e., collection to data archival) lifecycle approach that NCCOS takes in addressing coastal management needs, however each of these focal areas can also be performed independently.

NCCOS' diverse experience in these focal areas enables the team to focus and customize each product specifically to partners' and clients' needs. Multiple focal areas can be applied to provide an end to end solution, or specific focal areas can be executed for targeted applications.

Focal Areas



Mapping Coordination & Spatial Prioritization
The habitat mapping program has designed a participatory spatial prioritization process to provide critical information on "where" and "why" mapping data are needed and promote mapping coordination, planning,

and collaboration among multiple agencies.

Remote Sensing & Signal Processing
The habitat mapping program applies advanced signal processing to remotely sensed acoustic and optical data to provide comprehensive interpretations of bottom and water column habitats and features.

Uncrewed Systems for Mapping (UxS)
The habitat mapping program uses airborne, surface, and underwater UxS to enhance remote sensing for habitat mapping. UxS provide high resolution acoustic and optical imagery to augment crewed
systems or in remote areas. Precise controls allow for long-endurance and repeatable surveys.

Image Analysis, Artificial Intelligence, & Deep Learning
The habitat mapping program is exploring further applications for machine learning in image analysis and its potential to assist in HMT's workflow. These automation techniques streamline data analytics, allowing
for an increased focus on the critical steps of data interpretation and product development.

Predictive Habitat Modeling
The habitat mapping program uses predictive modeling approaches to create benthic habitat maps. These predictive maps are quantitative and can be used to understand habitat changes over time. This modeling framework can also be deployed in the cloud, allowing HMT to process large datasets more efficiently.

Data Visualizations & Applications
The habitat mapping program specializes in developing visualizations and immersive spatial data tools to support decision making, science communication and outreach.

More details on the Focal Areas within the FY 2021-2026 Habitat Mapping Team Programmatic Plan can be found in Appendix E.

Habitat Mapping Workforce Framework
The habitat mapping program's workforce model is based on a hybrid mix of federal employees and contractors. This model allows The habitat mapping program to staff a permanent core group of federal employees with a mix of contractors. Contractor personnel allows HMT to add technical capabilities to fill needed gaps or adjust skills as necessary, and meet project staffing requirements. However, there are negative aspects to this model as well as it has high dependency on external or competitive "soft" funding to support the contractor workforce, which generally lacks annual stability for multi-year forward planning. Federal positions lost to attrition or retirement are difficult and slow to fill.

In general, the habitat mapping program's federal employees are often: experienced project managers and senior subject matter experts, proficient at building new partnerships, identifying and pursuing new sources of funding, and identifying future research efforts. The habitat mapping program's contractors are primarily technical and field support staff, analysts with specialties in many technical disciplines needed to support the success of our projects.

Multi-year funding uncertainties contribute to workforce staffing challenges. Subsequently, the habitat mapping program has limited capacity to support or engage in new projects. Most employees are fully tasked, so the ability to add additional projects or support new program priorities is extremely challenging and requires careful balancing. As such under current conditions, evaluating the habitat mapping program's carrying capacity and potential new starts requires careful and frequent evaluation and balancing of funding needed, personnel and project delivery commitments.

Skillset Gaps

The habitat mapping program continually explores opportunities to increase and diversify skills and expertise amongst its staff, resulting in a more adaptable and flexible approach to the needs of partners and projects. In an effort to discern the current level and variety of expertise and skills within the habitat mapping program, an assessment of competencies and capabilities was conducted in 2021 to identify and define core competencies needed to achieve HMTs objectives (see Focal Areas) and to gauge HMT's current level of proficiency for each competency.

Each member of the habitat mapping program conducted a self-evaluation to report their respective proficiency levels (expert, moderate, beginner, none) for 22 detailed competencies organized into three categories: core technical, core professional, and specialty competencies. The three
competency categories were defined as:

Core Professional Competency

Critical area of expertise that includes "soft skills" or universal skills sets that relate to staff members' abilities to conduct, communicate, work as a team, support continued learning, or other functions that serve as a
cross cut of the staff members' specific area of expertise and the larger habitat mapping mission.

Core Technical Competency

Critical area of expertise that forms a "must have" for any staff member working within the mission space of the habitat mapping program. This covers the technical aspects of the job to include methodologies, procedures, use of equipment, or other capabilities that form the backbone of the HMT mission function .

Specialty Competency

Area of expertise that separates an overall average to slightly above average employee to one that may excel in the mission area (e.g., machine learning, average staff members may have computational skills but someone proficient in machine learning would provide higher
value in this mission area).

The results of the self-evaluation highlighted the diverse competency skills of habitat mapping personnel, promoting the capabilities in providing multi-faceted approaches to habitat mapping. The results specifically identified competency gaps at expert level proficiency in “Core Technical” and “Specialty” categories for: Data Management, Instrument Maintenance, Database Operations, Instrument Engineering, Application Development, Spatial Statistics, and Spatial Modeling. The Data Management category was addressed with one additional hire in September, 2021. It is anticipated additional hires into these positions and training of these skills will provide expertise which permutates to the project level. Application development, which includes the design and implementation of applications and web mapping services, is currently being provided at the Biogeography Branch level. Web mapping services and visualization were identified as a growing technical need and capability within the habitat mapping program, and have been partially addressed by utilizing capabilities within other parts of the Biogeography Branch.

The habitat mapping program continues to invest in the expansion or increased utilization of uncrewed systems and vehicle and sensor payloads, which require expertise in procuring, testing, engineering, integration, operation, and maintenance. Furthermore, there were bi-modal results for Project Management and Research Proposals in the “Core Professional” category, identifying high proficiency of these two competencies, but for only a few individuals.

Service Delivery at NOAA

Service delivery lies at the heart of NOAA’s mission and is critical in all that it does. Users look to NOAA for a range of data, information, tools and services, but sometimes find them difficult to efficiently and effectively access and understand. Some users seek additional support to apply NOAA’s data, information, and tools to their situation. They want answers, guidance, training, and a helping hand. Through continuous customer engagements, NOAA personnel glean important information about how data, products and tools are, or are not, serving specific localities or sectors. NOAA has been transforming from a scientific and technologically constrained set of products and services, to valuing user needs as a critical input for developing useful, actionable information. Timely and specific user needs are essential inputs for advancing and deploying new technologies, models, tools, and resources.

Effective implementation of service delivery requires relationships between information producers and consumers built on mutual trust and respect. Key to developing and maintaining these relationships is sustained engagement and collaboration that will facilitate the integration of services into actionable information. NOAA’s existing network of line offices and affiliated partners is a critical asset to support improved service delivery. Many of these entities already have the desired level of trust and frequent engagement with their community members. This new model for service delivery offers a guiding concept to transform interaction among these groups. It documents best practices for service-oriented approaches, processes, and tools to improve how NOAA’s products and services are developed and delivered to society.

For more information see *A Model of Service Delivery for the NOAA Water Initiative*.

Review Session Summaries

Mapping Coordination and Spatial Prioritizations

Coastal and marine mapping is a logistically intensive, time consuming, and costly enterprise. Providing accurate geospatial map products to users is one of the mapping program's principal objectives, but doing so depends upon having a thorough understanding of mapping requirements and coordination among data providers and users. This session uses two projects as case studies for mapping coordination, one to describe a spatial prioritization of shallow coral reefs and the other to describe collaborative benthic habitat mapping in the Great Lakes. These case studies highlight NCCOS's expertise in identifying stakeholders and data gaps, defining mapping requirements and priorities, selecting and operating appropriate research vessels, platforms, and sensors, coordinating among partners and stakeholders, and generating maps which meet client objectives in a timely manner.

Session Presenters:

- Charles Menza, *Marine Biologist*
- Sarah Hile*, Marine Ecologist*

Remote Sensing and Signal Processing

The Seascape Ecology and Analytics (SEA) Branch uses remote sensing technologies to collect spatial data in benthic environments for mapping, modeling and monitoring marine ecosystems. These data include acoustic sonar, lidar, multispectral satellite, aerial and underwater photo imagery. Two case studies that demonstrate the SEA Branch's continued progress/innovation in acquisition and processing of remote sensing data are: 1) the use of Structure from Motion (SfM) in Guam and Saipan, Commonwealth of the Northern Mariana Islands (CNMI) as ground validation data across large (km) spatial scale habitat mapping study areas and 2) collaborative efforts with NOAA Office of Coast Survey (OCS) in developing a multibeam backscatter best practices reference manual for optimal backscatter calibration, acquisition, processing and quality control. These case studies demonstrate new workflows used by NCCOS that generate more accurate, efficient, and increased spatial coverage environmental data. The time saved in delivering more reliable products to resource managers translates to better habitat conservation.

Session Presenters:

- Ed Sweeney, *Marine Spatial Ecologist*

Predictive Habitat Modeling

Predictive habitat modeling plays a vital role in identifying the locations of benthic taxa and habitats within project areas, employing sophisticated mathematical models, including machine learning, to deliver precise predictions. The Seascape Ecology and Analytics Branch (SEA) harnesses these models to produce detailed maps that inform marine management actions, primarily funded through reimbursable dollars and in-kind contributions from collaborative partners. This session highlights SEA's capabilities through two compelling case studies. The first focuses on predicting the locations of branching corals and other morphologies using machine learning techniques, aimed at enhancing coral restoration and shoreline protection efforts around Saipan, CNMI. The second case study addresses the prediction of deep-sea coral and sponge communities within the Papahānaumokuākea Marine National Monument, supporting its nomination as a new national marine sanctuary. Both shallow and deep marine resources face significant threats, and the decline of these essential ecosystems diminishes their ecological value while adversely affecting local communities dependent on recreation, tourism, fishing, and other ocean-related activities. SEA strives to equip managers with better information, enabling effective monitoring and management strategies to address these critical challenges.

Session Presenters:

- Bryan Costa, *Research Ecologist*
- Ed Sweeney, *Marine Spatial Ecologist*

Uncrewed Systems for Mapping

Creating habitat maps for the next generation of ocean planning and ecosystem restoration demands geospatial data at broader extents, finer resolution and richer detail. Achieving these requirements is facilitated through integrating acoustical and optical sensors on uncrewed maritime systems like autonomous surface vessels (ASVs) and autonomous underwater vehicles (AUVs). NCCOS has rapidly adopted uncrewed maritime systems in the mapping enterprise using a multi-modal approach including contracted data services from industry, partnerships with academia and other government agencies and growing internal capacity in engineering and field operations. Two case studies will highlight major efforts to transition research and development into operational surveys. First, acoustic and optical sensors developed for military and industry applications are showing promise to significantly increase seabed detail and extent of coverage to characterize mesophotic and deep coral habitats. Second, managing uncrewed systems requires close attention to maintenance, vehicle performance, and operator proficiency to ensure readiness to meet the needs of projects and programs. This case study will outline a new internal dashboard system for uncrewed vehicle maintenance and budget planning, operator training, a central location of concepts of operations and procedural documents. Collectively, these efforts are immediately achieving mapping objectives within NCCOS applied research programs while also addressing top priorities for the NOAA Science Strategy in Uncrewed Systems.

Session Presenters:

- Chris Taylor, *Research Ecologist*
- Mike Bollinger*, Analyst*

Image Analysis, Artificial Intelligence, and Deep Learning

The Seascape Ecology and Analytics (SEA) Branch specializes in utilizing remote sensing technologies to collect and analyze spatial data in benthic environments. This data, gathered through various means including acoustic sonar, lidar, multispectral satellite imagery, and aerial and underwater photography, forms the foundation for mapping, modeling, and monitoring marine ecosystems. A key focus of the SEA Branch is predictive habitat modeling, which plays a vital role in identifying the locations of benthic taxa and habitats within project areas. By employing sophisticated mathematical models, the branch delivers precise predictions and produces detailed maps. These outputs directly inform marine management actions, providing crucial data for decision-making processes. A significant bottleneck between collecting data and processing it for use in developing spatial models lies in data annotation. In the following case studies, we explore the use of Artificial Intelligence (AI) and computer vision techniques to assist in automating tasks related to imagery annotation. By adopting machine learning approaches, the SEA branch can streamline tedious and time-consuming processes, significantly enhancing the efficiency and scale of analyses.

Session Presenter:
- Jordan Pierce*, Marine Data Scientist*

Data Management, Visualization and Applications
Robust data management is of critical importance to project and organizational integrity. Every data driven organization needs to prioritize and embrace investment in all aspects of the data management life-cycle. The session highlights the suggestions made during the 2019 review, efforts made to incorporate them, and the advancements made with respect to data management, dissemination, and visualization. The first case study focuses on data standardization and integration using a Structured Query Language (SQL) Server database as an enterprise solution. Segregated management of data limits the development of a robust dataset required for holistic analyses. Scaling up the SQL Server database to the NCCOS level is a potential solution to our current data management approach which is focused on portfolios instead of the organization. The second case study highlights the efforts made towards integrating portfolio resources (including data) for better collaboration, efficiency, and visibility, including the development of an ArcGIS Online Hub. The template can be scaled up for other projects to streamline data dissemination and visualization. Data collection efforts by NCCOS are going to expand in the future in terms of spatial extent, technology, and investment. An enterprise solution is imperative if the return on investment needs to be maximized. Other focus areas of the organization such as predictive habitat modeling and artificial intelligence also rely on the quality of the data, making data management a foundation for all our decisions - business and science.

Session Presenters:
- Asmita Shukla, *Data Management Specialist*

Species Predictive Modeling & Climate
NCCOS uses species distribution models to provide critical information about the potential distributions of key biota and habitats in support of coastal and marine resource management. Maps and data products from NCCOS species distribution models have been used to inform offshore energy planning, fishery management council decisions, and National Marine Sanctuary management, as well as to guide research and exploration. The first case study demonstrates NCCOS collaboration with its partners to integrate seafloor mapping, collection of ground-truthing data, and species distribution models to fill significant gaps in the understanding of the extent of deep-sea coral and sponge habitats in the Gulf of Maine. The second case

study highlights the incorporation of climate projections into species distribution models to make predictions about potential shifts in marine bird distributions in the U.S. Atlantic. The integration of seafloor mapping, climate change information, and species distribution modeling will enable the Seascape Ecology and Analytics Branch to strengthen its ability to provide relevant information to resource managers.

Session Presenters:

- Matt Poti, *Marine Biologist*

Slides for each of the session presentations and additional supplemental information can be found in Appendix F.

Appendices

APPENDIX A: Tabular Report Template for Reviewers

Each member of the review panel will use her / his scientific expertise and professional judgment to provide independent observations, evaluation, and recommendations on different aspects of the NCCOS habitat mapping and characterization portfolio, including product value and utilization. Each member of the Review Panel will also prepare notes on his/her observations, comments and recommendations that, at a minimum, address the three core evaluation criteria: Quality, Relevance, and Performance. For convenience, a tabular format is provided for recording comments on different aspects of the review.

A link to the Tabular Report Template for Reviewers can be found in at this link.

APPENDIX B: HABITAT MAPPING PORTFOLIO PUBLICATIONS 2019–2024

Journal Articles & Book Chapters

2019. Camapanella, F., Auster, P., Taylor, J. C., and Munoz, R. Dynamics of predator-prey habitat use and behavioral interactions over diel periods at sub-tropical reefs. *PLoS ONE*,*14*(2), e0211886. https://doi.org/10.1371/journal.pone.0211886

2019. Costa, B. Multispectral acoustic backscatter: How useful is it for marine habitat mapping and management? *Journal of Coastal Research*, *35*, *5*, 1062–1079. https://doi.org/10.2112/JCOASTRES-D-18-00103.1

2019. Paxton, A. B., Peterson, C. H., Taylor, J. C., Adler, A. M., Pickering, E. A., and Silliman, B. R. Artificial reefs facilitate tropical fish at their range edge. *Communications Biology*, *2*, 168. https://doi.org/10.1038/s42003-019-0398-2

2019. Scott, A. R., Battista, T. A, Blum, J. E., Noren, L. N., and Pawlik, J. R. Patterns of benthic cover with depth on Caribbean mesophotic reefs. *Coral Reefs*, *38*, 961–972. https://doi.org/10.1007/s00338-019-01824-6

2019. Wilson, N., Parrish, C. E., Battista, T., Wright, C. W., Costa, B., Slocum, R. K., Dijkstra, J. A., and Tyler, M. T. Mapping seafloor relative reflectance and assessing coral reef morphology with EAARL-B topobathymetric lidar waveforms. *Estuaries and Coasts*, *45*, 1–15. https://doi.org/10.1007/s12237-019-00652-9

2020. Brown, C. M., Paxton, A. B., Taylor, J. C., Van Hoeck, R. V., Fatzinger, M. H., and Silliman, B. R. Short-term changes in reef fish community metrics correlate with variability in large shark occurrence. *Food Webs*, *24*, e00147. https://doi.org/10.1016/j.fooweb.2020.e00147

2020. Johnson, K. H., Paxton, A. B., Taylor, J. C., Hoyt, J., McCord, J., and Hoffman, W. Joint ecological and archeological shipwreck surveys using submersible video and laser-line scanning. *Bulletin of the Ecological Society of America*, *101*(4), e01782. https://doi.org/10.1002/bes2.1782

2020. Johnson, K. H., Paxton, A. B., Taylor, J. C., Hoyt, J., McCord, J., and Hoffman, W. Extracting ecological metrics from archeological surveys of shipwrecks using submersible video and laser-line scanning. *Ecosphere*, *11*(11), e03210. https://doi.org/10.1002/ecs2.3210

2020. Mabrouk, A. Conservation leadership: A case study from the Gulf of Aqaba, Red Sea, Egypt. In W. W. Taylor, A. K. Carlson, A. Bennett A. Lynch, and C P. Ferreri (Eds.), Lessons in Leadership: Integrating Courage, Vision, and Innovation for the Future of Sustainable Fisheries (pp. 53–59). American Fisheries Society.

2020. Paxton, A. B., Newton, E. A., Adler, A. M., Van Hoeck, R. V., Iversen, E. S., Jr., Taylor, J. C., Peterson, C. H., and Silliman, B. R. Artificial habitats host elevated densities of large

reef-associated predators. *PLoS ONE*, *15*(9): e0237374.
https://doi.org/10.1371/journal.pone.0237374

2020. Paxton, A. B., Shertzer, K. W., Bacheler, N. M., Kellison, G. T., Riley, K. L., and Taylor, J.C. Meta-analysis reveals artificial reefs can be effective tools for fish community enhancement but are not one-size-fits-all. *Frontiers in Marine Science*, *7*, 282.
https://doi.org/10.3389/fmars.2020.00282

2020. Van Hoeck, R. V., Paxton A. B., Bohnenstiehl, D. R., Taylor, J. C., Fodrie, F. J., Nowacek, D. P., Voss, C. M., and Peterson, C. H. Soundscapes of natural and artificial temperate reefs: Similar temporal patterns but distinct spectral content. *Marine Ecology Progress Series*, *649*, 35–51. https://doi.org/10.3354/meps13434

2020. Walker, B. K., Eagan, S., Ames, C., Brooke, S., Keenan, S., and Baumstark, R. Shallow-water coral communities support the separation of marine ecoregions on the west-central Florida gulf coast. *Frontiers in Ecology and Evolution*, *8*, 210.
https://doi.org/10.3389/fevo.2020.00210

2020. Winship, A. J., Thorson, J. T., Clarke, M. E., Coleman, H. M., Costa, B., Georgian, S. E., Gillett, D., Grüss, A., Henderson, M. J., Hourigan, T. F., Huff, D. D., Kreidler, N., Pirtle, J. L., Olson, J. V., Poti, M., Rooper, C. N., Sigler, M. F., Viehman, S., Whitmire, C. E. Good practices for species distribution modeling of deep-sea corals and sponges for resource management: Data collection, analysis, validation, and communication. *Frontiers in Marine Science*, *7*.
https://doi.org/10.3389/fmars.2020.00303

2021. Binder B. M., Taylor, J. C., Gregg, K., and Boswell, K. M. Fish spawning aggregations in the Southeast Florida Coral Reef Ecosystem Conservation Area: A case study synthesis of user reports, literature, and field validation efforts. *Frontiers in Marine Science*, *8*, 671477.
https://doi.org/10.3389/fmars.2021.671477

2021. Paxton, A. B., Harter, S. L., Ross, S. W., Schobernd, C. M., Runde, B. J., Rudershausen, P. J., Johnson, K. H., Shertzer, K. W., Bacheler, N. M., Buckel, J. A., Kellison, G. T., and Taylor, J. C. Four decades of reef observations illuminate deep-water grouper hotspots. *Fish and Fish*eries, *22*: 749–761. https://doi.org/10.1111/faf.12548

2021. Pickens, B. A., Carroll, R., Schirripa, M. J., Forrestal, F., Friedland, K. D., and Taylor, J. C. A systematic review of spatial habitat associations and modeling of marine fish distribution: A guide to predictors, methods, and knowledge gaps. *PLoS ONE*, *16*(5), e0251818.
https://doi.org/10.1371/journal.pone.0251818

2021. Pickens, B. A., Carroll, R., and Taylor, J. C. Predicting the distribution of penaeid shrimp reveals linkages between estuarine and offshore marine habitats. *Estuaries and Coasts*, *44*, 2265–2278. https://doi.org/10.1007/s12237-021-00924-3

2021. Pickens, B. A., Taylor, J. C., Finkbeiner, M., Hansen, D., and Turner, L. Modeling sand shoals on the U.S. Atlantic shelf: Moving beyond a site-by-site approach. *Journal of Coastal Research*, *37*(2), 227–237. https://doi.org/10.2112/JCOASTRES-D-20-00084.1

2021. Runde, B. J., Buckel, J. A., Rudershausen, P. J., Mitchell, W. A., Ebert, E., Cao, J., and Taylor, J. C. Evaluating the Effects of a deep-water marine protected area a decade after closure: A multifaceted approach reveals equivocal benefits to reef fish populations. *Frontiers in Marine Science*, *8*, 775376. https://doi.org/10.3389/fmars.2021.775376

2022. Morris, J. T., Enochs, I. C., Besemer, N., Viehman, T. S., Groves, S. H., Blondeau, J., Ames, C., Towle, E. K., Grove, L. J. W., and Manzello, D. P. Low net carbonate accretion characterizes Florida's coral reef. *Scientific Reports*, *12*, 19582. https://doi.org/10.1038/s41598-022-23394-4

2022. Paxton, A. B., Ebert, E. F., Casserley, T. R., and Taylor, J. C. Intuitively visualizing spatial data from biogeographic assessments: A 3-dimensional case study on remotely sensing historic shipwrecks and associated marine life. *Frontiers in Climate*, *4*,1011194. https://doi.org/10.3389/fclim.2022.1011194

2022. Paxton, A. B., Steward, D. N., Harrison, Z. H., and Taylor, J. C. Fitting ecological principles of artificial reefs into the ocean planning puzzle. *Ecosphere*, *13*(2). https://doi.org/10.1002/ecs2.3924

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2023. Gilliland, V. A., Fessler, A. E., Paxton, A. B., Ebert, E. F., Tharp, R. M., Runde, B. J., Bacheler, N. M., Buckel, J. A., and Taylor, J. C. Spatial extent and isolation of marine artificial structures mediate fish density. *Frontiers in Marine Science*, *10*, 1240344. https://doi.org/10.3389/fmars.2023.1240344

2024. Jung, J., Parrish, C., Costa, B., and Yoo, S. Simultaneous invariant normalization of waveform features from bathymetric lidar, SINWav: A Saipan case study. *ISPRS Journal of Photogrammetry and Remote Sensing*, *214*, 1–20. https://doi.org/10.1016/j.isprsjprs.2024.05.024

2024. Pavoni, G., Pierce, J., Edwards, C. B., Corsini, M., Petrovic, V., and Cignoni, P. Integrating widespread coral reef monitoring tools for managing both area and point annotations. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *XLVIII-2-2024*, 327–333. https://doi.org/10.5194/isprs-archives-XLVIII-2-2024-327-2024

(In Review). Sweeney, E., Costa, B., Jung, J., and Parrish C. E. Predicting the location of threatened marine taxa using machine learning and bathymetric lidar waveforms. *Remote Sensing of Environment*.

(In Review). Herrera, F. K., Uhrin, A. V., Winans, W. R., Parrish, C. E., Murphy, P., and Battista,T. A. Enhanced detection and classification of stranded macrodebris using polarimetric imagery. *Journal of Coastal Research*.

(In Prep). Poti, M., Costa, B., Kelley, C., Baco, A., Hourigan, T., Parrish, F., Kobayashi, D., Martinez, J., Kosaki, R., and Parke, M. Using Predictive Habitat Modeling to Identify Deep-Sea Coral and Sponge Habitats for Future Exploration and Conservation within the Papahānaumokuākea Marine National Monument, Hawaii. Target Journal: *Deep-Sea Research Part I*.

Reports

2019. Battista, T. W. Sautter, M. Poti, E. Ebert, L. Kracker, J. Kraus, A. Mabrouk, B. Williams, D.S. Dorfman, R. Husted, and C.J. Jenkins. 2019. Comprehensive seafloor substrate mapping and model validation in the New York Bight. OCS Study BOEM 2019-069 and NOAA Technical Memorandum NOS NCCOS 255. https://doi.org/10.25923/yys0-aa98

2019. Costa, B., K. Buja, M. Kendall, B. Williams, J. Kraus. Prioritizing areas for future seafloor mapping, research, and exploration offshore of California, Oregon, and Washington. NOAA Technical Memorandum NOS NCCOS 264. https://doi.org/10.25923/wa5c-vn25

2019. Menza, C., and Kendall, M.S. (eds). Ecological assessment of Wisconsin - Lake Michigan. NOAA NOS National Centers for Coastal Ocean Science, Marine Spatial Ecology Division. NOAA Technical Memorandum NOS NCCOS 257. http://doi.org/10.25923/b9my-ex29

2019. Slocum, R. K., Wright, W., Parrish, C., Costa, B., Sharr, M., and Battista, T. A. Guidelines for bathymetric mapping and orthoimage generation using sUAS and SfM: An approach for conducting nearshore coastal mapping. NOAA Technical Memorandum NOS NCCOS 265. https://doi.org/10.25923/07mx-1f93

2020. Battista, T., Shuler, A., Taylor, C., Kraus, J., Bassett, R., Salgado, and E., Etnoyer, P. J. Cruise Report for NOAA Ship *Nancy Foster* NF-19-01: Mapping essential fish habitat in the US Caribbean to inform MPA management. NOAA Technical Memorandum NOS NCCOS 274. https://doi.org/10.25923/4d02-aj05

2020. Kendall, M. S., Buja, K., Menza, C., Gandulla, S., and Williams, B. Priorities for lakebed mapping in Lake Huron's Thunder Bay National Marine Sanctuary. NOAA Technical Memorandum NOS NCCOS 276. https://doi.org/10.25923/qyrf-tq71

2020. Kendall, M. S., T. A. Battista, M. Carson, W. Caskey, K. Grissom, B. Guthrie, M. Head, C. F. G. Jeffrey, M. Kuzemchak, K. W. Roberson. T. J. Rowell, B. Shortland, and J. A. Stanley. Observations of visitation to Gray's Reef National Marine Sanctuary. NOAA Technical Memorandum NOS NCCOS 281 https://doi.org/10.25923/hct8-6y08

2020. Kraus, J., Williams, B., Hile, S. D., Battista, T., and K. Buja. Prioritizing areas for future seafloor mapping and exploration in the US Caribbean. NOAA Technical Memorandum NOS NCCOS 296. https://doi.org/10.25923/w5v3-ha50

2021. Taylor, J. C., Johnston, D. W., Ridge, J. T., Jenkins, W., Wakely, A., Hernandez, D., Robinson, S., McCombs, J., Eastman, S., and Dietz, K. Drones in the coastal zone: Report from a regional workshop for the US Southeast and Caribbean. NOAA NOS NCCOS Technical Memorandum 294. https://doi.org/10.25923/g9m4-ts27

2022. Costa, B., Sweeney, E., and Mendez, A. Leveraging artificial intelligence to annotate marine benthic species and habitats. NOAA Technical Memorandum NOS NCCOS 306. https://doi.org/10.25923/7kgv-ba52

2022. Harter, S. L., Paxton, A. B., Winship, A. J., Hile, S. D., Taylor, J. C., Poti, M., and Menza, C. Workshop report for approaches to mapping, ground-truthing, and predictive habitat modeling of the distribution and abundance of mesophotic and deep benthic communities. National Oceanic and Atmospheric Administration. DWH MDBC Summary Report 2022-02. https://doi.org/10.25923/sedd-8w68

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2022. Kraus, J., C. A. Buckel, B. Williams, C. Ames, D. Dorfman, F. Pagan, E. K. Towle. Agency priorities for mapping South Florida's Coral Reef Ecosystems. NOAA Technical Memorandum NOS NCCOS 304. https://doi.org/10.25923/qc9e-gt19

2022. Mabrouk, A., Menza, C., and Sautter, W. Best Practices for ground-truthing and accuracy assessment of lakebed maps in the Great Lakes: A case study offshore the Bayfield Peninsula in Lake Superior. NOAA Technical Memorandum NOS NCCOS 295. https://doi.org/10.25923/f1tn-0694

2022. Office of National Marine Sanctuaries. Olympic Coast National Marine Sanctuary condition report: 2008–2019. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries. https://sanctuaries.noaa.gov/science/condition/ocnms/

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2023. Edwards, C. B., Viehman, T. S., Battista, T., Bollinger, M. A., Charendoff, J., Cook, S., Combs, I., Couch, C., Ferrari, R., Figueira, W., Gleason, A. C. R., Gordon, S., Greene, W., Kuester, F., McCarthy, O., Oliver, T., Pedersen, N. E., Petrovic, V., Rojano, S., Runyan, H., Sandin, S. A., and Zgliczynski, B. J. Large-area imaging in tropical shallow water coral reef monitoring, research, and restoration: A practical guide to survey planning, execution, and data extraction. NOAA National Ocean Service, National Centers for Coastal Ocean Science. NOAA Technical Memorandum NOS NCCOS 313. https://doi.org/10.25923/5n6d-kx34

2023. Habitat Mapping Team Programmatic Plan 2021–2026. Prepared by the NCCOS Marine Spatial Ecology Division. https://cdn.coastalscience.noaa.gov/page-attachments/HMT/HMT-Programmatic-Plan_2021-2026_Final.pdf

2023. Harter, S., David, A., Taylor, J. C., and Shukla, A. Cruise Report: MDBC Expedition NOAA Ship Pisces June 29–July 30, 2022. National Oceanic and Atmospheric Administration. DWH MDBC Cruise Report 2023-01. https://doi.org/10.25923/wdgd-bz66

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2024. Costa, B., Sweeney, E., and Kraus, J. Characterizing benthic habitats of Western Saipan, CNMI. NOAA Technical Memorandum NOS NCCOS 328. https://doi.org/10.25923/psjm-h924

2024. Hann, A. M., Anderson, M., Dwyer, L., Blancher, J., Cox, C., Nakamura, L., Mowitt, W., Knox, A., Reich, J., Cook, M., Doerr, J., Waldsmith, J., Costa, B., O'Sullivan, J., Sweeney, C. Bairer, B., Cole, B., and Gallagher, M. NOAA Uncrewed aircraft systems report for fiscal year 2023. NOAA technical memorandum OMAO UxS 003. https://doi.org/10.25923/0112-7302

2024. Hann, A. M., Malley, D., Fruh, E., Bergeron, J., Cox, C., Nakamura, L., Mowitt, W., Ruberg, S., Olsen, E., Gallagher, M. I, Annis, M., McMillan, C., Bowers, J., Weathers, K., Burnett, W., ONeil, K., Petraitis, D., Elmore, A., Prusinky, N., Bailey, K., Jenkins, K., Mansour, J., Downs, R., Getrich, M., Sarkis, S., and Battista, T. NOAA Uncrewed Marine Systems highlights report for fiscal year 2023. NOAA Technical Memorandum OMAO UxS 004. https://doi.org/10.25923/k081-jf67

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Press Releases

11/2/2023 Kraken Receives Synthetic Aperture Sonar Order from HII

12/05/2023. NOAA, RTSys & Arctic Rays Partner for Underwater Research Vehicle - Ocean Science & Technology

08/12/2024 NOAA Puts Voyis Sensors to Work for Mesophotic and Deep Benthic Community Restoration

09/09/2024 HII Delivers Advanced REMUS 620 UUVs to NOAA Less than 24 Months after Unveiling

NCCOS News Items

02/04/2019 NCCOS Tests Drones to Map Coastline and Nearshore Waters

02/12/2019 Drone Mapping Team Receives Inaugural NCCOS Innovation Incentive Award

05/14/2019 Artificial Reefs May Help Tropical Fish Expand Geographic Range (video) - NCCOS Coastal Science Website

05/14/2019 NOAA, Partners Map Lakebed in Michigan's Thunder Bay National Marine Sanctuary - NCCOS Coastal Science Website

06/05/2019 NCCOS, Partners Publish Ecological Assessment of Wisconsin – Lake Michigan

07/15/2019 NCCOS Research Contributes to Third NOAA Emerging Technologies Workshop

08/05/2019 Coral Reef Expedition Marks Fifteen Years of Discovery in Caribbean - NCCOS Coastal Science Website

08/13/2019 Researchers Explore Gulf of Mexico's Moving 'Phantom' Bottom - NCCOS Coastal Science Website

10/03/2019 NCCOS, Partners Survey Thunder Bay National Marine Sanctuary Lakebed

10/04/2019 Scientists Characterize Seafloor for Proposed New York Offshore Wind Energy Project

11/22/2019 Underwater Robots Help Scientists Understand How Fish Use Shipwrecks for Habitat

12/03/2019 Researchers Study Ecological Role of North Carolina Shipwrecks and Reefs (video)

01/15/2020 Spatial Analysis Completed to Prioritize U.S. Caribbean Mapping and Exploration

01/30/2020 Guidelines Published for Mapping Nearshore Coastal Seafloor Using Aerial Drones

04/07/2020 NCCOS Science Supports Creation of New Maps for Allen Coral Atlas

04/30/2020 NOAA, BOEM Develop New Tool to Reduce Dredging Impacts to Essential Fish Habitat

05/11/2020 NOAA Study Finds Artificial Reefs Enhance Fish Communities, Solutions are Location-specific

08/05/2020 Scientists, Managers Identify Mapping Priorities for Lake Huron's Thunder Bay National Marine Sanctuary

08/25/2020 Study: Fish Biodiversity in a Caribbean Mangrove Bay 30-50% Lower than 25 Years Ago - NCCOS Coastal Science Website

09/02/2020 Explore North Carolina's Shipwrecks, Marine Life Virtually with 'Living Shipwrecks 3D'

09/03/2020 Research Suggests Predators Prefer Artificial over Natural Reefs, Influence Community Structure of Such Habitat - NCCOS Coastal Science Website

10/01/2020 Seafloor Mapping Mission Supports Better Characterization of Florida Keys Coral Ecosystem

10/20/2020 Visitation Patterns Measured at Gray's Reef National Marine Sanctuary - NCCOS Coastal Science Website

11/14/2020 Drone Workshop Grows Partnerships in U.S. Southeast and U.S. Caribbean

12/07/2020 Visually Exploring the Deep Sea Using Free and Open Source Software

01/13/2021 Study Demonstrates Benefits of Joint Archeological and Ecological Shipwreck Exploration

01/30/2022 Researchers Develop Drone-based System to Detect Marine Debris, Expedite Clean Up (Video) - NCCOS Coastal Science Website

02/10/2021 Climate Change Alters Timing of Fish Larvae Entering North Carolina Estuaries - NCCOS Coastal Science Website

03/10/2021 NCCOS Releases Priorities for U.S. Caribbean Seafloor Mapping and Exploration

03/15/2021 NOAA Continues to Survey Essential Fish Habitat in Florida Keys National Marine Sanctuary

03/26/2021 Study Illuminates Patterns in Atlantic Deep-water Grouper Hotspots - NCCOS Coastal Science Website

05/19/2021 StoryMap Highlights Boat Visitations at Gray's Reef National Marine Sanctuary - NCCOS Coastal Science Website

07/06/2021 NCCOS Science Supports Designation of New Marine Sanctuary in Lake Michigan (Video)

12/06/2021 Machine Learning Collaboration Yields New Methods to Measure Shoreline Marine Debris - NCCOS Coastal Science Website

03/09/2022 NCCOS Research Supports Olympic Coast National Marine Sanctuary Condition Report

03/21/2022 Artificial Reef Design and Siting in US Missing Ecological Principles - NCCOS Coastal Science Website

05/11/2022 Valor in the Atlantic 2022: Diving into North Carolina's Maritime History - NCCOS Coastal Science Website

05/31/2022 Scientific Cruises Set Sail to Help Restore Open Ocean Communities - NCCOS Coastal Science Website

09/15/2022 Study Calculates Area Covered by Natural vs Artificial Reefs in Southeast US

11/09/2022 New Report Presents Agency Priorities for Mapping South Florida's Coral Reef Ecosystems

01/19/2023 NCCOS Scientists Lead DWH Adaptive Management Workshops

02/27/2023 Report Details Agency Priorities for Mapping Coral Reef Ecosystems in U.S. Caribbean

05/17/2023 Autonomous Underwater Vehicle Collects Imagery to Evaluate Coral Restoration Effort - NCCOS Coastal Science Website

06/26/2023 Study Aims to Identify Which Artificial Oyster Reefs Fish Prefer - NCCOS Coastal Science Website

10/10/2023 Design, Distribution of Artificial Reef Structures Affect Fish Abundance (Video) - NCCOS Coastal Science Website

11/01/2023 New Research Explores Risk of Ciguatera Fish Poisoning on Artificial Structures - NCCOS Coastal Science Website

12/19/2023 Scientists Study Shipwrecks to Understand Underwater Ecology - NCCOS Coastal Science Website

01/18/2024 First Calculation of Artificial Reef Area in U.S. Ocean Published (Video) - NCCOS Coastal Science Website

03/20/2024 Deepwater Horizon 2023 Gulf of Mexico Deep Sea Expedition Season, By the Numbers

04/16/2024 Help Scientists Restore Gulf of Mexico Habitats with Click-a-Coral

05/31/2024 Story Map on Florida Deep Water Mapping Highlights NCCOS Spatial Prioritization Tool

06/05/2024 Scientists Test Improved Laser Scanning and Imaging Capabilities for Mapping Mesophotic Coral Communities

08/06/2024 Enhancing Shallow Coral Reef Management: A Unified Review of Data Needs - NCCOS Coastal Science Website
08/13/2024 NCCOS, Partners Assess State of Deep-sea Habitats in Gulf of Mexico

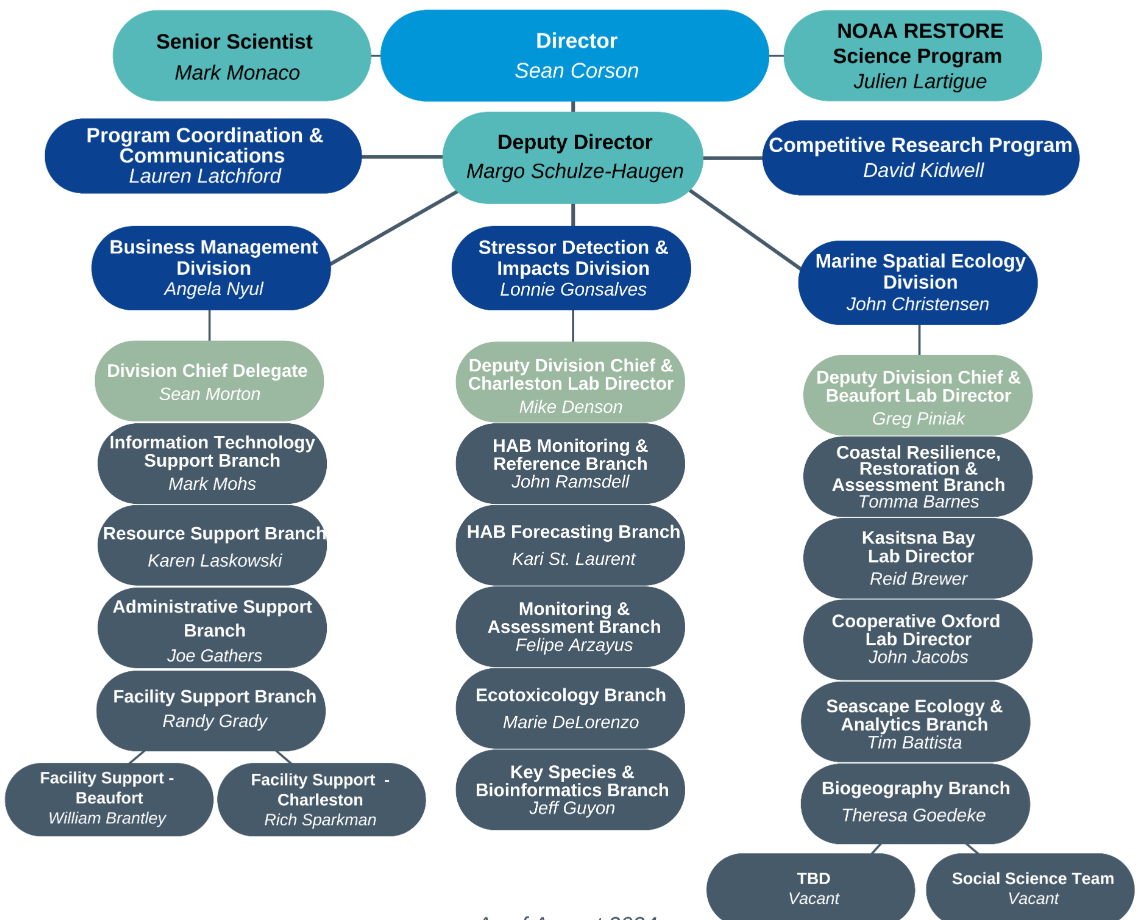
8/19/2024 Twenty Years of U.S. Caribbean Seafloor Mapping Aboard NOAA Ship Nancy Foster

APPENDIX C: NCCOS Formation

Background

The National Oceanic and Atmospheric Administration (NOAA) formed the National Centers for Coastal Ocean Science (NCCOS) in 1999 as the focal point for NOAA's coastal ocean science efforts. We help NOAA meet its coastal stewardship and management responsibilities, and provide coastal managers with the scientific information necessary to decide how best to protect environmental resources and public health, preserve valued habitats, and improve the way communities interact with coastal ecosystems. NCCOS has six strategic priorities, developed through a comprehensive stakeholder engagement process. These priorities guide NCCOS' science and competitive research investments and provide the information necessary to address complex coastal challenges.

Organizational Chart



As of August 2024

APPENDIX D: NCCOS Strategic Plans

The full PDF document for the FY 2017-2021 Strategic Plan: Advancing Coastal Science can be found at this link. For reviewers' convenience we have included relevant sections below.

Marine Spatial Ecology (MSE)
Coastal communities need to balance the inherent trade-offs between resource use and conservation. Managers need comprehensive information to evaluate the benefits and consequences of actions on both the ecosystem and the community. Marine Spatial Ecology (MSE) integrates a broad spectrum of physical, biological, and social sciences, to inform coastal and marine decision making. Communities, state and federal stewards, and industries such as aquaculture, offshore energy, and tourism use MSE to make decisions so that the economy can thrive and residents and visitors can enjoy our Nation's natural heritage, now and for generations to come.

NCCOS has long been a leader in the MSE community, providing a three-decade foundation of reliable and objective ecological and socioeconomic information. NCCOS scientists will continue to provide integrated biogeographic, ecological and social assessments – alongside mapping and monitoring products and services – to provide an end-to-end MSE enterprise in support of customers in the coastal and ocean management community. These unique capabilities are used by federal, state, and local decision makers to ensure that special places are valued, protected, and preserved, and to assist in growing the economies that are dependent on our Nation's maritime resources.

Consistent with NOAA's role as a public information agency, NCCOS includes stakeholder involvement as a standard in developing MSE products for decision makers. NCCOS focuses its MSE activities primarily where there is a clearly articulated management objective and user-defined application. NCCOS has identified four distinct MSE sub-priorities.

Ecological and Biogeographic Assessments
Stewardship of our Nation's coastal and marine resources is one of the primary purposes of the National Ocean Service, and NCCOS's nationally-recognized ecological and biogeographic assessments are critical to achieving that mission. Biogeographic assessments examine spatial and temporal distributions of organisms, habitats, and the historical and biological factors that produced them. Ecological assessments are more broad-based activities and range from defining the characteristics and status of ecosystem components that provide baseline conditions to detecting change in those conditions over time.

The Departments of Defense, Energy, the Interior, and state coastal zone programs and other federal, state, local, academic, not-for profit, and industry customers use our ecological and biogeographic assessments to meet their missions. Our customers use these assessments in various ways, such as to design and define the efficacy of marine protected areas which protect cultural or natural resources; preserve future recreational and commercial fisheries through identification of habitats used by fish; quantify and map social values and ecosystem services; and to implement sound national energy policy.

Habitat Mapping

Coastal resource managers and many coastal and offshore industries like energy and shipping need high-quality and reliable map products to make smart management and business decisions. Understanding coastal, pelagic, and benthic habitats can allow industry, regulators and special interest groups to come together to make more comprehensive planning decisions regarding, for example, the siting of offshore energy facilities or navigation routes for ships that are safer for whales, and beneficial to coastal tourism.

Federal agencies need NCCOS's habitat mapping products for management of living marine resources, monitoring and assessing conditions from the shore to the seabed over the short and long-term, and assessing the effectiveness of federal or state management actions. NCCOS's efforts to map coastal, pelagic, and benthic habitats also supports technology development, as we work with private industry and academia push the boundaries of time-sensitive, efficient and integrated data collection and visualization.

Regional Ecosystem Science

Oceans, rivers, coastal features, and the species that inhabit them do not limit themselves to the political boundaries of cities, states or their elected officials or career resource managers. Management of these resources therefore benefits from scientific study at a regional scale.

Managers use NCCOS data, tools, and predictive models to evaluate alternative management strategies with emphasis on regional scale ecosystem processes that support ecosystem-based management. The public and/or key stakeholder groups must also be engaged in understanding and accepting the regional ecosystem science that underlies the management options and decisions if they are to give the support needed for difficult and fiscally challenging management decisions. Regional governance bodies value the broader ecosystem science approach NCCOS provides, as their management issues remain complex, crossing scientific disciplines as well as geopolitical borders.

Coastal Aquaculture Siting and Sustainability

Over 90% of seafood consumed in the United States is imported, resulting in a $12 billion trade deficit, food insecurity, and missed economic opportunities. For many coastal communities, aquaculture promises economic development, revitalization of working waterfronts, and a more resilient coastal landscape. With an immense exclusive economic zone, U.S. coastal resources are vast and capable of providing environmentally sustainable seafood to meet growing U.S. and global demand.

Coastal managers, planners, and the aquaculture industry need NCCOS's innovative science. Predictive models, datasets, maps, tools, and targeted research are defining and informing sustainable aquaculture development along every coastline of the Nation. NOAA, the aquaculture industry, and coastal communities are working together to maintain healthy resilient coastal ecosystems to cultivate a sustainable aquaculture economy.

The full PDF document for the FY 2022-2026 Strategic Plan: Science Service Coastal Communities can be found at this link. For reviewers' convenience we have included relevant sections below.

Advancing Ecosystem Science for Conservation and Sustainable Use
NCCOS is a nationally recognized leader in conducting management-driven ecosystem science in the nation's oceans, coasts, and Great Lakes, including coral reefs, estuaries, National Marine Sanctuaries, and National Estuarine Research Reserves. Ecosystem science is the study of interrelationships among living organisms, physical features, biogeochemical processes, natural phenomena, and human activities. Ecosystem-based management approaches are required to link natural and social-economic systems to support resource management. NCCOS will continue to advance ecosystem science by using innovative technologies and ecological modeling to develop products that support coastal managers.

The Ecosystem Science priority is broad due to the complex nature and geographic extent of coastal ecosystems and the myriad dynamic natural resource conservation issues. As a result, NCCOS has developed four sub-priority focal areas of importance to managers. These are:

- Marine Spatial Planning (MSP),
- Habitat Mapping,
- Biogeographic/Ecological Assessments and Research, and
- Monitoring and Research in Coral Reef Ecosystems.

Coral ecosystems are called out given NCCOS's investments in corals and NCCOS's significant role in executing research supported by NOAA's Coral Reef Conservation (CRCP) and Deep Sea Coral Research and Technology Programs.

MSP is a process of analyzing and allocating the spatial and temporal distribution of human activities to balance ecological, economic, and social objectives for specific locations. The other three sub-priorities, and other parts of the NCCOS science portfolio, support the tenets of MSP and many other key aspects that inform ecosystem-based management. NCCOS's habitat mapping uses a suite of remote sensing technologies to acquire acoustic and optical data to develop digital species distributions and habitat maps. In addition, various technologies are used to assess and map ecosystem conditions, such as impacts of coastal pollution and location of marine debris. Defining the conditions of coastal environments and locations of human use activities, enables ocean industries (e.g., aquaculture, wind energy), regulators, and conservation planners to come together using common and authoritative data and information to make comprehensive MSP decisions.

Biogeographic assessments and research examine the spatial and temporal distributions of organisms, habitats, and the historical and biological factors that produce ecological patterns.

Ecological assessments and research are more broad-based activities and range from defining the status of ecosystem components to determine baseline conditions to detecting change in those conditions over time. NCCOS's ecosystem science portfolio includes defining boundaries and evaluating the efficacy of marine protected areas (MPAs) (e.g., NOAA National Marine Sanctuaries) based on species home ranges and habitat use patterns (e.g., animal acoustic telemetry) and ecological connectivity research (e.g., larval transport and post-recruitment spillover, and marine mammal health assessments).

NCCOS is a major contributor to NOAA's CRCP's portfolio, serving the science needs of U.S. states and territories with corals. We conduct a suite of natural and social science investigations, including determining the impact of pollution and diseases on coral reef ecosystems, restoration science, and increasing our overall understanding of reef ecology. NCCOS continues to lead components of CRCP's National Coral Reef Monitoring Program, including monitoring of reef fishes, habitats, and understanding people's perceptions and uses of coral ecosystems. NCCOS is an active partner with the Deep Sea Coral Research and Technology Program through our scientific leadership of regional initiatives, participation in field expeditions, contributions to research projects, and work in our laboratories to understand the biology and ecology of deep sea corals and their vulnerability to environmental stressors.

Given NCCOS's role to support the science needs of NOS, over the next five years, our research portfolio will include MPA assessments, coastal community and habitat vulnerability assessments, understanding habitat and ecosystem connectivity, mesophotic and deep coral research, predicting climate-related changes in species distributions and connectivity, and conducting science to support coastal resiliency and habitat restoration.

Habitat mapping products will continue to advance the use of machine learning techniques and artificial intelligence to increase the accuracy and efficiency in producing habitat maps. Many aspects of biogeographic and ecological assessments, research, and monitoring will continue to evolve, including advanced ecosystem models to forecast potential results of alternative management decisions. We will use new technologies for data collection to define the status and trends in conditions of coastal ecosystems. This will result in "big data" and analytics (e.g., imagery) requiring increased investments in data management. NCCOS will enhance our remote sensing capabilities through use of uncrewed systems (e.g., satellites, gliders, and drones) to monitor pelagic and benthic environments and evaluate habitat restoration activities. As part of NOAA's Natural Resource Damage Assessment (NRDA) response to the Deepwater Horizon oil spill, NCCOS has a significant role to map and restore mesophotic and deep benthic communities and support other science and restoration efforts associated with NRDA investigations.

Developing and Implementing Advanced Observation Technologies and Ecological Forecasts

Harmful algal blooms (HABs), hypoxia, and pathogens have major impacts on coastal and Great Lakes ecosystems and communities, and pose risks to economies, public health, and coastal resources, including protected wildlife. Climate change (e.g., sea level rise, warming oceans, extreme temperatures, changing precipitation patterns), coastal development and other environmental stressors, such as chemical contaminants, ocean acidification, and hypoxia, also drive coastal habitat and ecosystem changes that impact coastal communities. The delivery of timely, relevant, and actionable information and forecasts, allows coastal resource managers, public health officers, emergency officials, and the public to mitigate impacts to coastal ecosystems and communities.

Ecological forecasting is an interdisciplinary science capability that relies on observation technologies, the data they provide, and models to make predictions about ecological processes (i.e., the interrelationships among living organisms, physical features, biochemical processes, environmental drivers, natural phenomena, and human activities) and their impacts on people, economies, and communities. NCCOS is a leader in developing and providing ecological forecast products for HABs, hypoxia, pathogens, and coastal habitats to federal, state, tribal, local, and territorial authorities, as well as to the public, so that they can make decisions that protect and support thriving coastal economies, communities, and ecosystems.
For FY22–FY26, NCCOS will strengthen its capability to predict where, when, magnitude/severity, and socioeconomic impacts of HABs, hypoxia, pathogens, and coastal habitat changes (which also determine the abundance and distribution of species) on coastal ecosystems, communities, and economies by investing in:

- Developing and using models that integrate a more diverse set of data (e.g., biological, physical, chemical, environmental, socioeconomic, spatial, temporal, etc.);
- Using advanced observation platforms such as satellites, uncrewed systems, and field-portable devices;
- Developing and deploying more capable and cost-effective passive and active sensors that deliver real-time data at finer spatial and temporal resolutions;
- Reducing the time between data collection and processing to make data available for use in early warning systems and forecasts;
- Increasing the accuracy and extending the time period covered by forecasts;
- Expanding forecasting and observing capabilities to serve new regions and addressing emerging ecological concerns; and
- Integrating models (e.g., HAB, ocean acidification, hypoxia, pathogen, climate, biogeochemical, habitat, and socioeconomic models) that individually capture sub-components of coastal ecosystems and communities, but once linked and working together will deliver more comprehensive, powerful, and useful ecological forecasts.

Investing in our People and Achieving Organizational Excellence
Our commitment to our people and organizational excellence (i.e., standards, procedures, and practices for ensuring the effective use and management of our resources and assets and the motivation of staff to exceed expectations) ensures the successful delivery of scientific products and services of the highest quality. NCCOS applies innovative approaches to both research and science support functions and our staff, because their in-depth expertise and willingness to collaborate and contribute are sought after by a broad range of stakeholders and partners.

Our response to current and future environmental challenges, and our goal of supporting NOAA's mission and the U.S. economy, require strategic investments in our scientific portfolio in a holistic and systemic manner and the implementation of innovative recruitment strategies to meet diversity goals. With our commitment to training staff and modernizing our facilities and information technology (IT) infrastructure, we will ensure that we have staff, facilities (including research equipment), and an IT infrastructure with capabilities that will allow us to adapt and excel in meeting existing and emerging research and operational challenges. In the next five years, NCCOS will use its newly developed Strategic Workforce Plan to recruit and retain a workforce that reflects America's diverse population and cultivate an innovative culture in both the scientific and operational/business sides of NCCOS.

Resources include, but are not limited to, people, funding, facilities, and time. We will align and manage our resources with our scientific priorities through improved communication and a programmatic approach to funding research activities that are aligned with the NCCOS Strategic Plan. Investments in laboratories and facilities will be guided by a new Facilities Assessment Plan, and we will operate and manage our facilities as scientific assets in cooperation with co-located federal, state, and university partners. Safety, environmental stewardship, and security will be hallmarks of our facility operations.

We will expand our partnerships and strengthen our stakeholder engagement activities to improve our scientific capabilities and ensure that we are meeting the needs of coastal decision makers and the public. Increasing the diversity of the federal NCCOS workforce has begun with early career researchers through Special Hiring Authorities in the STEM disciplines. We will increase our ability to quickly and effectively respond to changing and emerging coastal environmental challenges by improving our business practices, in areas such as optimizing agreements with coastal managers and the extramural scientific research community, and by increasing resource sharing. NCCOS scientists and staff will provide support, guidance, and expertise to achieve cooperation and collaboration on scientific research with our partners.

NCCOS is committed to communicating our science activities, findings, and products to the public, stakeholders, partners, NOAA leadership, and Congress. We will apply our expertise to inform coastal planning and management, federal policy and legislation, the scientific community, and the public (through social and traditional media). A cohesive communication effort is critical to develop consistent communication and outreach products for social and traditional media, web, internal and external information sharing as well as gathering input from public, stakeholders and partners to identify gaps in our efforts, identify opportunities, and ensure alignment with their ongoing or changing needs.

Internal And External Science: A Dual Model For Science Delivery
NCCOS uses a dual model for science delivery to coastal managers. Substantive internal science capacity is complemented by competitive external funding programs that use the expertise of scientists from across the country, including NCCOS scientists. NCCOS has over 200 active projects involving hundreds of internal and external scientists who actively engage with stakeholders to provide actionable coastal science products. While operated separately to

maintain the competitiveness of external programs, these projects allow NCCOS science to cover a diverse portfolio in communities across every coastal state and territory. For example, NCCOS maintains a suite of capabilities that are available to assist state, local, and other partners in responding to harmful algal bloom events. These capabilities include direct funding support through the Event Response program, bloom forecast products, and analytical toxin detection services.

APPENDIX E: FY 2021-2026 Habitat Mapping Team Programmatic Plan

The full PDF document for the FY 2021-2026 Habitat Mapping Team Programmatic Plan can be found at this link.

APPENDIX F: Review Session Presentations

The following slides include all presentations for the review, including the sessions and supplemental information.

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

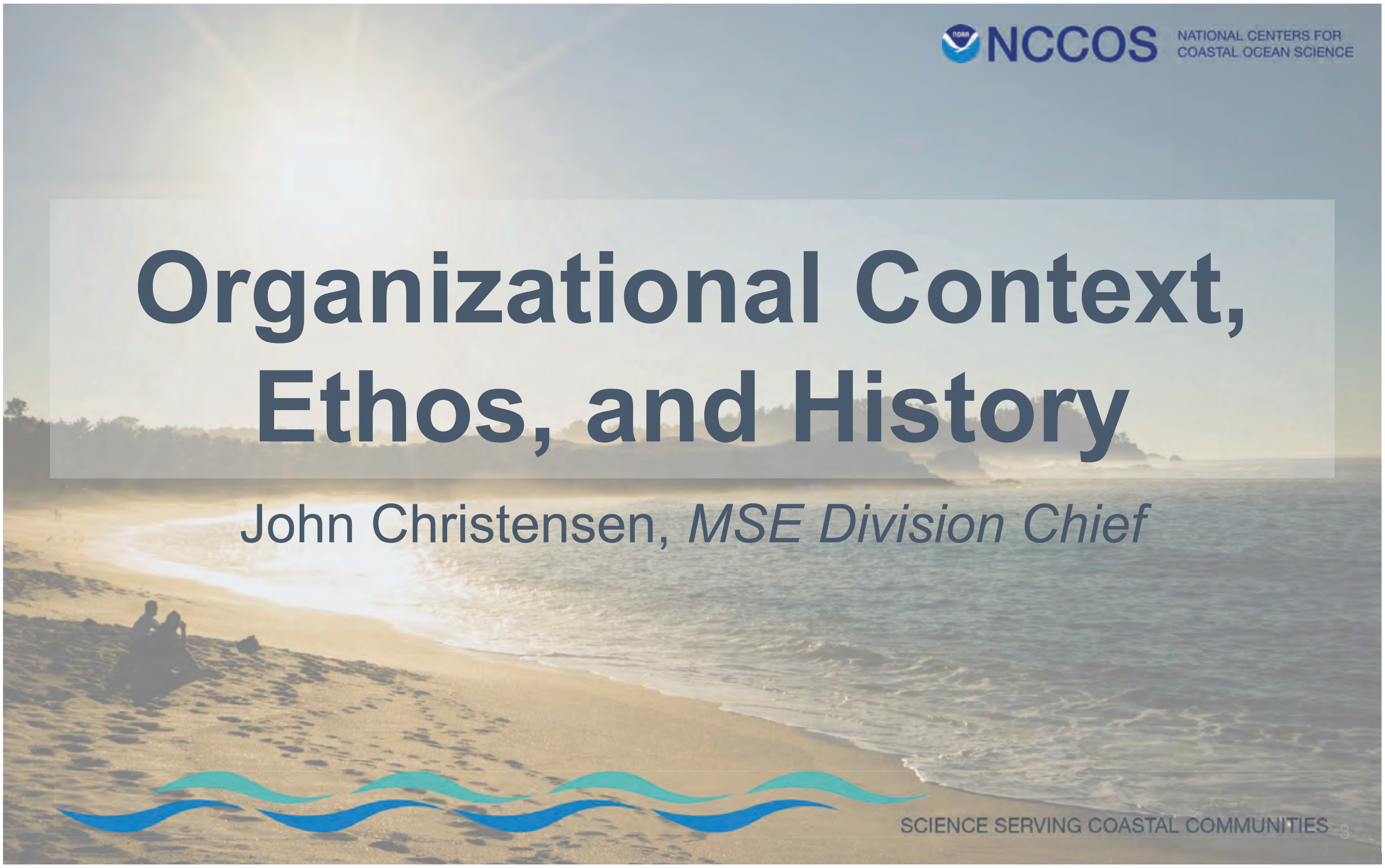
NCCOS Annual Science Review: Habitat Mapping and Characterization

Silver Spring, Maryland
22-23 October, 2024

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

Welcome

Sean Corsen, NCCOS Director


NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE
Organizational Context, Ethos, and History
John Christensen, *MSE Division Chief*
SCIENCE SERVING COASTAL COMMUNITIES
3


NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE
NOAA
Marine & Aviation
Fisheries
Research
National Ocean Service
Weather
Satellites
NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE
Ecosystem Science
Ecological Forecasting
Environmental Stressors
Coastal Resilience & Adaptation
Social Science
4

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

Organizational Structure

Staffing
- 137 Feds
- 125 Contractors/ Associates/ Commissioned

FY24 Enacted Budget
- **$54.8M** - Coastal Science Assessment, Response, and Restoration
- **$20M** - Competitive Research

Directorate

Program Coord. & Comms. | Restore Science Program

Business Mgmt. Division	Marine Spatial Ecology Division	Stressor Detection and Impacts Division	Competitive Research Program
IT Support Branch	Coastal Resilience and Restoration	HAB Monitoring & Reference	Harmful Algal Blooms
Resource Support Branch	Cooperative Oxford Laboratory	HAB Forecasting	Hypoxia
Admin. Support Branch	Kasitsna Bay Laboratory	Monitoring & Assessment	Sea Level Rise & Inundation
Facility Support Branch	Seascape Ecology & Analytics	Ecotoxicology	Regional Ecosystem Research
	Biogeography	Key Species & Bioinformatics	Ocean Acidification
			Ecosystem Connectivity
			Mesophotic Corals

Social Science | Spatial Planning

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

Our Core Values

Value #1 – We stand for scientific and professional integrity
- We conduct our business in accordance with the highest standard of professional behavior and ethics.
- We conduct our science in a manner that ensures objectivity, reproducibility, and accessibility of data and freedom of scientific expression.

Value #2 – We serve the American people by making a difference in all we do
- We strive to contribute to a sustainable, healthy coastal environment that strengthens communities and ecosystems.
- We maintain a strong fiduciary responsibility and utilize our resources intelligently and with purpose.

Value #3 – We value people and embrace diversity
- We appreciate the perspectives, attributes, and contributions of staff, colleagues, partners, and stakeholders.
- We treat everyone with respect, civility, and dignity and actively create an inclusive, supportive, and welcoming workplace.
- We support a healthy work-life balance.

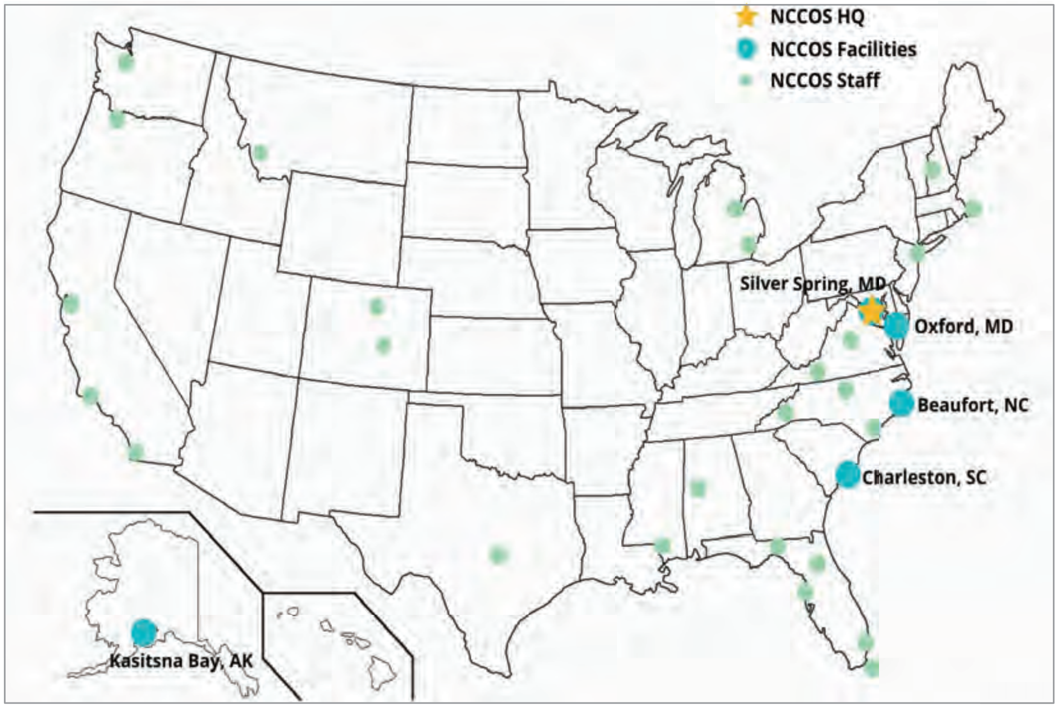
Where We Work

Science office in NOAA's National Ocean Service

- Created in 1999 as the focal point for NOAA's coastal ocean science

Staffing & Facilities

- HQ in Silver Spring
- 4 NCCOS Laboratories
- Staff nationwide



Habitat Mapping & Characterization

Informing Ocean Use Decisions

Wind Energy & Aquaculture Siting
How can we balance ocean uses with conservation?

Mapping & Characterizing Habitat
How can we best observe and predict living resource distribution?

Sanctuary Designation & Boundary Expansion
Where should NOAA place new Sanctuaries? How should we change existing Sanctuary boundaries?

Informing Fisheries Management Council Decisions
Where and how should we protect marine resources?

A Brief History

1999
NCCOS established

2000
NOAA Coral Reef Conservation Program established, shallow water (<30m) coral reef ecosystem mapping begins

2008
Moderate depth (30-60m) coral reef ecosystem mapping begins

2012
Completed Shallow Water Coral Ecosystem Mapping & Characterization of U.S. States, Territories and Commonwealths

2015
Mapping prioritization process & tool developed and deployed in Pacific Northwest

2021
First Unmanned Underwater Vehicles Delivered and Tested for Mid- to Deepwater Mapping

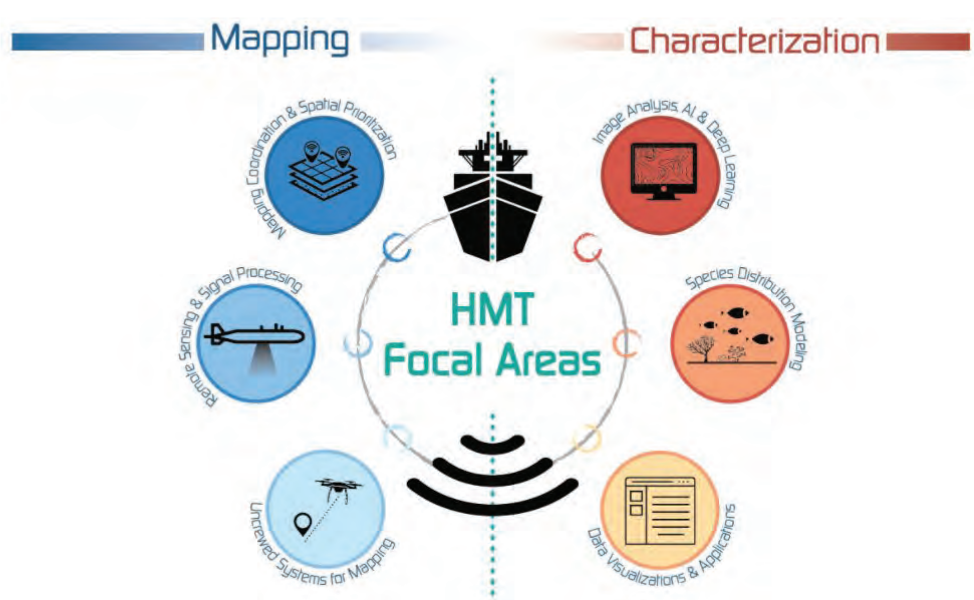
2022
Mapping prioritization process & tool developed and deployed in Pacific Northwest

2024
Seascape Ecology Branch Established

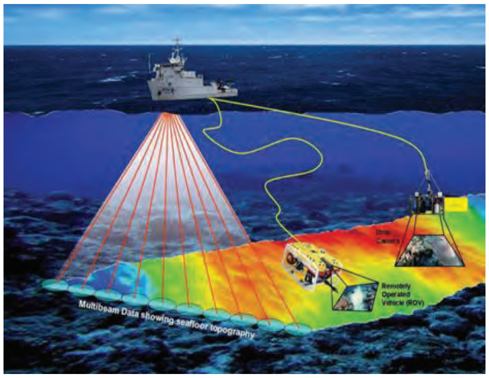
We are Here

Habitat Mapping & Characterization Goal

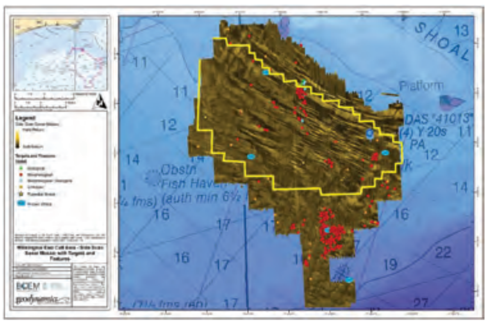
To provide cutting-edge spatial data on geology and seafloor habitats, and associated marine life for place-based ecosystem management

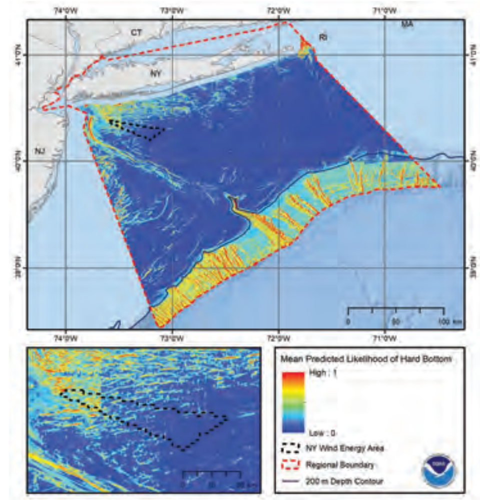


Case: Informing Offshore Wind Energy Development



Our seafloor maps helped BOEM refine **North Carolina, Oregon, Gulf of Mexico, and Gulf of Maine** Wind Energy Areas

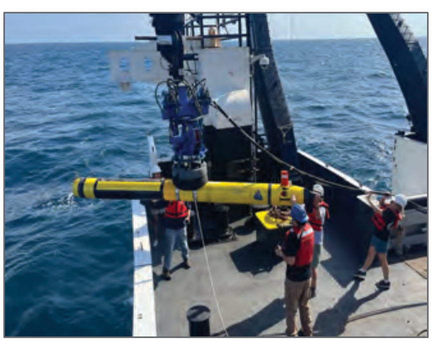




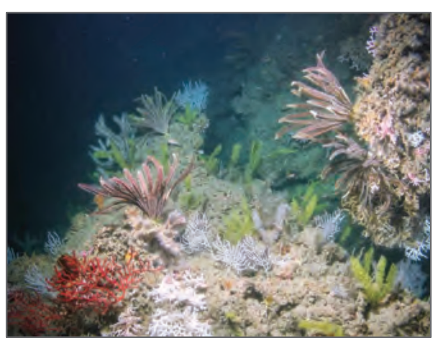
Our seafloor maps helped **NY State** identify new wind energy areas for Wind Master Plan to achieve 50% renewables by 2030

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

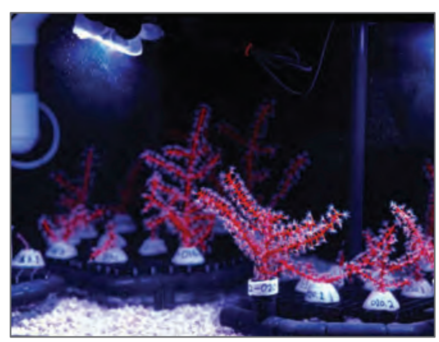
Case: Deepwater Horizon Natural Resource Damage Assessment & Restoration ($105M over 8 years)



Mapping, Ground-truthing, & Predictive Habitat Modeling



Habitat Assessment and Evaluation



Coral Propagation Technique Development

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Helpful Links

Habitat Mapping

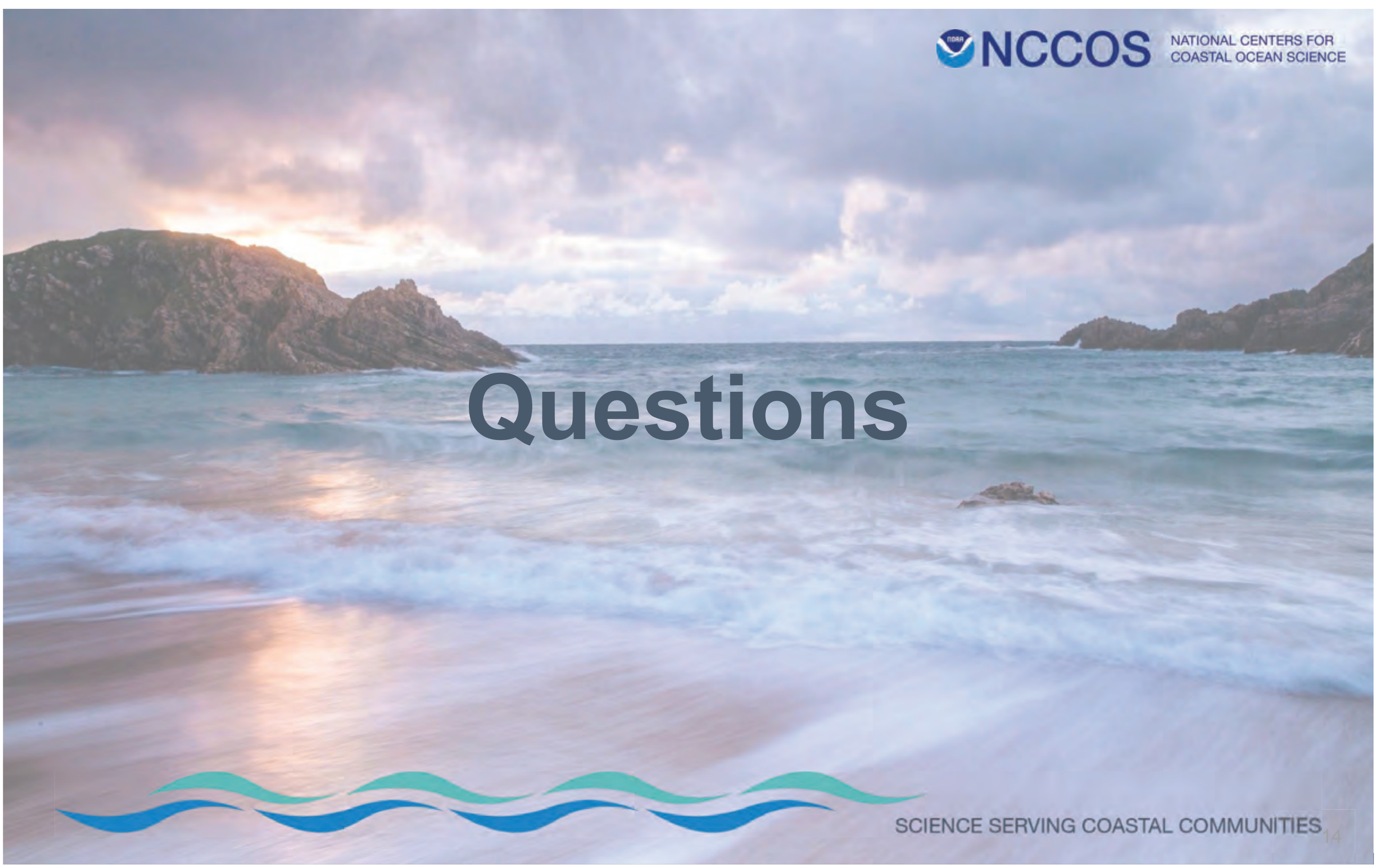
- Mapping Coordination and Prioritization [LINK]
- Remote Sensing & Signal Processing [LINK]
- Uncrewed Systems [LINK]

Habitat Characterization

- Image Analysis, Artificial Intelligence [LINK]
- Predictive Modeling [LINK]
- Data Visualization [LINK]

NCCOS

- Office Strategic Priorities [LINK]
- Coastal & Marine Planning [LINK]
- Social Sciences [LINK]
- Coral Reef Ecosystems [LINK]
- Ecosystem Restoration [LINK]
- Coastal Pollution [LINK]
- Climate Change [LINK]
- Harmful Algal Blooms [LINK]



NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

Overview of Feedback from 2019 Biogeography Review

Tim Battista, SEA Branch Chief

SCIENCE SERVING COASTAL COMMUNITIES

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

Overview

a. **Key and relevant recommendations from the 2019 Biogeography Program Review**

b. **Our strategy for addressing the recommendations**
   Formulating the Habitat Mapping "Team" Programmatic Plan
   Six Focal Areas
   Our Creed

c. **Where we are now**
   SEA Branch is born
   Building and Integrating New Focal Areas

d. **Conclusion**

2019 Program Review Panelists

- Captain Rick Brennan - NOAA Office of Coast Survey
- Dr. Caroline Rogers - US Geological Survey (USGS)
- Dr. Brad J. Blythe - Bureau of Ocean Energy Management (BOEM)
- Katrina Lassiter - Washington State Department of Natural Resources
- Jeff Donze - Environmental Systems Research Institute (ESRI)

Staffing & Succession

unattended
attending
complete

"There are vulnerabilities within the branch (GIS Application developer, data management) that should be monitored. I think it is a major concern that there is no in-house data manager for the Branch. I would strongly recommend that this position be developed and filled as quickly as possible"

"The program does not have a clear data management strategy, nor [appropriate personnel] to manage data. The program should think about long term stable funding for data management"

"Having more base-funded employees and activities would be preferable [to your model]. Innovation and new blood that arrives with short-term contract employees can provide flexibility, but these employees often leave, even very fulfilling jobs, for the security of a permanent position elsewhere."

Innovation & Methods

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unattended
attending
complete

There is a lot of great work being done by Biogeography Branch staff in methods and technology development. It may be wise to consider a small dedicated funding line for this purpose and to encourage staff to [innovate]"

"BioGEO staff and management should continue to seek ways to ensure that field surveys that are conducted are as cost effective as possible, and employ spatial analysis and field collection tools that are now available"

"There seems to be a significant opportunity to utilize unmanned systems and artificial intelligence (AI) to speed the processing and expand the area of coverage possible per day at sea"

Support

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unattended
attending
complete

"Ideally, there would be some discretionary funds to support new ideas arising from the employees themselves or from their collaborations with others."

"Given how innovative this team is, it would be helpful to build research and development into the job descriptions of key staff working on and with innovative technology and data integration."

Partnerships

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unattended
attending
complete

"There are significant synergies to be realized in the Mapping portfolio through a deeper partnership with Coast Survey (e.g. personnel, partnership on base-funded projects, training, hardware and software procurement, and research and development"

"Establishing an integrated connection with the research and conservation [and academic] communities could significantly strengthen your work"

"It may be beneficial for the program to improve partnerships across line offices in NOAA [and external to NOAA] to find funding efficiencies, avoid duplication, and broaden geographic reach"

Data & Tools

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unattended
attending
complete

"For the size and scale of the resources for outreach and website management, the program has done extremely well. It may be a consideration to [develop] web portals to convey data and products to both partners and the public (e.g. Digital Coast, or the NOAA Geoplatform). This may offer a more automated means to sharing of applications and information products"

"There is a growing community within NOAA that is providing their software code on GitHub so that it can be used, improved, and vetted within the open source community. If appropriate, NCCOS should consider posting this code on the NOAA [NCCOS] GITHUB page"

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Data Management & IT

unattended
attending
complete

"While the program has a strong foundation of science, investing in a more highly evolved data management [cloud processing] with support from IT to better manage the observation data and geospatial data will be important to keep in step with the increasing data and interests in the data"

"A review of best practices for data management for the program office given the scale and complexity of data would be recommended"

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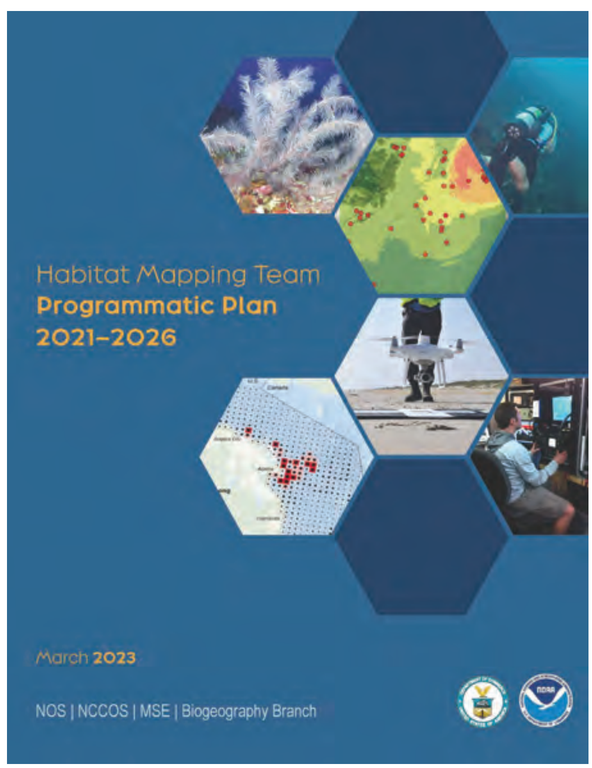
Programmatic Plan

NCCOS Habitat Mapping Portfolio Goal:

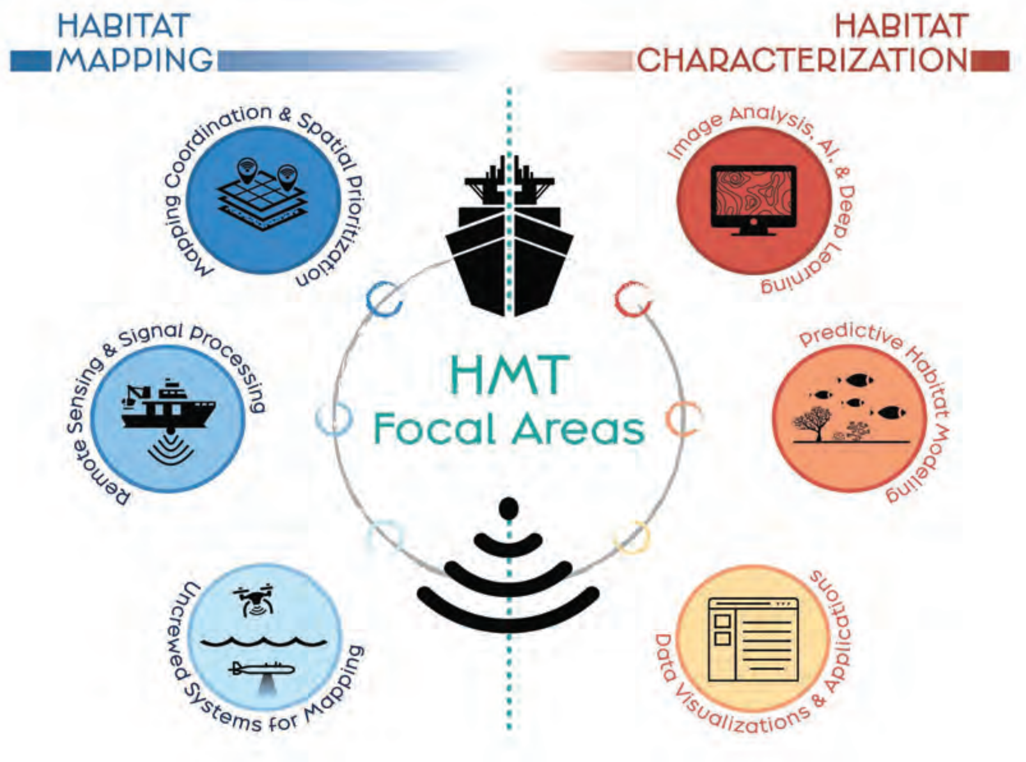
To provide cutting-edge spatial products on the geology and seafloor habitats, and associated marine life for place-based ecosystem management.



Programmatic Plan 2021-2026

Focal Areas

Our success towards meeting the mission of NOAA and our partners is **predicated on our ability to remain agile in the rapidly evolving coastal intelligence community…** to continue as effective leaders and geospatial pioneers of innovative applied science.



Inter-Niche

[in ·ter - ‘nich] verb

1. The act of “filling and connecting” gaps created by other niches

---

Inter-niche approach **fills and connects gaps to provide integrated coastal, geospatial, and applied science solutions to resource managers** using existing and enhanced technology, application development, and visualization tools.

SEA Branch

- **Seascape Ecology and Analytics Branch** was constituted April 2024
  - SEA Branch Planning workshop in May 2024
  - New important components combined into the Branch construct:
    - Species Predictive Modeling
    - Climate Ecosystem Forecasting

- *Draft* **New** SEA Focal Areas
  - Habitat Mapping
  - Habitat Characterization
  - Data Management, Visualization, & Applications
  - Quantitative Spatial Ecology
  - Geospatial–Statistical Support & Collaboration

Conclusion

- recently formulated new branch
- inherently problem solvers
- still developing & scoping "where we want to be in the future"

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Questions

SCIENCE SERVING COASTAL COMMUNITIES

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Program Review Structure, Schedule, and Roles

Terry McTigue

SCIENCE SERVING COASTAL COMMUNITIES

Structure

- Lecture presentations and briefing book
  - 6 sessions covering specific habitat mapping programs
  - 4 presentations covering other aspects of NCCOS (budget, future work, history, and past reviews)
- Partner Attestation
  - 1.5 hour conversational panel
  - ~7 users or co-developers of our work on a panel to answer prepared discussion questions

Reviewers will develop observations, evaluation, and recommendations on different aspects of the portfolio and provide a written report after the review.

Schedule

Day 1	Day 2
Welcome, Introductions, Purpose, & Charge	Welcome Back
Organizational Context, History, & Ethos	Reflections
Overview of Feedback from 2019	"By the Numbers"
Program Review Structure, Schedule, & Roles	Species Predictive Modeling
Session Presentations 1-3	Partner Attestation (1.5 hours) **CLOSED***
Lunch	***Lunch***
Session Presentations 3-6	Overview of Report Format and Submission Process
Question/Answer	Executive Session (50 minutes) **CLOSED***
Executive Session (1.5 hours) **CLOSED***	Panel Presentation and Summary
	Final Remarks
	Panel Reception

*Closed sessions will only include the review panel and select members of the planning team.

Roles

Planning Team: Tim Battista, John Christensen,Terry McTigue (*Facilitator*), Josie Galloway, Max Brown

Session Leads: Charlie Menza, Ed Sweeney, Chris Taylor, Jordan Pierce, Bryan Costa, Asmita Shukla, Matt Poti

Review Panel: Brandon Krumwiede, *NOAA OCM* (*Chair*); Jason Fahy, *URI/ OECI*; Dave Bernstein, *NV5*; Pete Esselman, *USGS GLSC*; Ashley Chappell, *DOT CMTS*

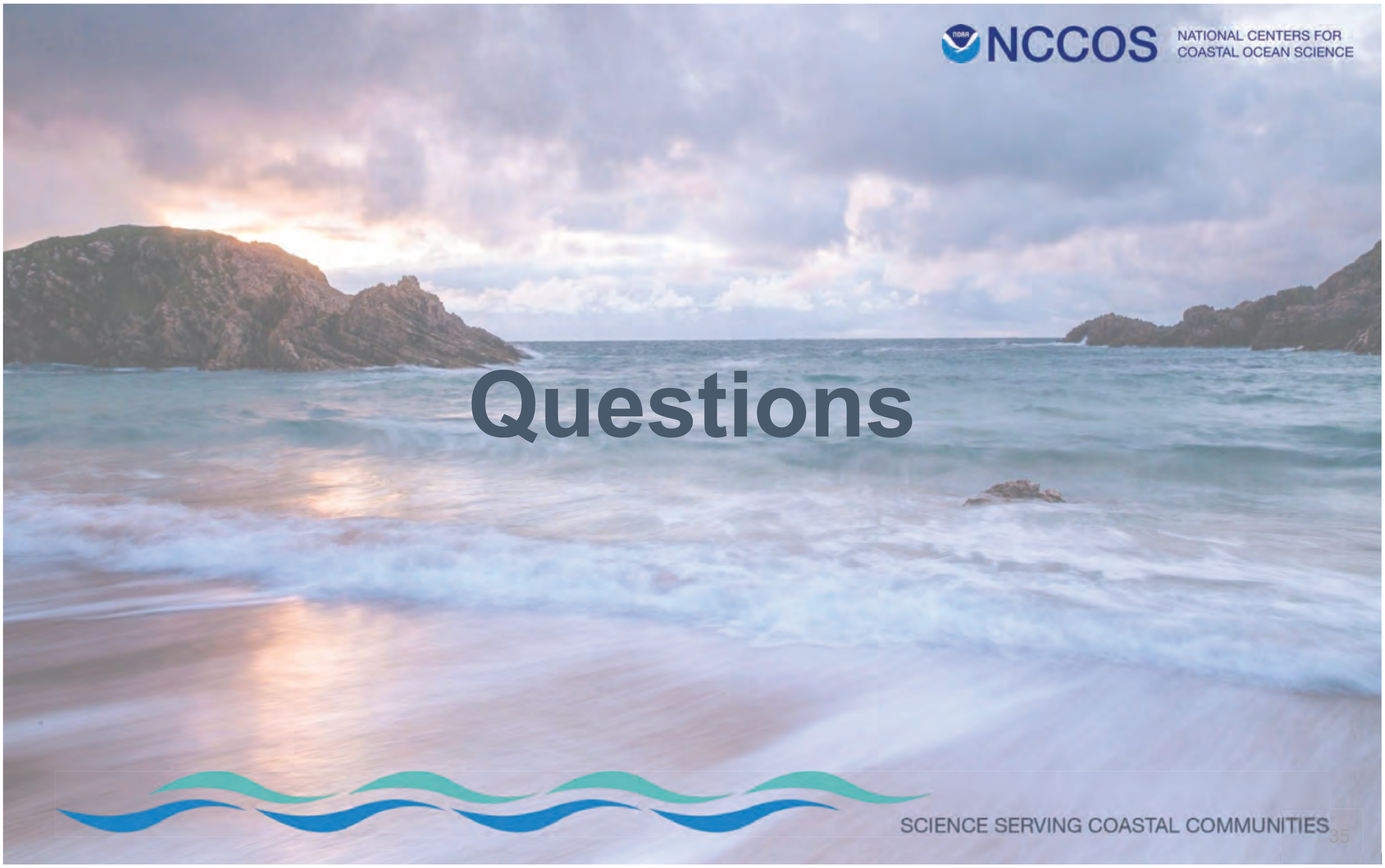
Participants: Others online or in the room that are mainly in "listening mode" to learn more about our program.

Group Norms

- Participate actively.
- Listen deeply.
- Ask questions to increase understanding.
- Share your perspective.
- Disagree without being disagreeable.
- Maintain confidentiality.

Online Participants:

- To respect the facilitator and your fellow participants, please mute yourselves when you are not speaking.
- Review panel questions will be prioritized during Q&A, but we will do our best to get to all questions.


NCCOS
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Questions
SCIENCE SERVING COASTAL COMMUNITIES
35


NCCOS
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Mapping Coordination and Spatial Prioritizations
Charles Menza and Sarah Hile
SCIENCE SERVING COASTAL COMMUNITIES
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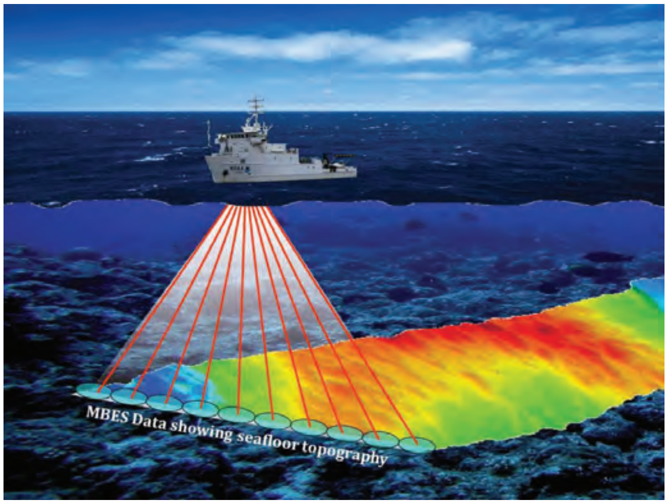
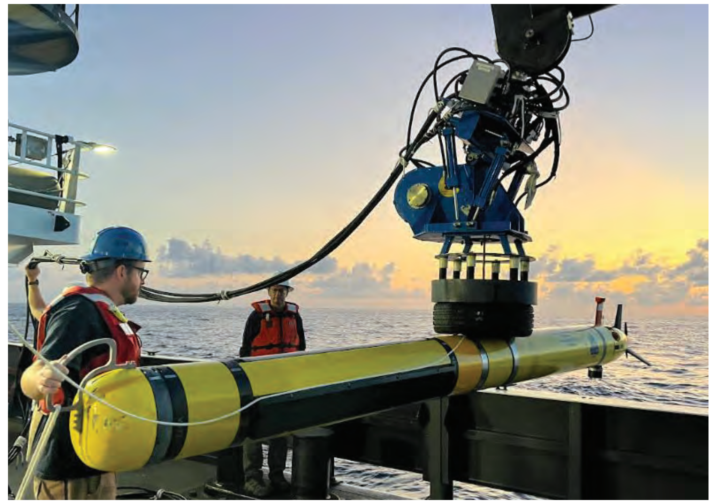
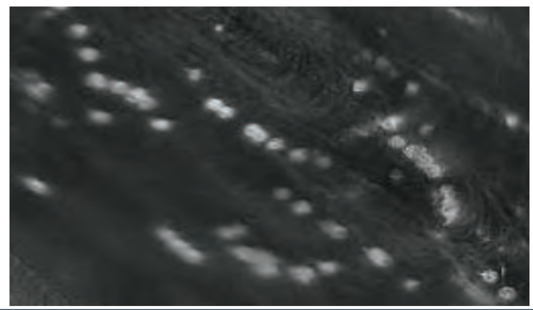
Overview







Strategy

Selected goals in the 2023 Programmatic Plan

2019 Program Review

GOAL 1:

Pursue innovative ways to advance coordination between and among coastal managers and researchers

- Continue to develop and refine the pGIS application to incorporate new technological advances in web applications and data sharing.
- Continue to identify additional agencies, partners, and regions that can benefit from prioritizations.

GOAL 2:

Increase HMT's recognition within NOAA and externally as a leading expert in planning, managing, and executing mapping campaigns at regional and local scales

- Develop new approaches to coordinate and strengthen mapping collaboration partnerships.
- Develop a platform for centralizing and disseminating NOAA benthic habitat mapping information and data.
- Execute prioritizations for all U.S. shallow coral reef ecosystem jurisdictions.
- Enhance the efficiency of broad -scale mapping initiatives in the Gulf of Mexico through the NRDA MDBC restoration settlement.

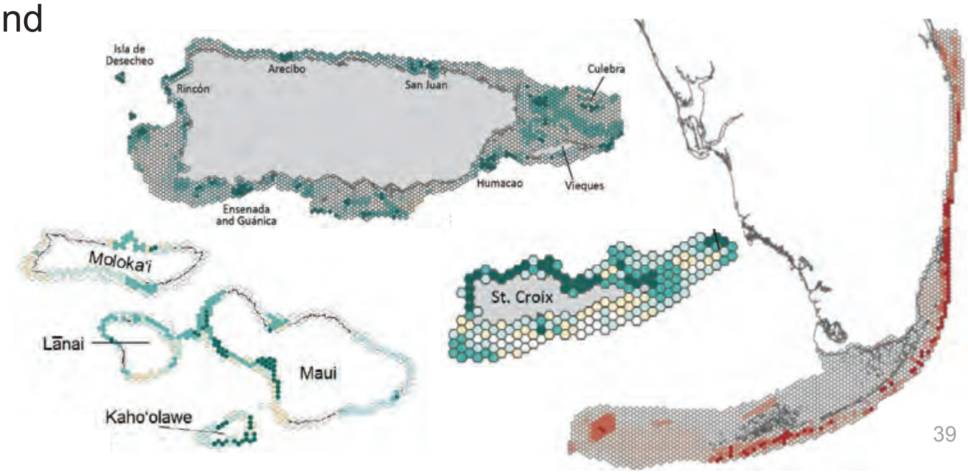
Case Study #1

Agency Priorities for Mapping Shallow Coral Reefs

Dates: October 2020 – May 2024
Funding: NOAA CRCP, NCCOS

Key Collaborators: CRCP and 50 participating groups

- 40% Federal
- 32% State/Territory
- 20% Academic
- 8% Other



Gaps in Mapping Data

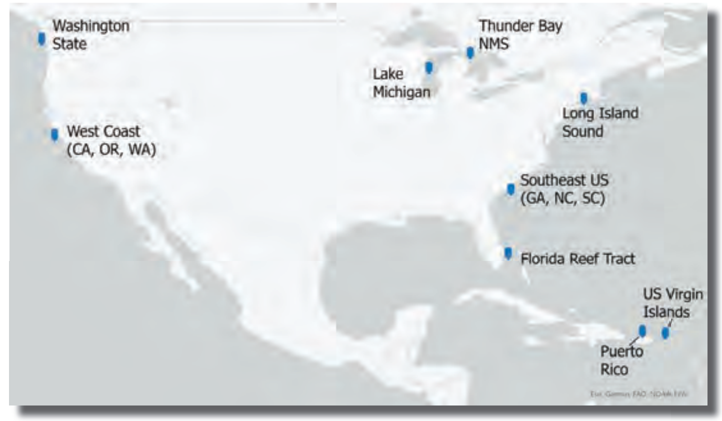
- Managers need data and tools to inform management decisions
- Need for assessing mapping requirements within jurisdictions
- Increased demand for mapping data at broader extents, finer resolutions
- Data collection/monitoring is expensive, time consuming, resource intensive
- Coral reef practitioners and managers leverage resources

Spatial Prioritizations

A way to gather mapping priorities from stakeholders in a study area

"Where" and "why" mapping data are needed

- Extensive experience
- Quantitative, objective, efficient, and systematic processes
- Identifies common research priorities and locations shared among partner organizations



➔ **NCCOS' Spatial Prioritization Widget**

Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- Inventory of existing mapping data - Data gaps in high priority areas - Data requirements: Management uses and map products - Online ArcGIS Hub - Jurisdictional Technical Memorandum	Identify potential mapping projects and partnering organizations - NOAA CRCP - Federal, State/Territory, Academic, Other (NGOs)
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
NOAA Coral Reef Conservation Program (CRCP)	*Status*: Complete *Next Steps*: Identification of priority locations for ESA coral recovery in the Indo-Pacific Region (U.S. Navy, Indo-Pacific Command)

Identify Needs

Management Uses
How will you use this data to inform coral reef management?

- Habitat Restoration
- Monitoring
- Coastal Vulnerability Planning
- Fisheries Management

Examples

\+

Map Product Requirements
What are your requirements for mapping data?

- Delineations of topographic features
- Delineations of substrate types
- Identification of coral spp & local environments

Examples

\+

Existing Map Data
Inventory of existing map data in shallow coral reef areas (40m)

\+

Prioritization Grid
Hexagon grid cells within 40 m contour

Input into Online Tool

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Engagement

Participants
CRCP and NCCOS generated a list of participants.

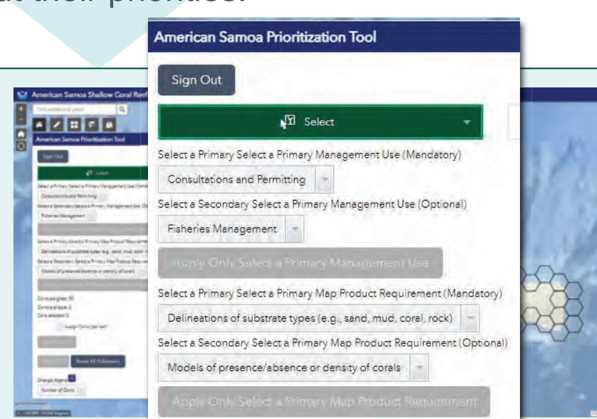
Communication
Began the participant engagement process

Prioritization
Participants allocated coins and input their priorities.

Results Webinar
Preliminary results presented.

Prioritization Widget – Online Tool

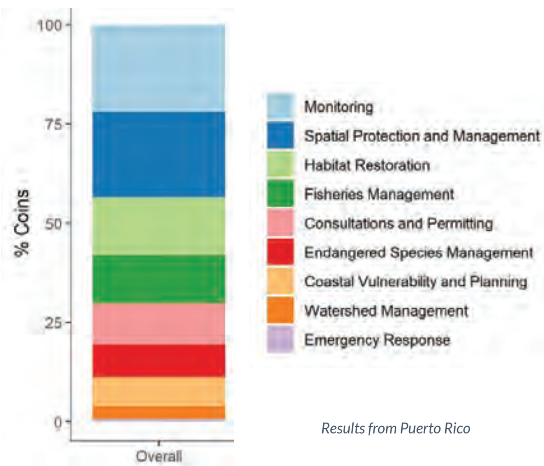
- **Participant driven**
  - ‘Spend coins’ indicating *when* and *where* data are needed
  - More coins input, more urgent data need is!
- **Customizable** with dropdown lists



Results – Summaries and Spatial Priorities

1) Summaries of % coins

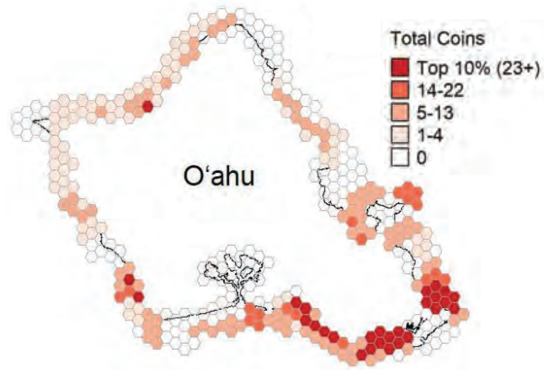
- Management Uses
- Map Product Requirements



Results from Puerto Rico

2) Spatial priorities

- Total # Coins
- Number of Groups
- Management Uses
- Map Product Requirements



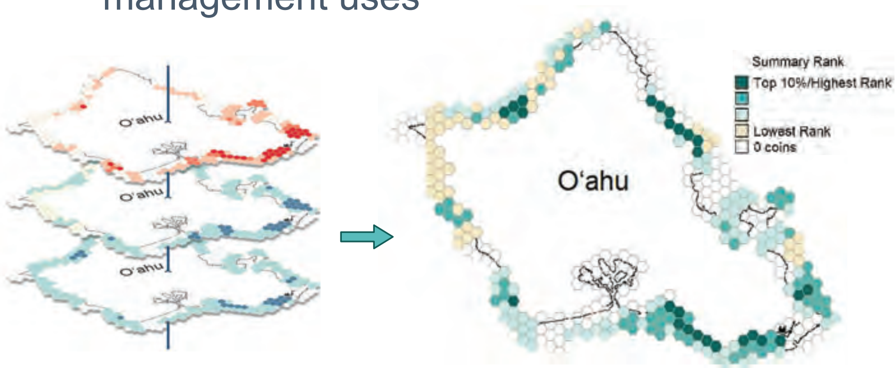
Identify Needs | Engagement | **Results**

Results – Focal Areas

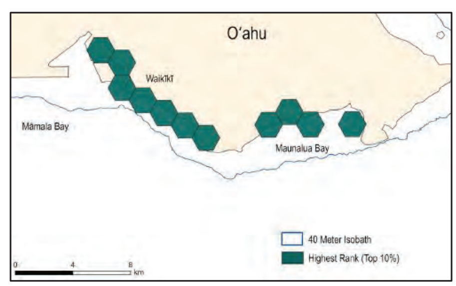
3) Identification of Focal Areas

Summary rank

- total coins, # of participants, # of management uses



- Adjacent Top 10% summary rank cells
- Highlight opportunities for collaboration



O ahu Focal Area (% coins)

Top Management Uses

Monitoring (46%)

Top Map Product Requirements

Substrate Type (39%)

ID of Coral Species (28%)

Identify Needs | Engagement | **Results**

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Products

✓ Mapping inventory

✓ Prioritization results

✓ Technical Memorandum

All available through NCCOS' online ArcGIS Hub

Identified Needs | Engagement | Results | **Products**

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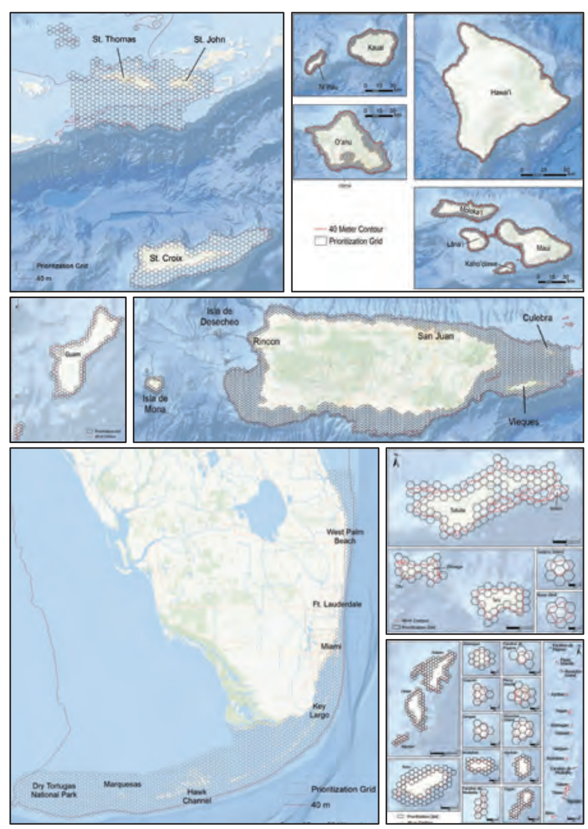
Lesson Learned

Successes

- Broad engagement
- Active engagement
- Potential collaborations
- Priorities identified, as well as focus areas

Challenges

- Prioritize participant engagement
- Reliance on local liaisons
- Priorities may shift over a short period of time
- Data collected has a timestamp
- Keeping up with recent data collections



Evaluation

Quality	Relevance	Performance
- Demonstrated the flexibility/scalability in the prioritization effort by customizing the tool according to client's needs - Inventory of mapping data in wide use - New map services to support future mapping work - Wide, but uneven engagement and collaboration	- Direct connection to over 50 coral reef managers - Co-development led to buy-in from stakeholders - Published reports and data provide information critical to prioritize planning	- Supports CRCP FY24–26 Implementation Planning - Informs the coral reef action plans under the Coral Reef Conservation Act Reauthorization - Upcoming project to map areas around CNMI based on needs identified through this prioritization - Map inventory has been used to reference existing data by NCCOS and partners - Data available on Seasketch for public

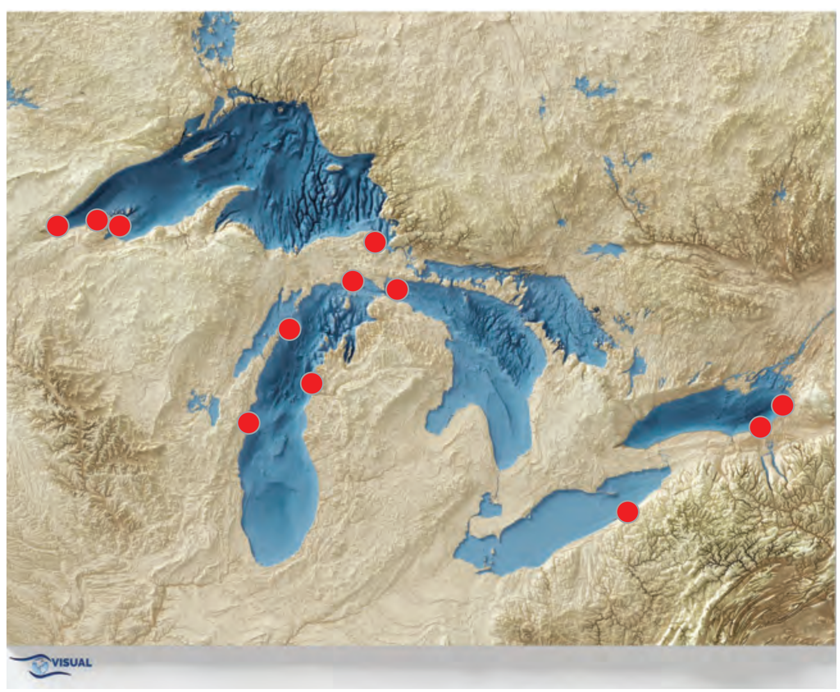
Case Study #2

Collaborative Benthic Habitat Mapping in nearshore waters of the Great Lakes

Key Partners: OCM, GLERL, ONMS, OCS, USGS, NPS, MTU

Timing: 2022-2026

Funding: $2.5 million GLRI



Collaborative Mapping

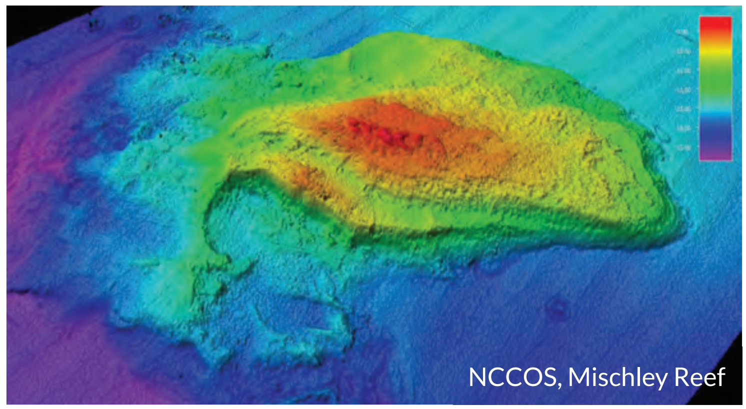
Benthic habitats degraded and stressed

Lakebed maps and characterizations are necessary to restore lake resources

Collaboration is critical

Quantity of data is challenging

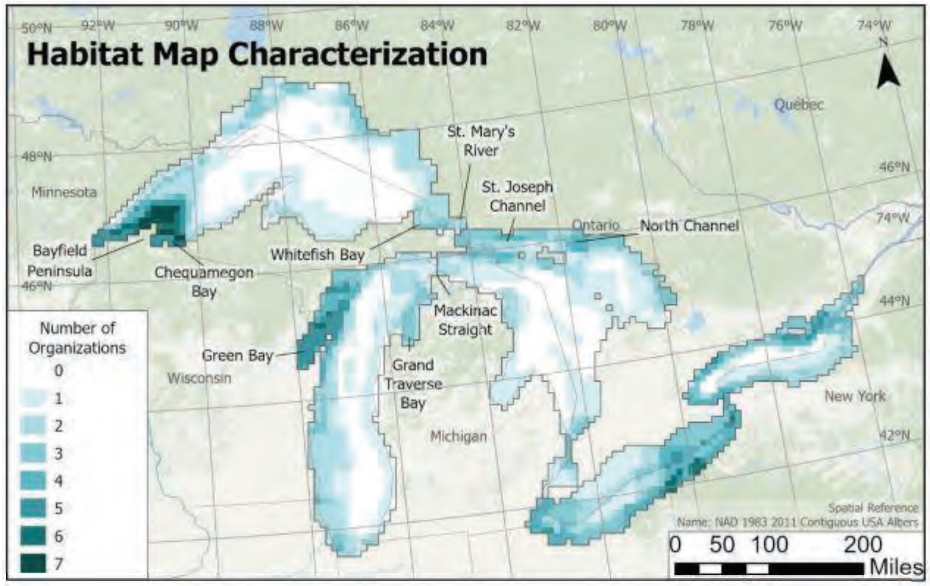

USFWS, Lake Trout


NCCOS, Mischley Reef

Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- Maps of key species and habitats - Enhanced regional mapping capacity - Leveraging of resources to fill data gaps - Clear requirements for habitat mapping products	- GL Restoration Initiative - Office of National Marine Sanctuaries - Nat'l Park Service - US Geological Survey - State natural resource mgmt agencies
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- NOAA: SEA, OCM, GLERL, ONMS, OCS - National Park Service, U.S. Geological Survey - Michigan Tech - CVision AI	- Requirements and workflows - Mapping capacity increased - Community of practice rooted - Proof-of-concept products delivered - Final products being worked on

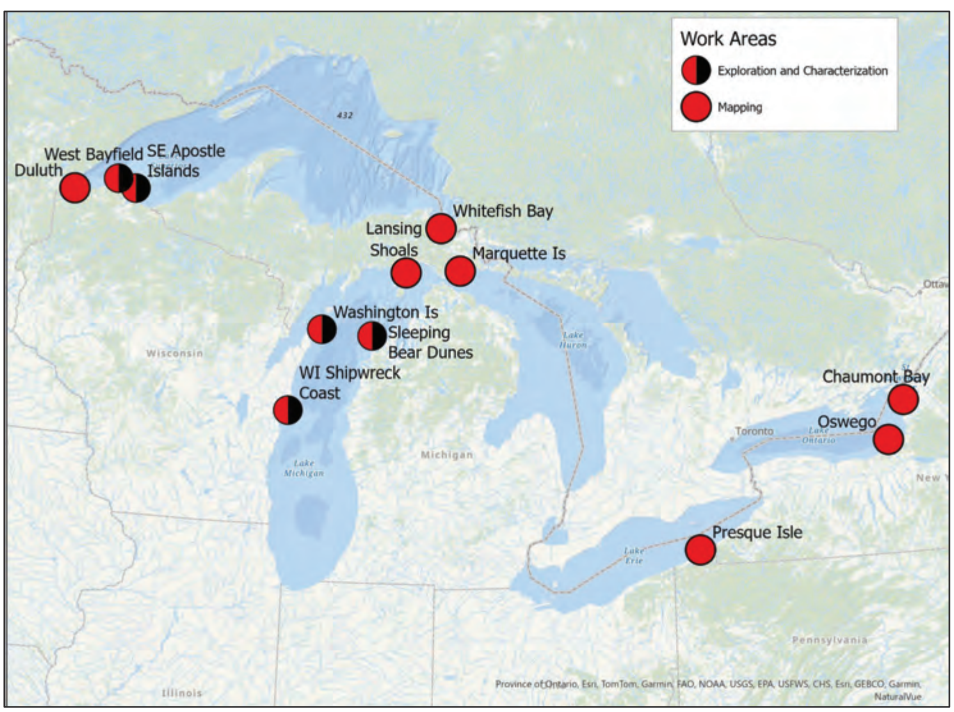
Spatial Prioritizations

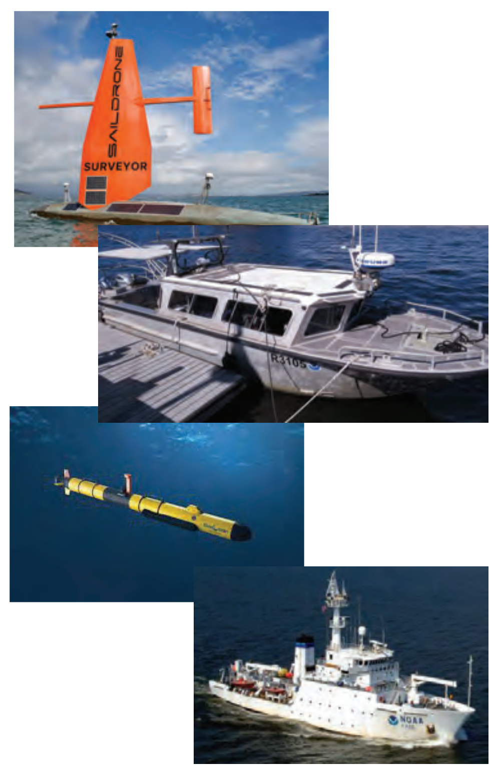
1. Thunder Bay
2. Wisconsin Shipwreck Coast
3. Great Lakes / Regional



Results from the Great Lakes spatial prioritization (Gouws 2022)

Mapping





Characterizations

Fostered robust partnerships and community of practice

Set goals to align effort (i.e. CMECS)

Divided labor to boost efficiency

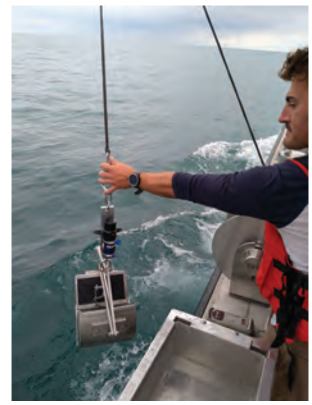
- GLERL - field work, operations
- USGS - AUV
- MTU - ROV
- Private Sector
- Bring in others

USGS

GLERL/NCCOS

Michigan Tech

GLERL

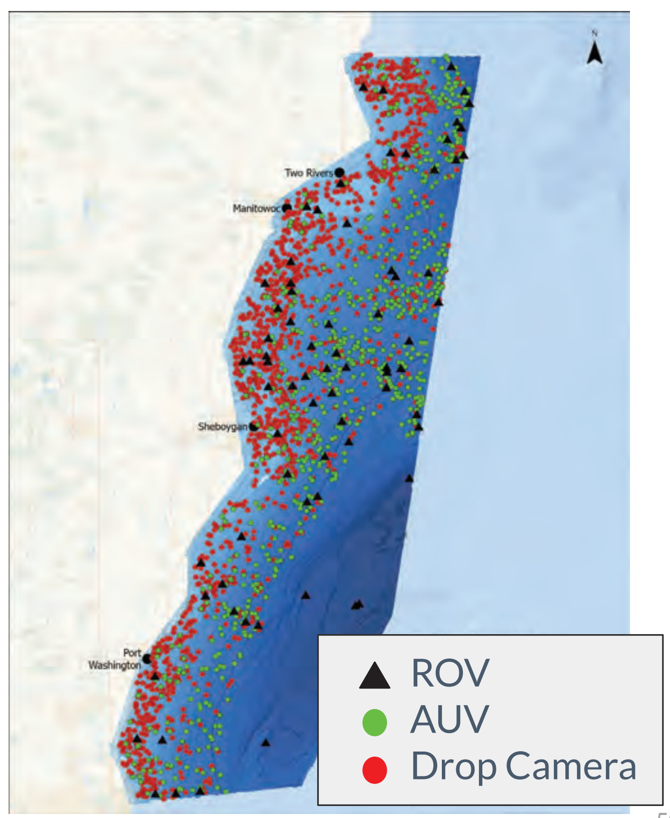


GLERL

Study Plan and Design

New design improved data collection

- Efficient capture of information
- Collaboration
- Acquisition by complementary platforms
- Nesting of predictive habitat models



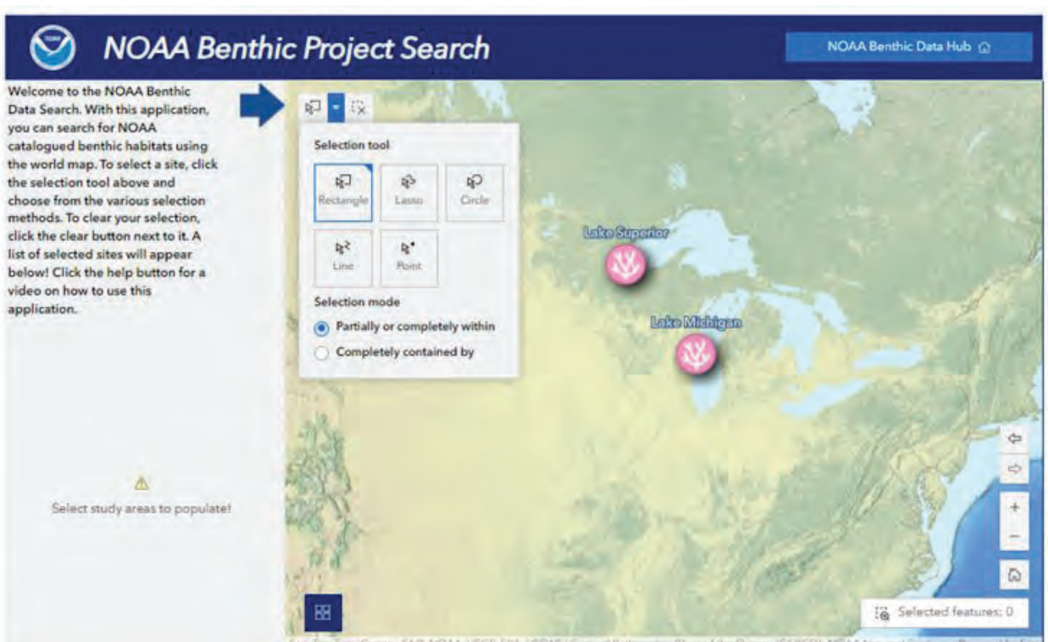
Collaborative Analysis

Analysis by a community of practice

- Standards - CMECS, resolution
- Web-based platform/TATOR
- Shared workflows and code

Data Delivery

1. NCEI
2. NOAA Library
3. Benthic Hub



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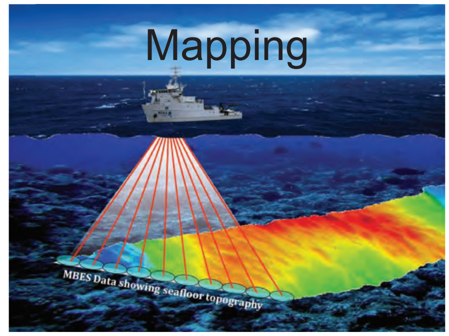
Lesson Learned

Successes

- Enhanced the efficiency of broad-scale benthic characterizations
- Strengthened technical partnerships
- Developed new characterization SOPs
- Modernized data management

Challenges

- Phasing mapping activities takes time
- Time requirements for tracking all moving pieces
- Connection between coastal researchers and managers



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Evaluation

Quality	Relevance	Performance
- NCCOS scientists are recognized as leaders in habitat mapping and characterizations - NCCOS conventions/ workflows in wide use - Identified novel sampling approach to capitalize on organizational specializations	- Key areas mapped and characterized with partners - Codevelopment of workflows and processes (i.e. AI tools for segmentation) - Harmonized benthic characterizations - Developed SOPs in the absence of standards	- Great Lakes mapping capacity increased (10X) - Increased coordination across federal agencies - Leveraged funding streams with other agencies - Supported lake herring management

Conclusion

NCCOS has unique capabilities to support coordination

Usefulness central tenet of NCCOS work

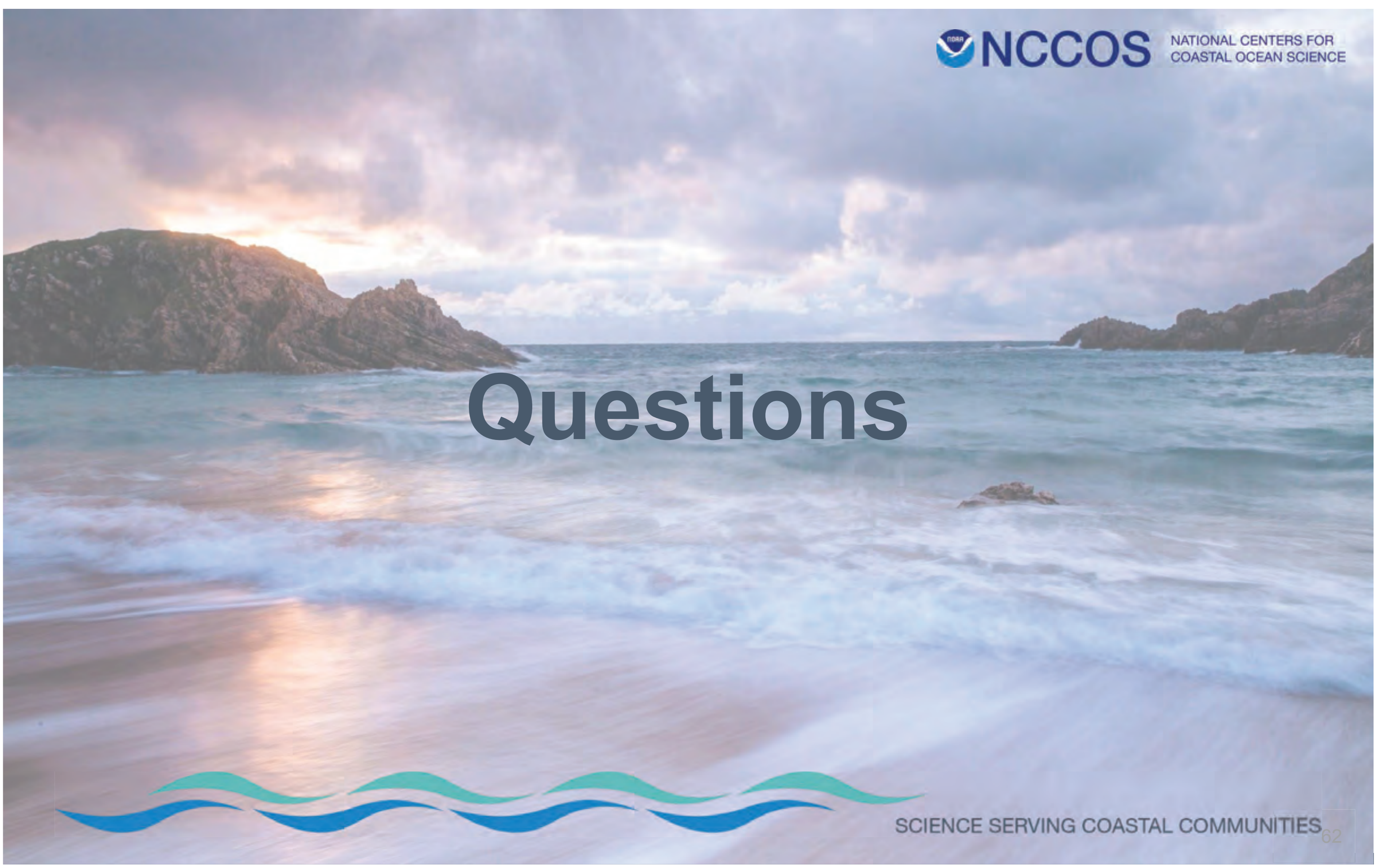
- Scale scope (simple to complex)
- Scale communication

Collaboration is critical

Quality, Efficiency and Timeliness important performance measures

Achieved goals developed in 2019

An example of multiple agencies coming together to collaborate on benthic mapping

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BREAK
Return by 10:50am
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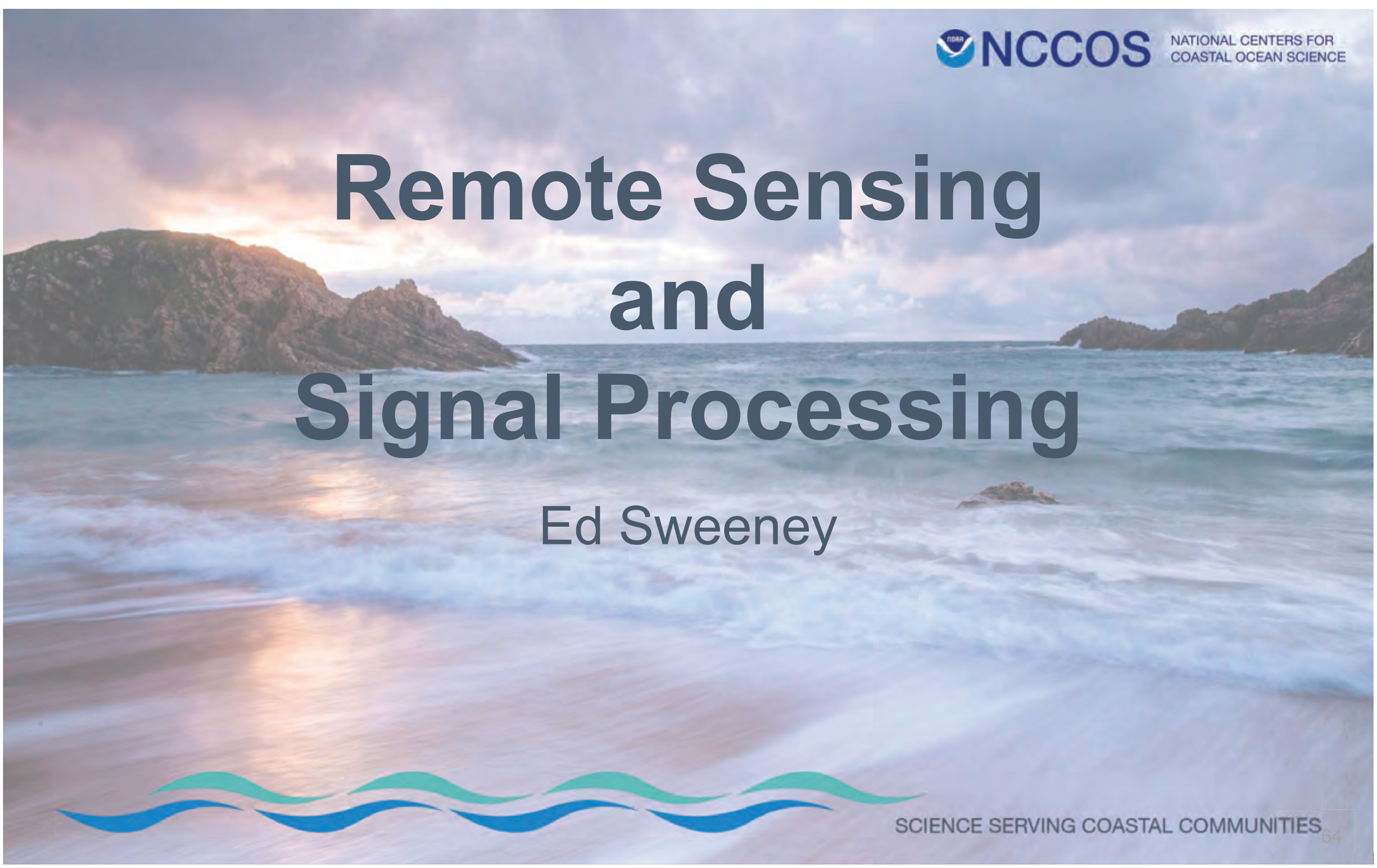
NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE
Remote Sensing
and
Signal Processing
Ed Sweeney
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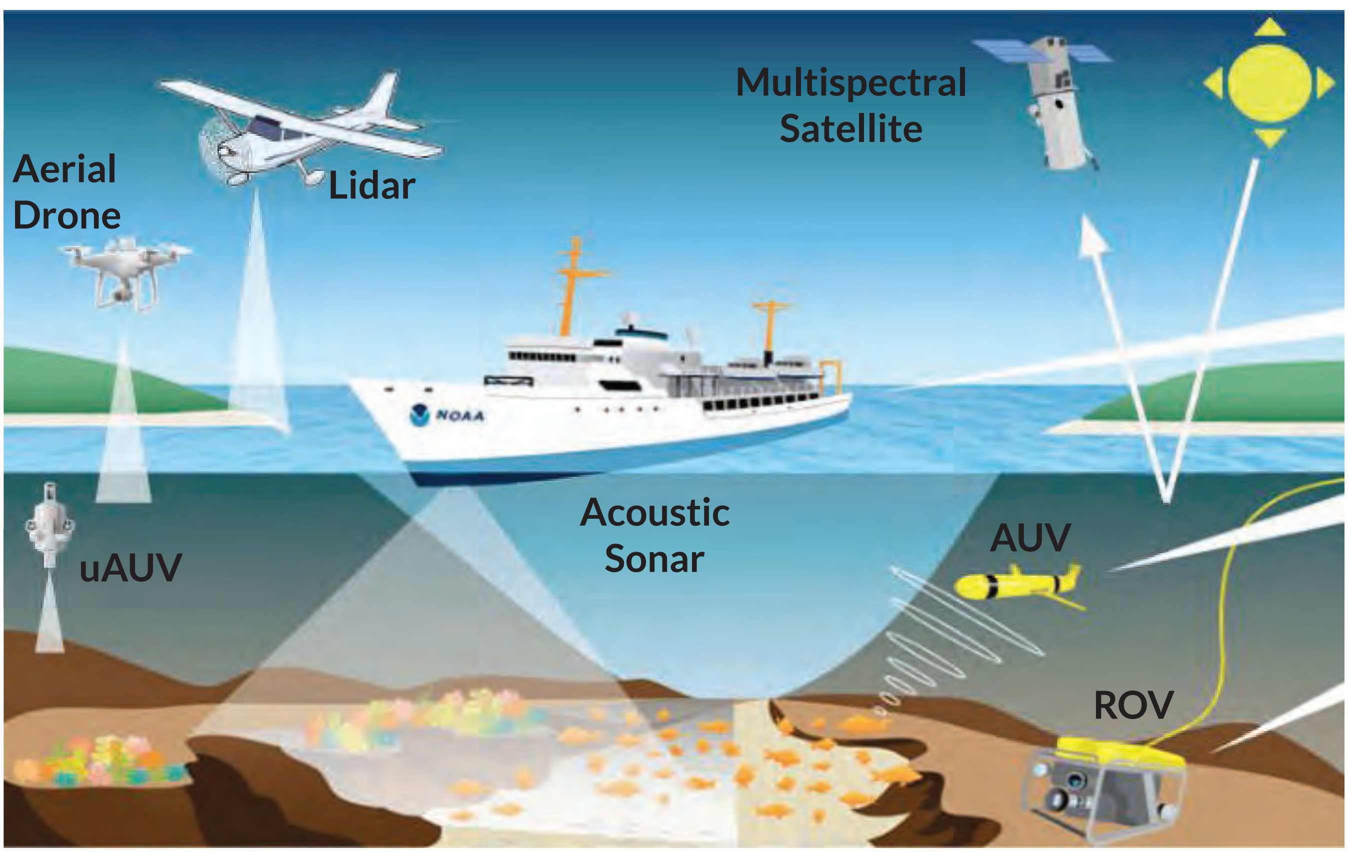
Overview

- What is **Remote Sensing**?
  - Acquiring information on a distant object or area
    - Examples: Satellites, drones, sonar, lidar, AUV/ROVs

Remote Sensing Overview

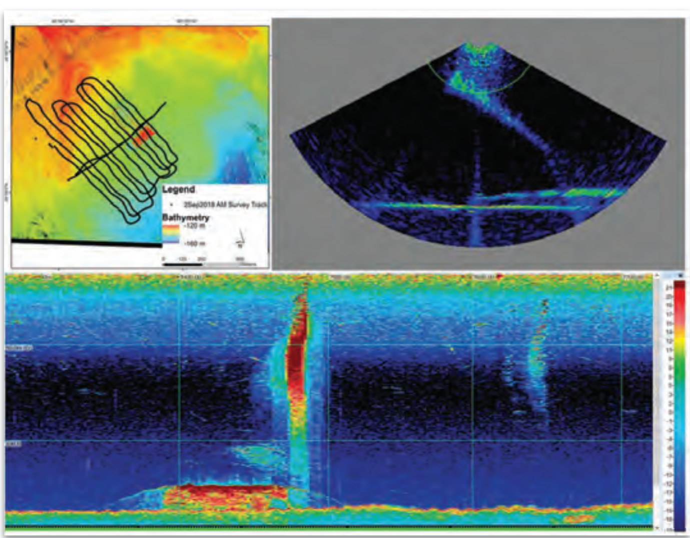


Overview

- What is **Remote Sensing**?
  - Acquiring information on a distant object or area
    - **Examples**: Satellites, drones, sonar, lidar, AUV/ROVs
- What is **Signal Processing**?
  - **Extraction** of signal information and **encoding** extracted signal with <u>meaning</u>*
    - **Examples**: Removing noise from backscatter data, 3D visualization point clouds, photo mosaicking

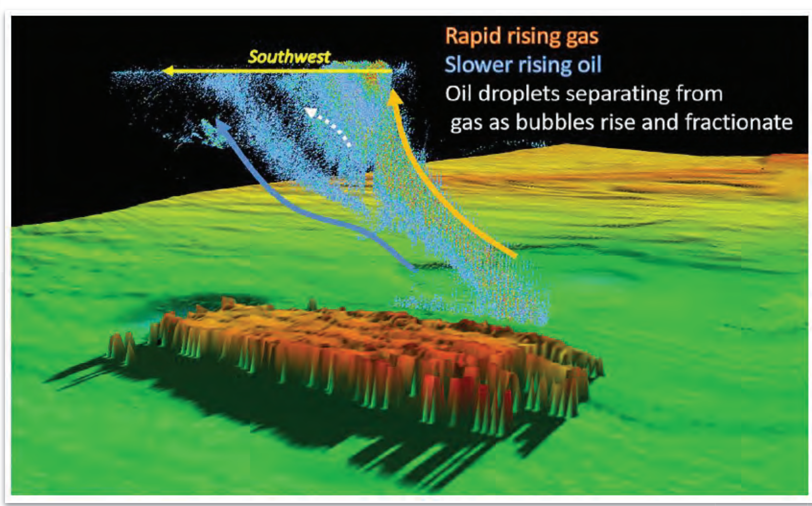
*Hartmann and Candy (2014)

Signal Processing - Gas Plume



Raw echosounder trace

Processed 3D visualization



Taylor and Boswell (2019)

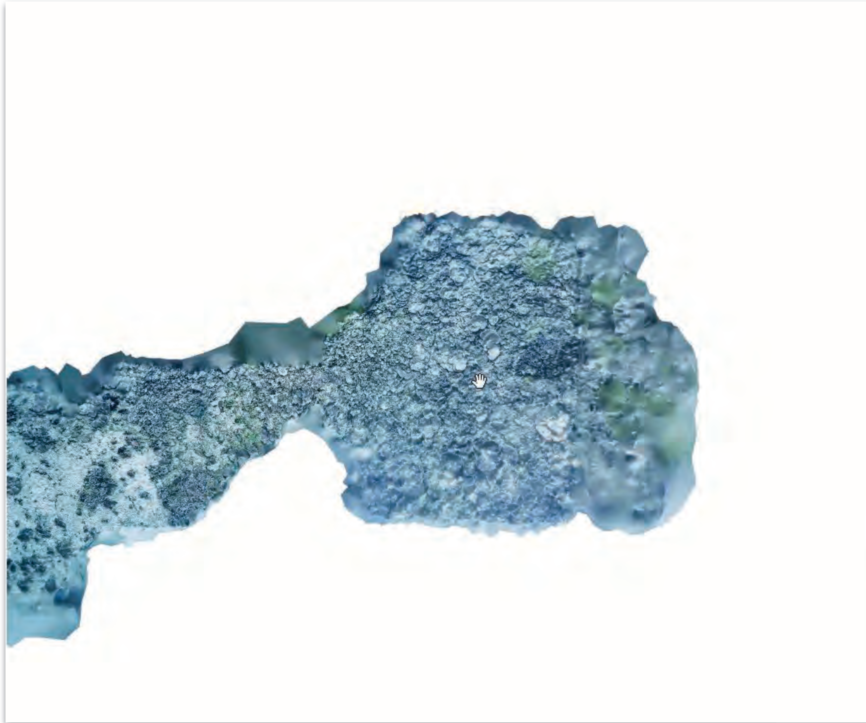
Case Study 1

Structure from Motion (SfM) for Ground Validation in Guam and Saipan

Why this case study?
Innovation, human in the loop model, future use

Dates: 2019-2024
Funding: NOAA CRCP, NCCOS, DoD
Team: Bryan Costa, Jordan Pierce, Ed Sweeney

Key Collaborators: DoD, ORBTL AI, JAMS



Structure from Motion (SfM)

(Top view images)

The use of 2D overlapping images to create 3D scenes with co-registered photomosaics

(Side view images)

(Subset of 50 images)

Project Areas - Guam and Saipan

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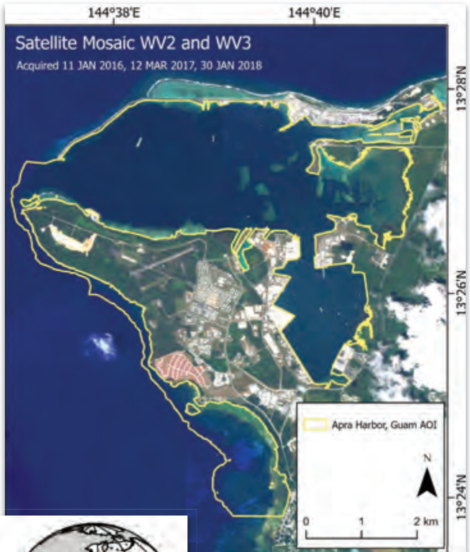
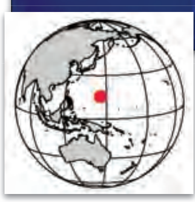
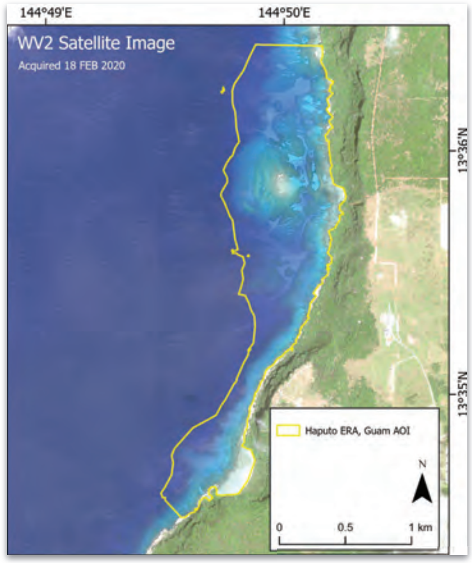
Apra Harbor | Haputo Ecological Reserve Area | West Coast Saipan





~19 km^2



~2 km^2

~95 km^2

Large Spatial Scale Habitat Maps - Guam

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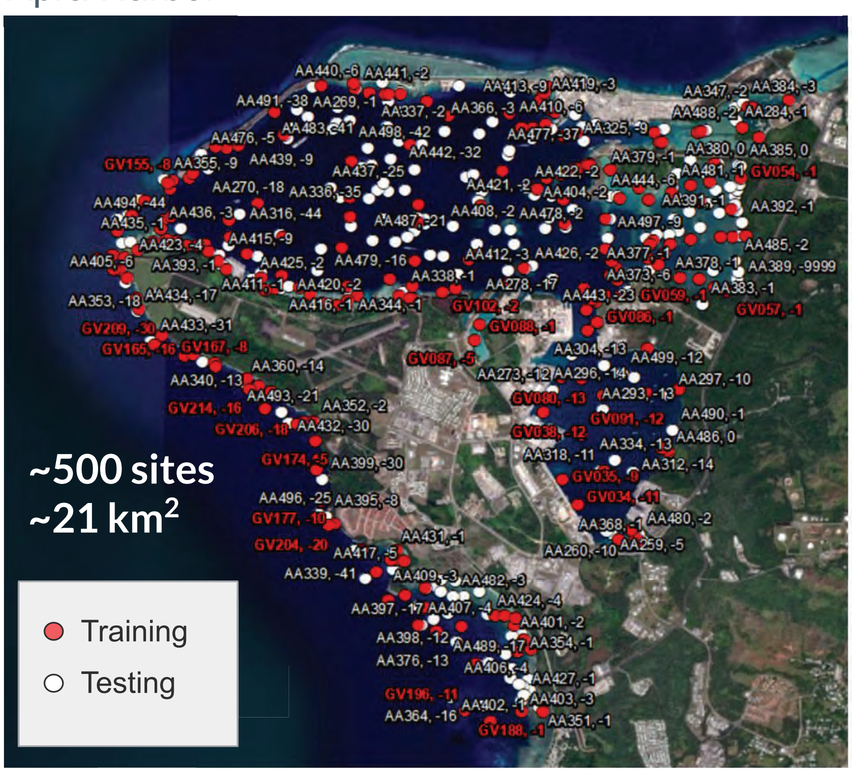
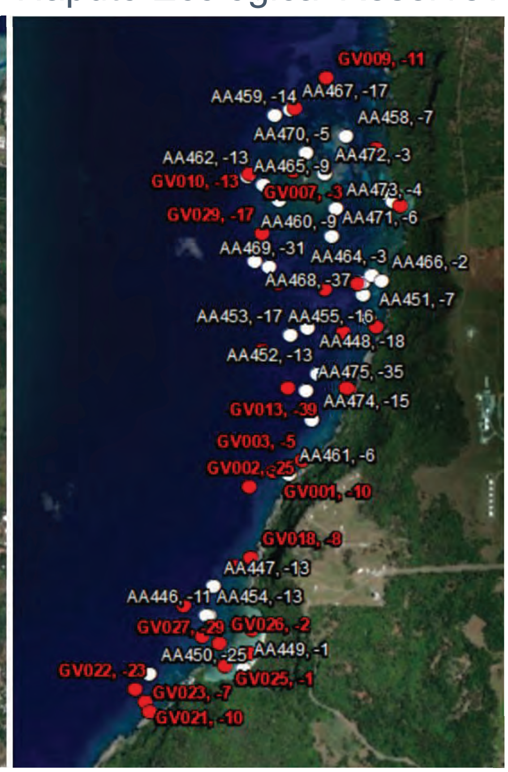
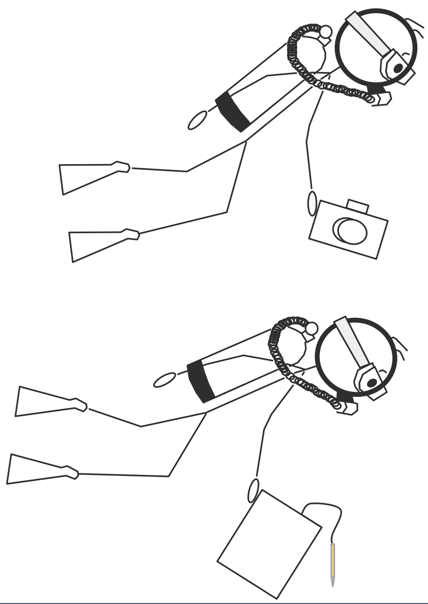
Apra Harbor



Haputo Ecological Reserve Area



Diver vs Drop Camera Ground Validation



Challenges with divers

- Length of time per site
- Spatial positioning
- Accessibility to remote locations
- Gear intensive
- In situ annotation subjective

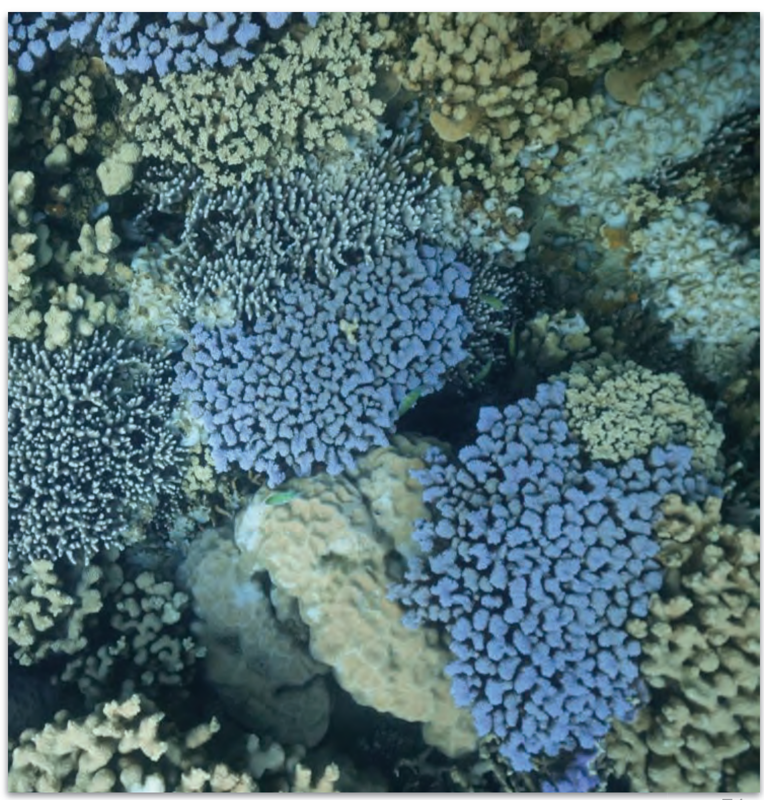
Coastal Management Impacts

How do these problems impact coastal management?

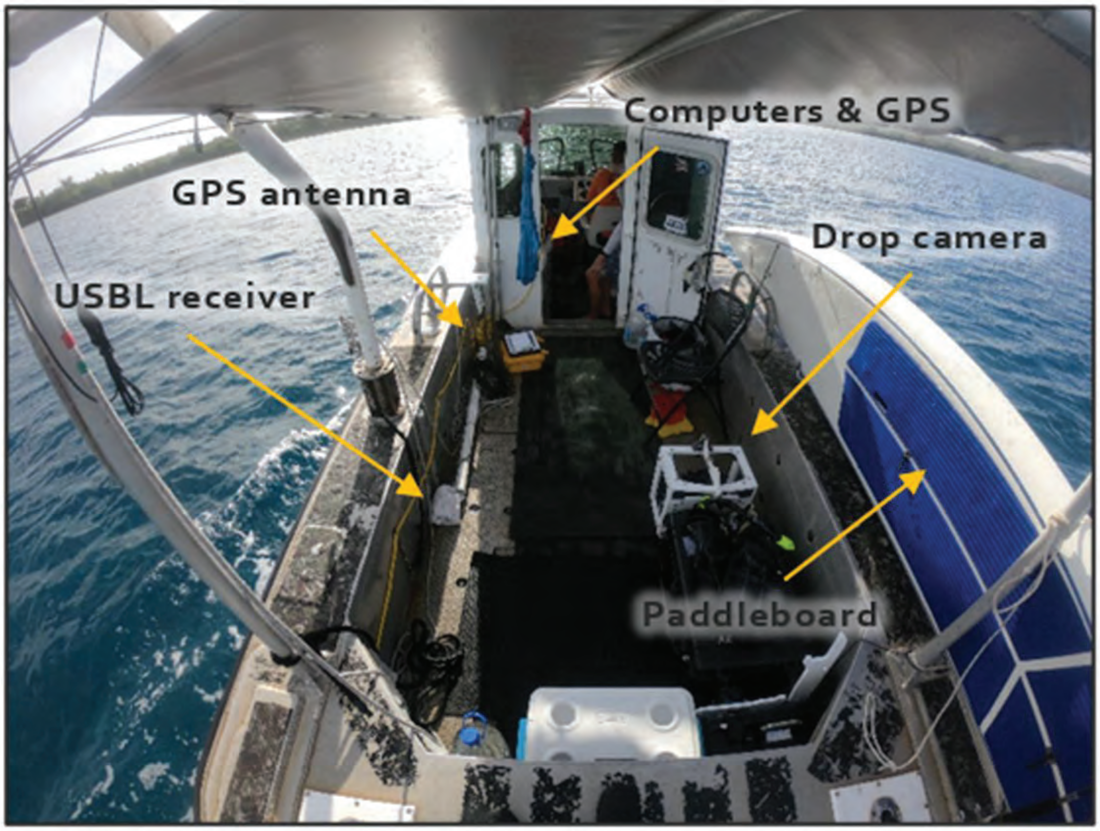
- Collection time and data bottlenecks increase deliverable timelines to managers

How do NCCOS workflows help address these issues?

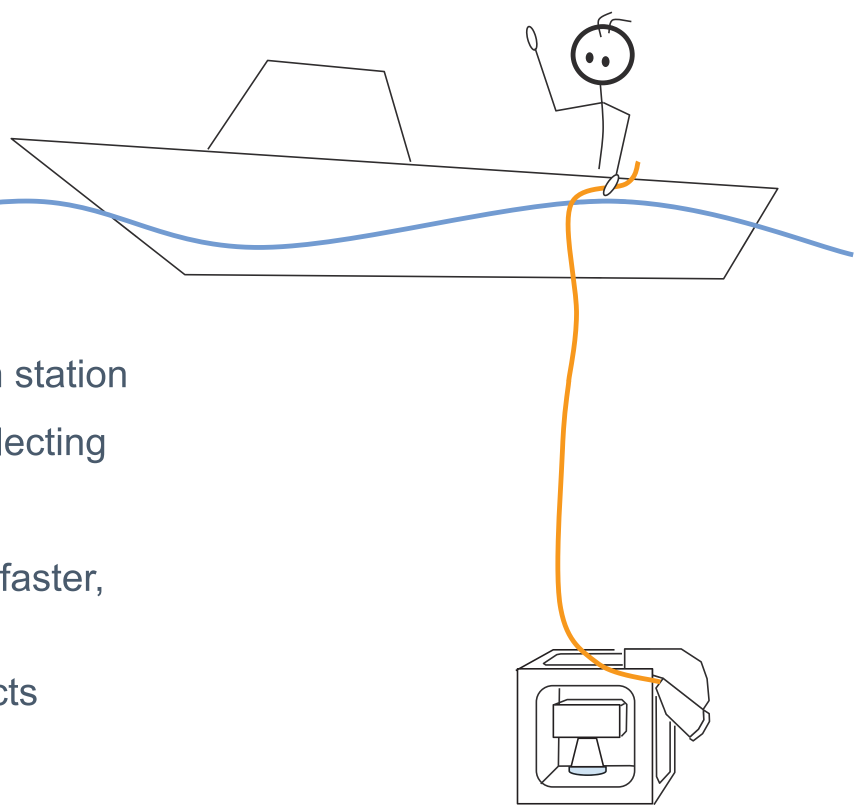
- Vessel deployed underwater photo tools (drop camera/AUV)
- Human in the loop automated imagery processing (API vs. GUI)
- Cloud computing (Microsoft Azure)



Guam Ground Validation Survey



Diver vs Drop Camera Ground Validation



Vessel Drop Camera

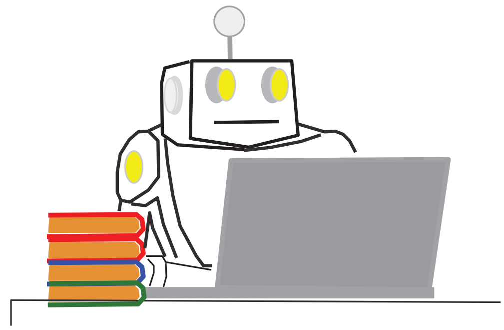
- 5-10 min per site (total) on station
- 1-3 min per site image collecting
- 130 - 250 photos per site
- Safer, cheaper, less gear, faster, access remote areas
- Metrics on imagery products
- Permanent record

Signal Processing - SfM case study

Previous SfM model creation via GUI

vs.

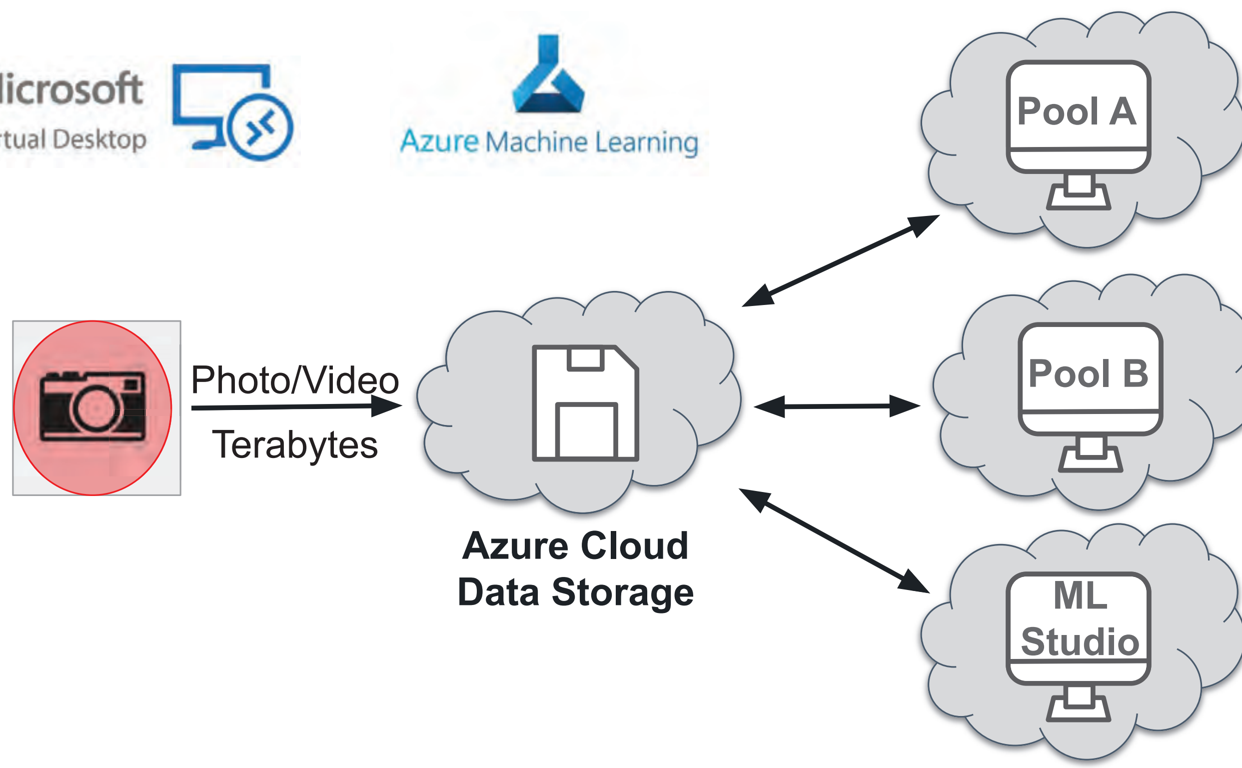
Guam/Saipan SfM model creation via API



SEA Azure Cloud Computing

Microsoft Azure Virtual Desktop

Azure Machine Learning



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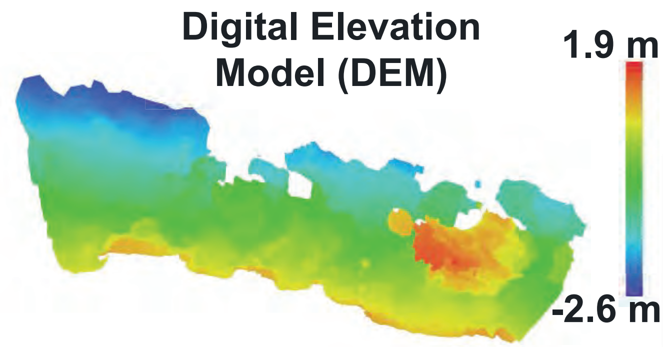
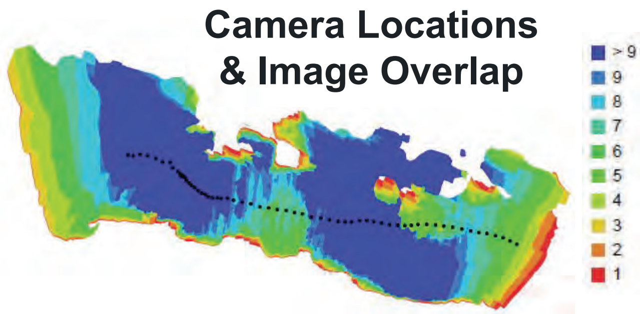
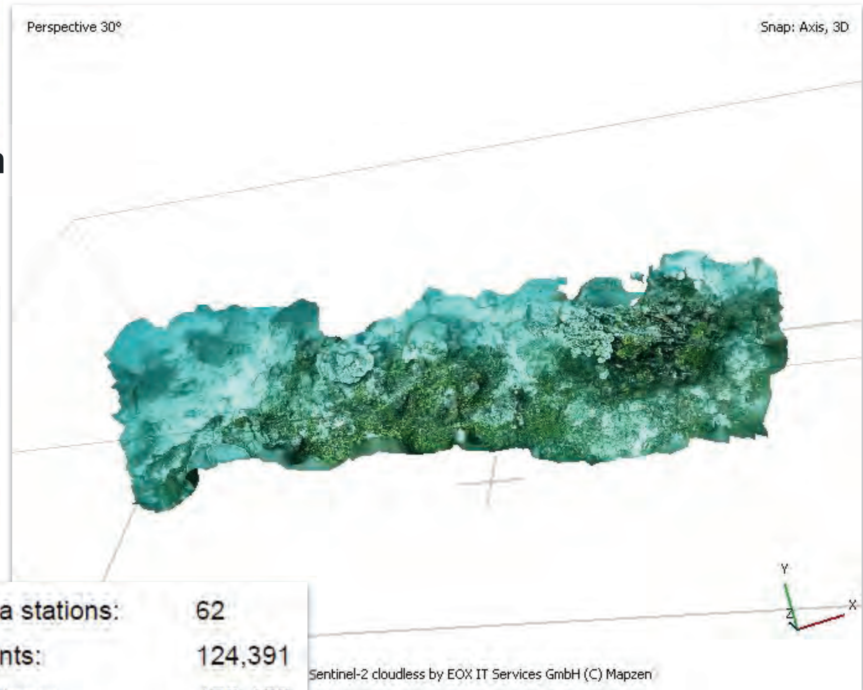
SfM End Products







Number of images:	62	Camera stations:	62
Flying altitude:	1.4 m	Tie points:	124,391
Ground resolution:	0.278 mm/pix	Projections:	478,105
Coverage area:	34 m^2	Reprojection error:	3.44 pix

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Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- *Geography:* Guam and CNMI (Saipan, Tinian and Rota) nearshore coastal areas - *Products:* - Orthomosaics - Digital Elevation Model (DEM)	- *Users:* CNMI territorial government, DoD, & NOAA CRCP - *Intended Use*: Protect valuable & vulnerable branching corals
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- NOAA Biogeo/SEA - DoD - NOAA CRCP - CNMI territorial gov - JAMS - ORBTL AI	- *Status*: Ongoing - *Next Steps*: Expand mapping area to other regions of Saipan, Guam, Tinian and Rota - Use of uAUVs to streamline data collection - Improve API processing

Lessons Learned

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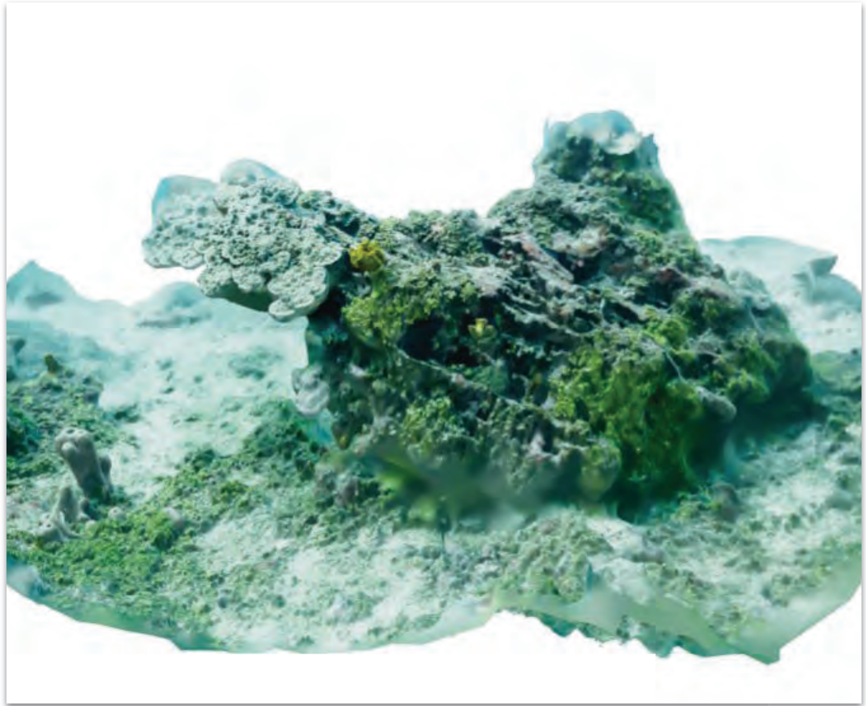
Successes:

- Vessel deployed ground validation time savings
- Efficiency of human in the loop automated processing workflow
- No longer compute limited (AVD/ML Studio)

Challenges:

- Finding the perfect tool for the job
- Fine-tuned position accuracy underwater
- Learning curve with transition to cloud compute



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Quality, Relevance, Performance

Quality	Relevance	Performance
- Ground validation on km spatial scale - Safer, cheaper, less gear, faster, easier access to remote areas - Transition to cloud computing infrastructure using Azure and human in the loop coding	- Addresses both mapping spatial scales and data volume / user time allocation issues - Project collaboration between NCCOS and DoD and researchers in Guam/CNMI - Technical collaborative effort between SEA and NCCOS IT group	- Many days, weeks, months saved using SfM data collection and workflows - Ability to monitor change over time, providing a record for climate change

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Case Study 2

Multibeam Acoustic Backscatter (MBAB) Best Practices

Why this case study?

Critical need for backscatter data in coastal management; collaboration; improved standardization; international future use

Dates:

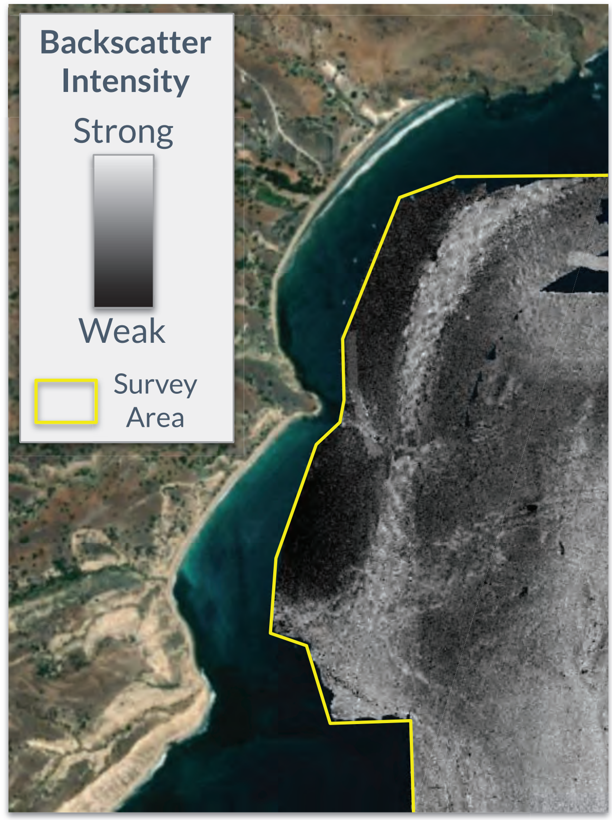
2023-2024

Team:

Chris Taylor, Harper Umfress, Bryan Costa

Key Collaborators:

NOAA NCCOS and NOAA Office of Coast Survey (OCS)



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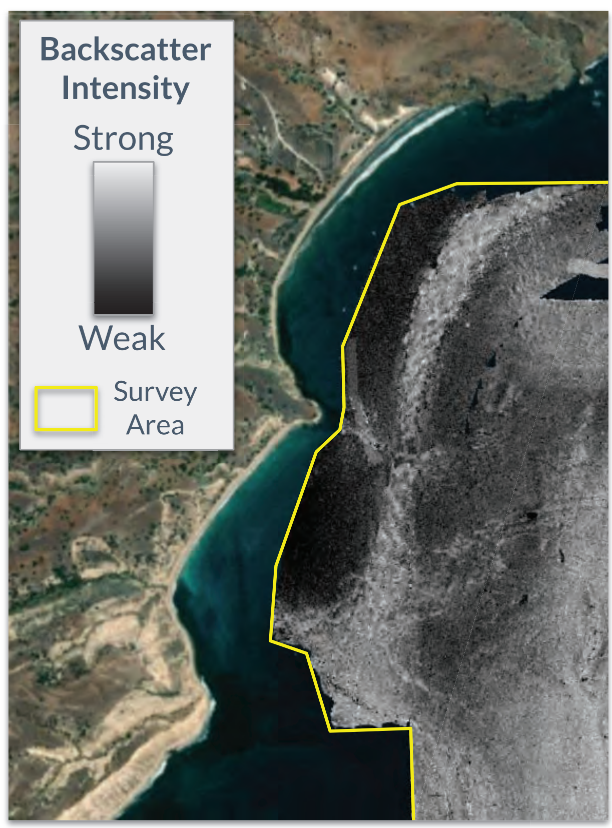
What is Backscatter?

- Backscatter is the intensity of sound returned (or scattered back from) the seafloor. Co-registered with depth data.
- The intensity of the returned signal is affected by the **physical properties** of the seafloor (**roughness and hardness**).
- These properties can be related to seafloor composition - sand, mud, rock, coral, seagrass…



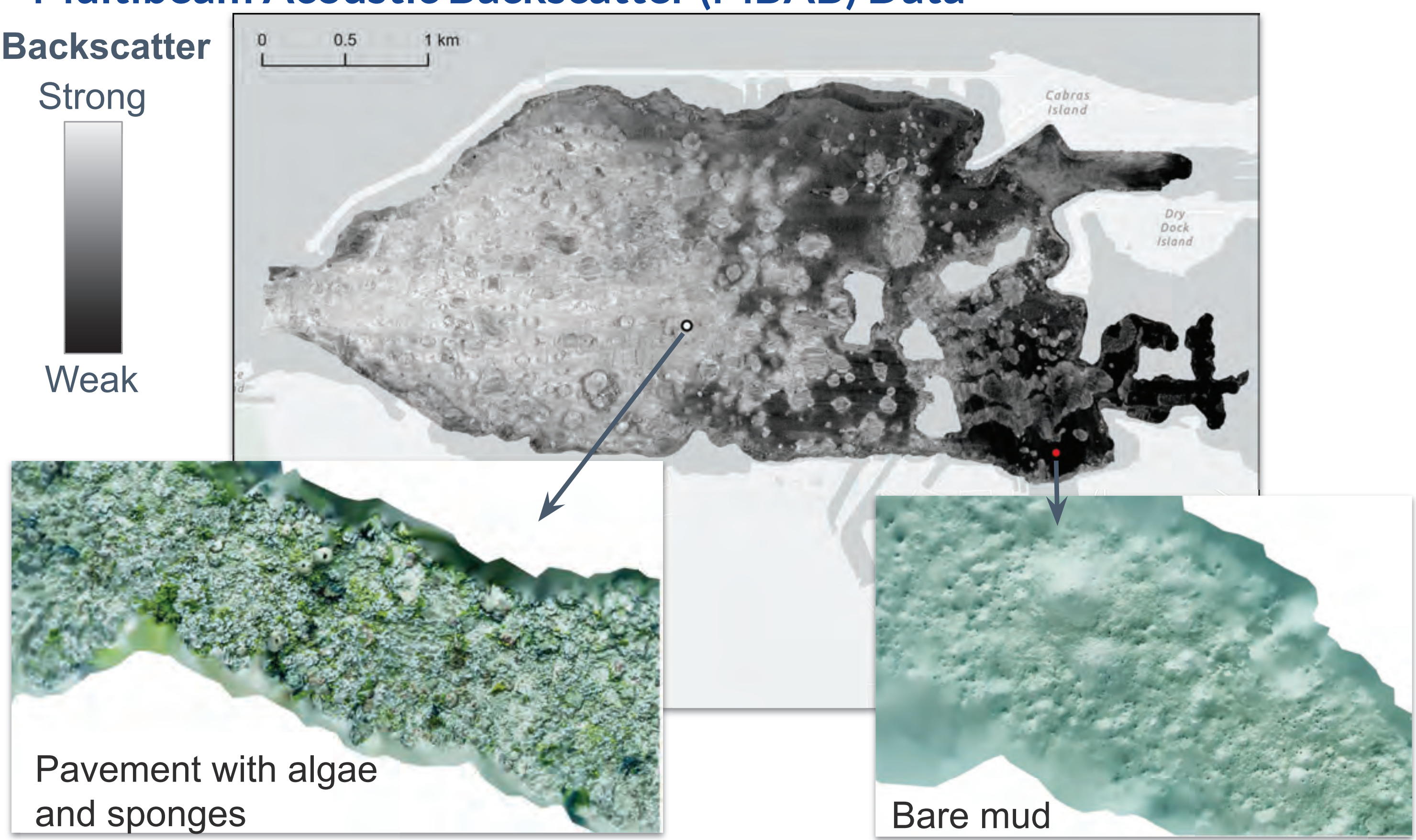
Multibeam Data

Bathymetry
Shallow
Deep

Backscatter
Strong
Weak

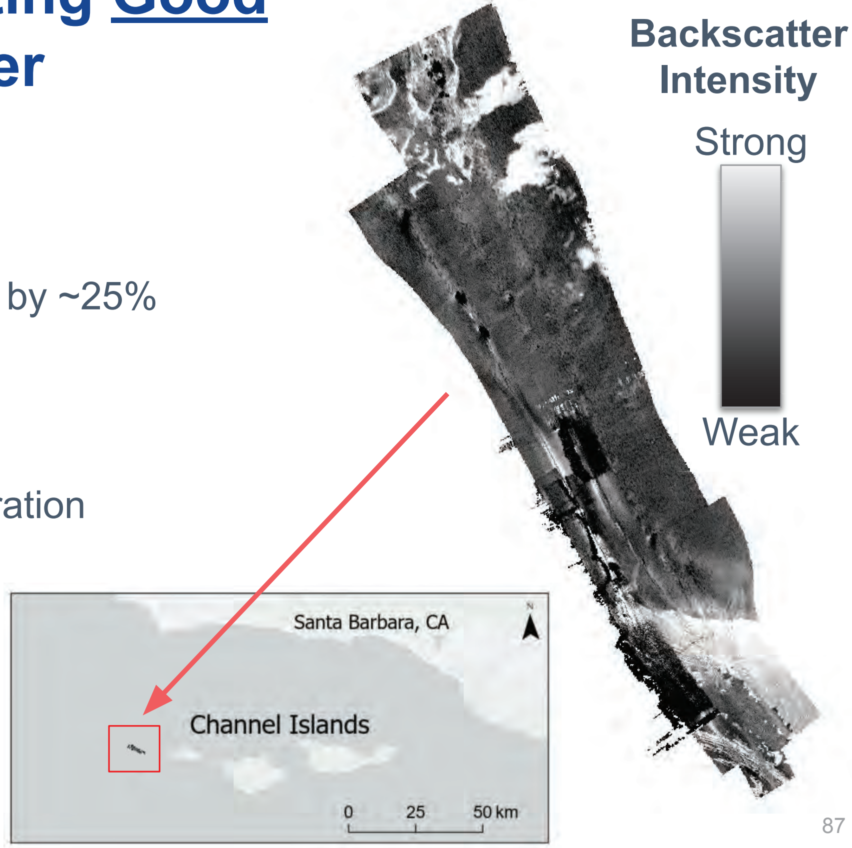
Multibeam Acoustic Backscatter (MBAB) Data

Backscatter
Strong
Weak

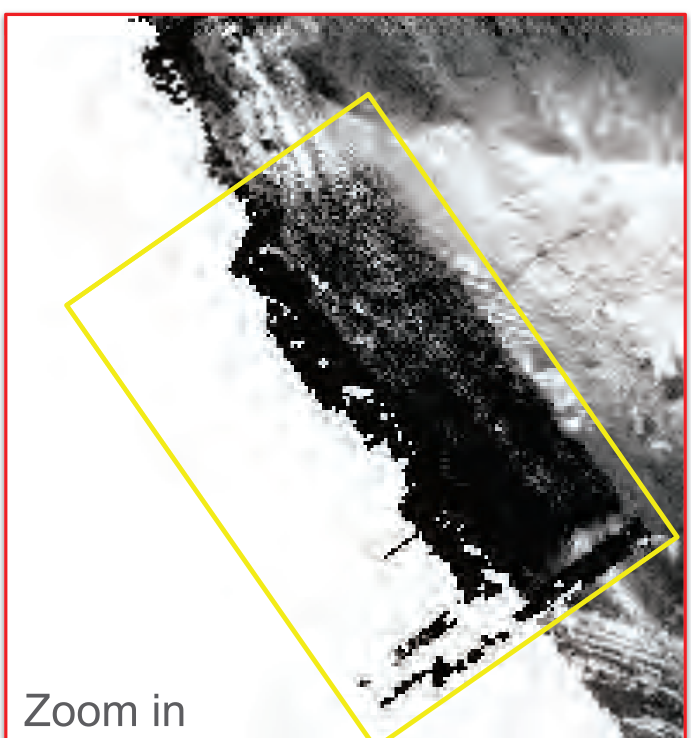


Importance of Collecting <u>Good</u> Multibeam Backscatter

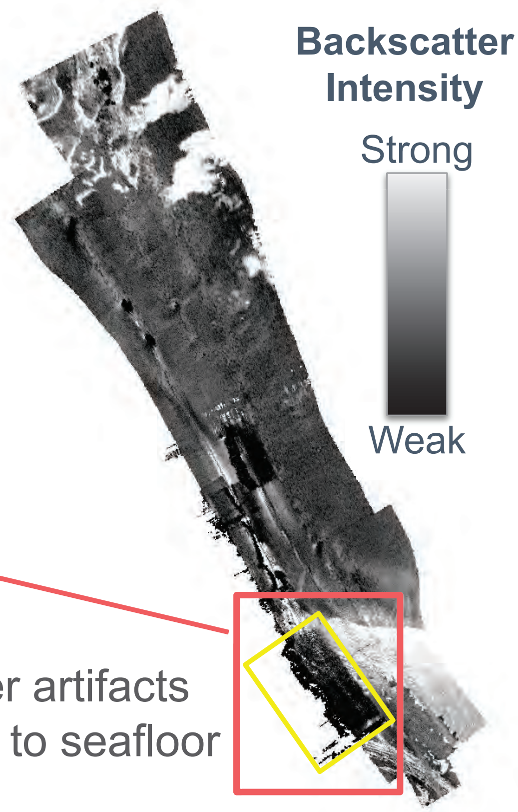
- Habitat characterization
  - Improve habitat predictions by ~25%
- Marine resource management
- Damage assessment and restoration
- Habitat change monitoring



Importance of Collecting <u>Good</u> Multibeam Backscatter



Backscatter artifacts not related to seafloor change



Importance of Collecting <u>Good</u> Multibeam Backscatter

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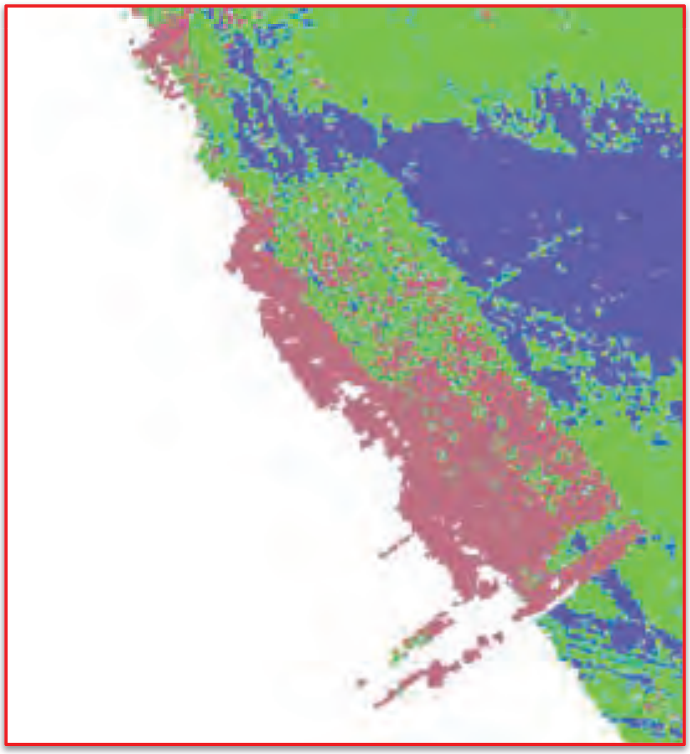
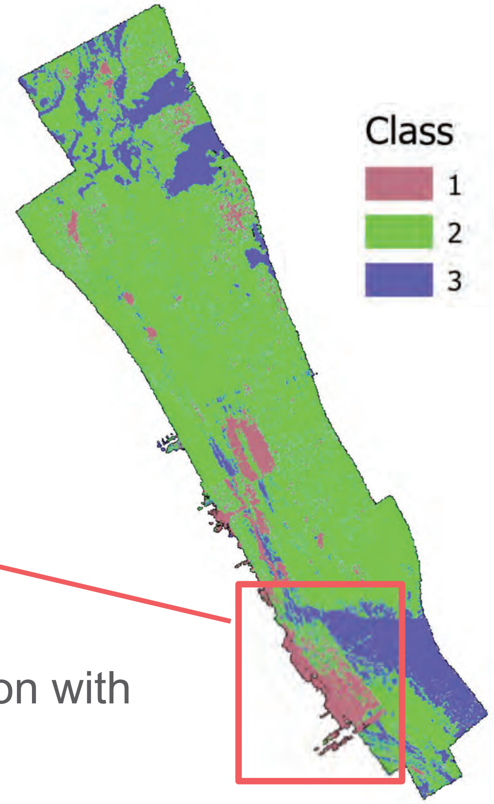


Classification with artifacts



Consolidating MBAB Best Practices

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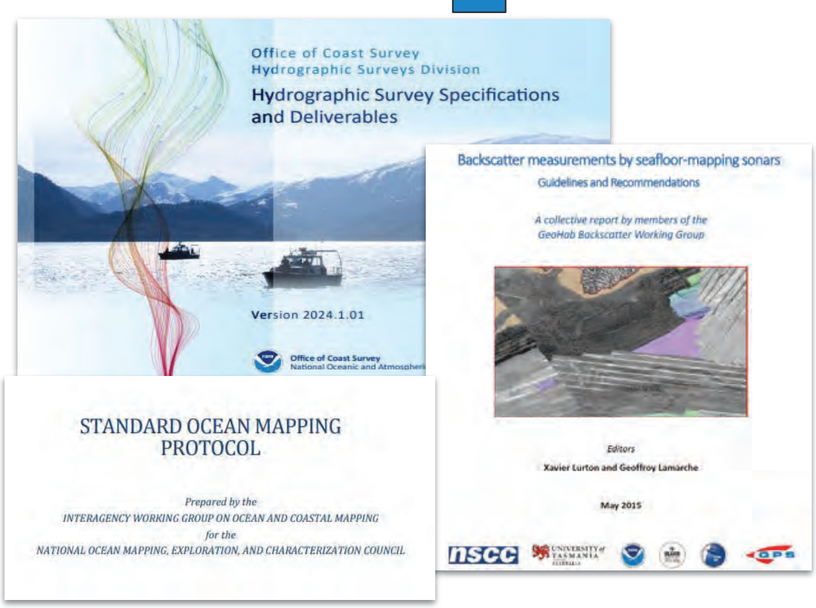

OCS Guide to Multibeam Backscatter

- **<u>Authors</u>**: Harper Umfress (OCS), Bryan Costa (NCCOS), Chris Taylor (NCCOS)
- **<u>Latest Version</u>**: Aug. 30, 2024
- **<u>Importance</u>**:
  - An encompassing document to be used underway
  - MBAB a primary deliverable

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Assessing MBAB Quality

iskaffe
multibeam backscatter
quality control

GitHub

- Iskaffe (Norwegian Bokmål for "iced coffee") is a free and open-source app to help assess the quality of MBBS
- Authored by Alexandre Schimel et al. of The Geological Survey of Norway
- **Don't need to be an expert in backscatter data to use**

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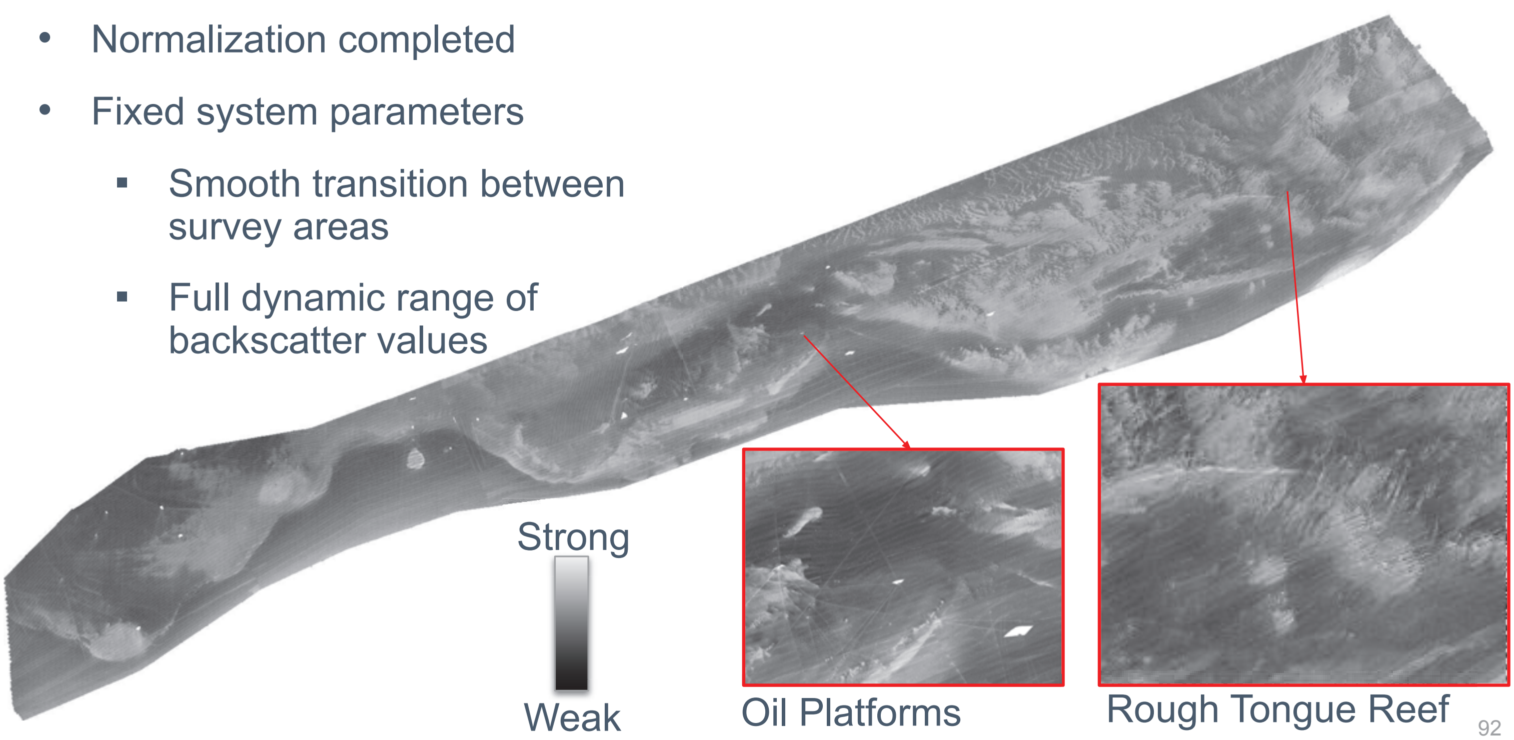
NOAA Hassler Backscatter Example ('Good')

- Normalization completed
- Fixed system parameters
    - Smooth transition between survey areas
    - Full dynamic range of backscatter values



Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)

- Geography: applicable for any multibeam survey
- Products:
  - 'Backscatter Best Practices' reference manual
  - Backscatter mosaics
	- NOAA OCS
	- Mapping community collecting / processing multibeam backscatter

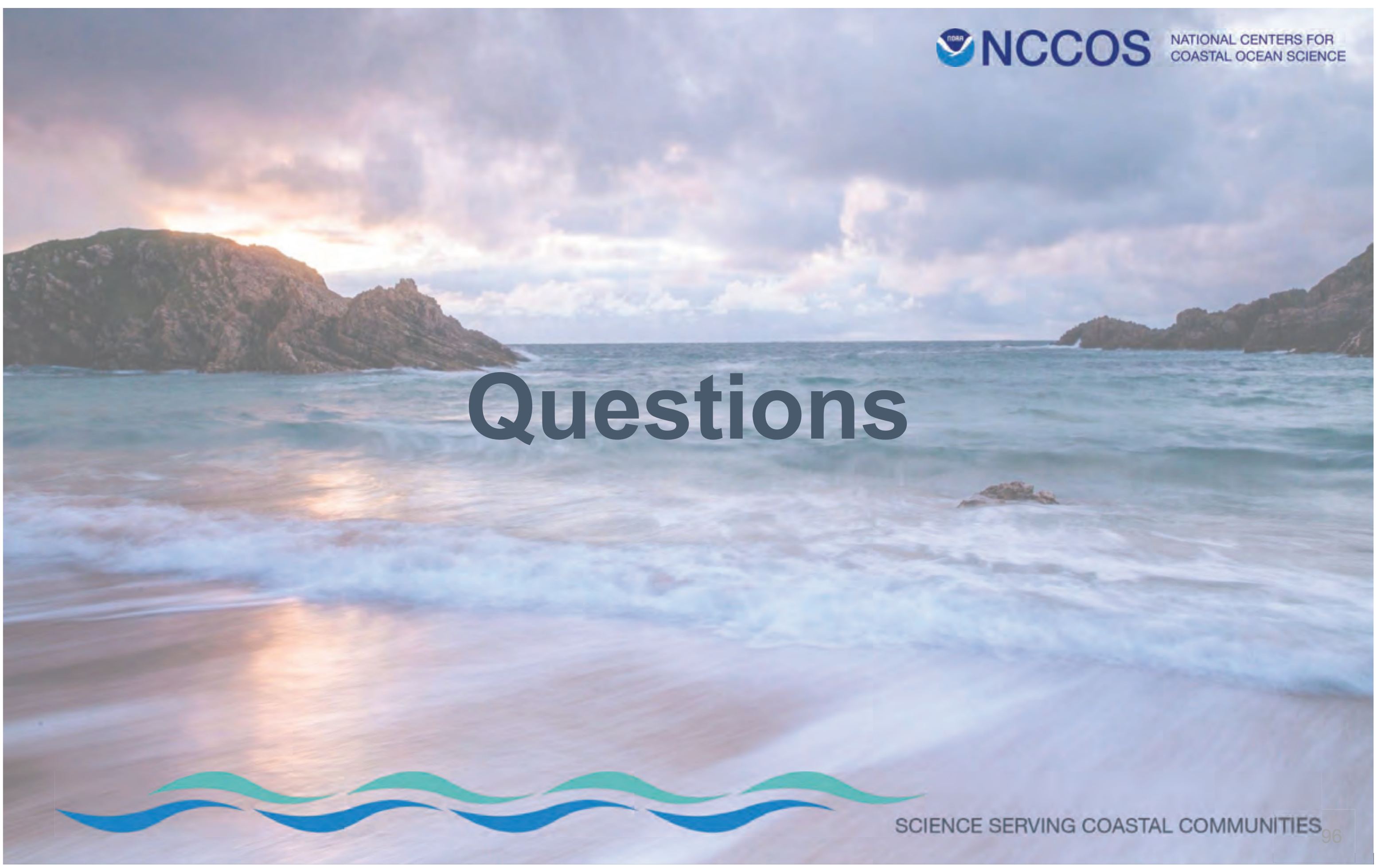
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- NOAA OCS - IOCM - Geological Survey of Norway - UNH CCOM	- Finalize Multibeam Backscatter Guide - Current is reviewable draft - Deploy to NOAA OCS - Review, update and implement any recommendations

Quality, Relevance, Performance

Quality	Relevance	Performance
- OCS Guide to Multibeam Backscatter - Iskaffe open source app for quantitative metrics MBAB quality for any user background level of processing	- NOAA NCCOS and NOAA OCS - International work corresponding with Geological Survey of Norway	- Higher quality backscatter products for better habitat maps and improved coastal resource management - More efficient backscatter data processing workflows

Conclusion

- Remote sensing and signal processing are important parts of the work done in the SEA branch
- Significant improvements in the acquisition and processing methodology using remote sensing tools to support coastal management needs
    - Photo imagery collection at large spatial scales
    - Cloud processing of structure from motion data
- Collaborative efforts with the research community (internal and external to NOAA) to further advance remote sensing and signal processing
    - Backscatter best practices



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Predictive Habitat Modeling

Bryan Costa, Ed Sweeney

SCIENCE SERVING COASTAL COMMUNITIES

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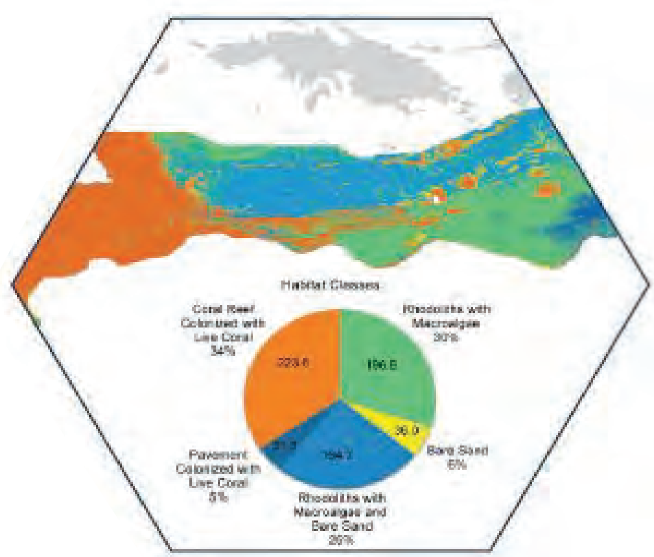
Overview



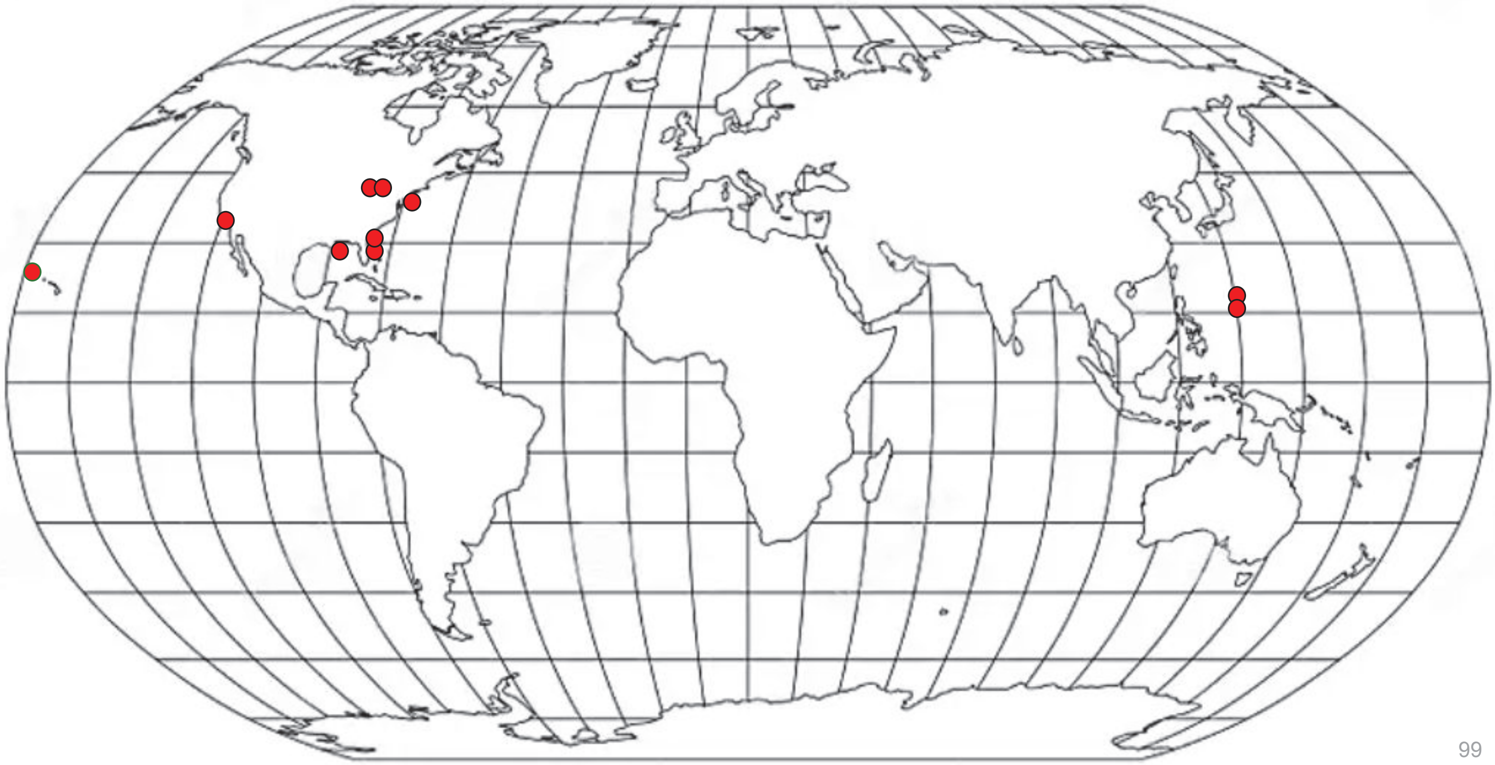
What is predictive habitat modeling?
The process used to predict the location of benthic taxa or habitats in a project area

What does SEA do?
SEA applies different mathematical models, including machine learning, to predict the location of these key habitats.

How are these products used?
The resulting maps inform marine management actions in the area.

How are these projects funded?
Reimbursable dollars and partner in-kind contributions are the most common funding sources.

Locations *(2019-Present)*



Case Study 1

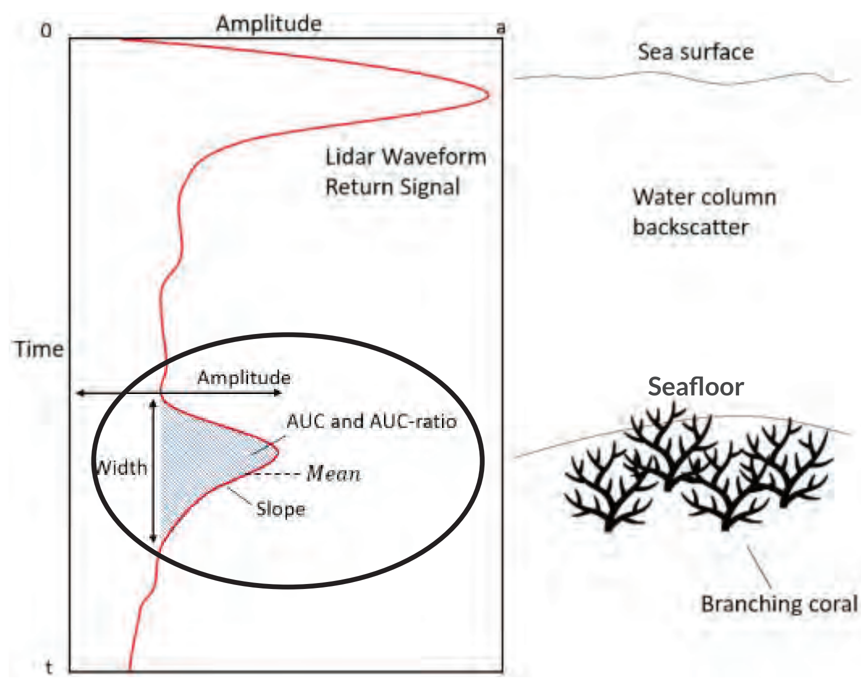
Predicting Coral Morphology to Inform Shoreline Protection around Saipan

Why this case study?
Exemplifies team's core values (collaborative, innovative, multi-use)

Dates: 2021-2024
Funding: NOAA CRCP, NCCOS
Team: Ed Sweeney

Key Collaborators: Oregon State University, Woolpert, Hexagon Leica, NOAA OCM, NOAA PIRO, U.of Guam, CNMI Territorial Government

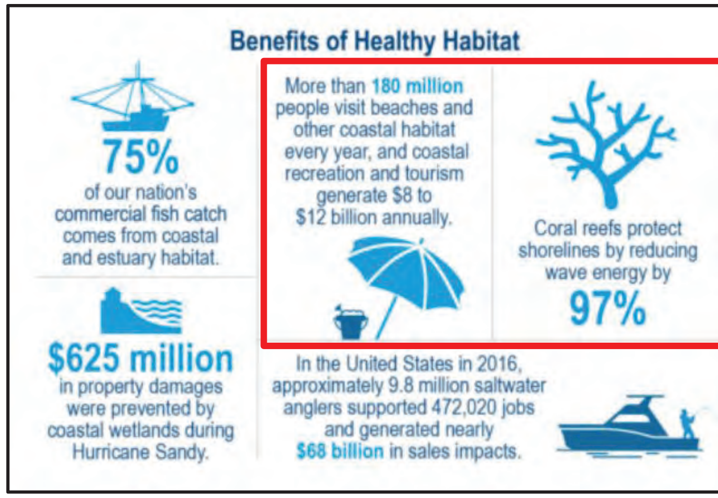
Fig. Bathymetric lidar waveform.



Problem and Impacts

What problems do these shallow taxa face?
Branching corals face threats from pollution, overfishing, invasive species, ship groundings, ocean acidification and heatwaves.

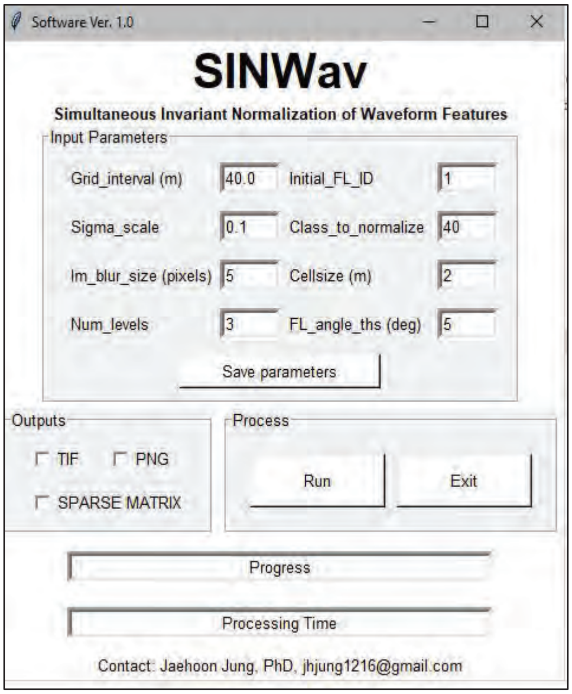
How do these problem impact communities?
Loss of these taxa reduces the economic services they provide, including recreation, tourism, fishing, and coastal protection.

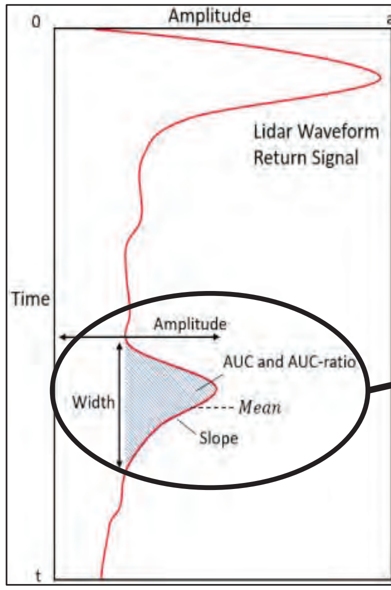


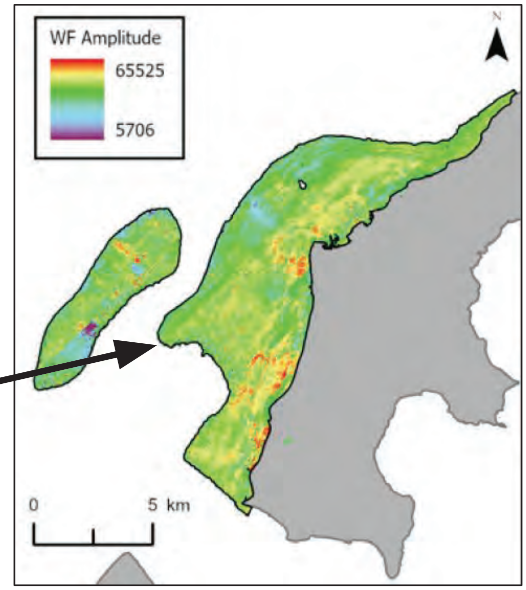
How do NCCOS's products help address these issues?
Goal = process and use lidar waveforms to increase the accuracy of branching coral spatial predictions. Better predictions = better information for managers to establish monitoring programs, evaluate management scenarios, and track changes.

Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- *Geography:* western Saipan, CNMI - *Products:* (1) SINWav software (2) Lidar waveform metric surfaces (3) Improved spatial predictions for branching corals	- *Users:* CNMI territorial government & NOAA NMFS - *Intended Use*: Protect valuable & vulnerable branching corals
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- NOAA Biogeo/SEA - Oregon State University - Woolpert, Hexagon Leica - NOAA CRCP, OCM, NMFS - CNMI territorial gov	- *Status*: Complete - *Next Steps*: Collaborate with industry to potentially integrate SINWav into their software

End Products # 1 & 2





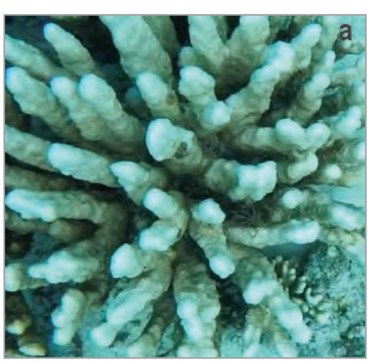


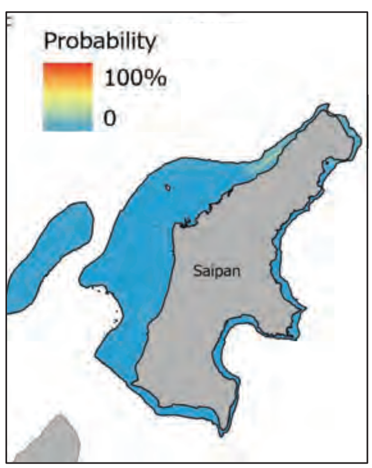
SINWav = software to extract waveforms, describe seafloor return, turn into maps

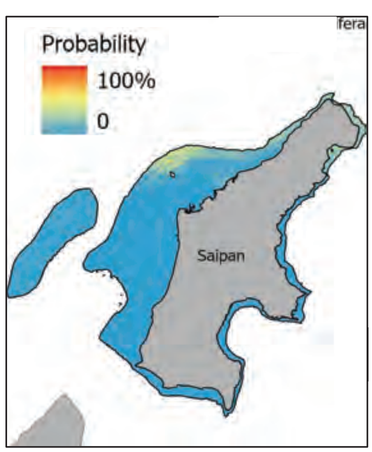
End Products # 3

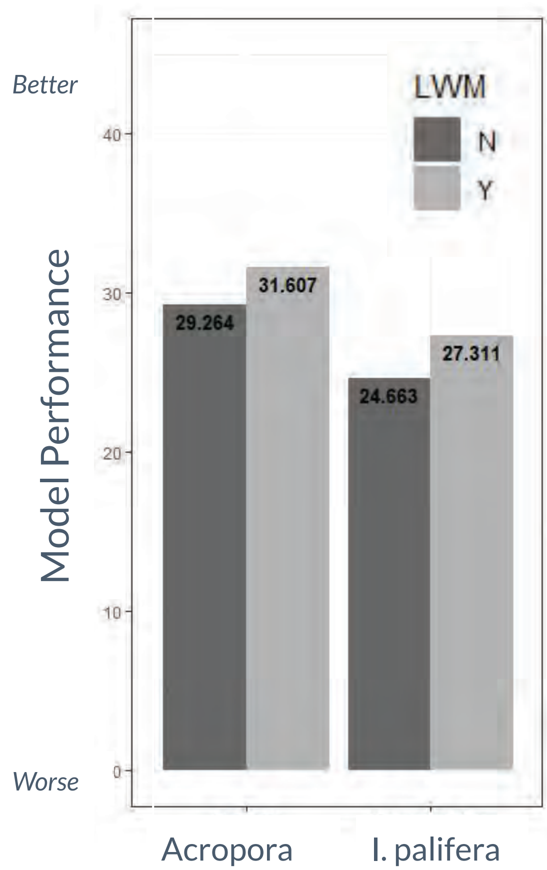
Acropora sp.

Isopora palifera









Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- *Geography:* western Saipan, CNMI - *Products:* (1) SINWav software - (2) Lidar waveform surfaces - (3) Improved spatial predictions for branching corals	- *Users:* CNMI territorial government & NOAA NMFS - *Intended Use*: Protect valuable & vulnerable branching corals
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- NOAA CRCP & NCCOS - Oregon State University - Woolpert, Hexagon Leica - NOAA OCM, NMFS - CNMI territorial gov	- *Status*: Complete - *Next Steps*: Collaborate with industry to operationalize process, & potentially integrate SINWav into their software

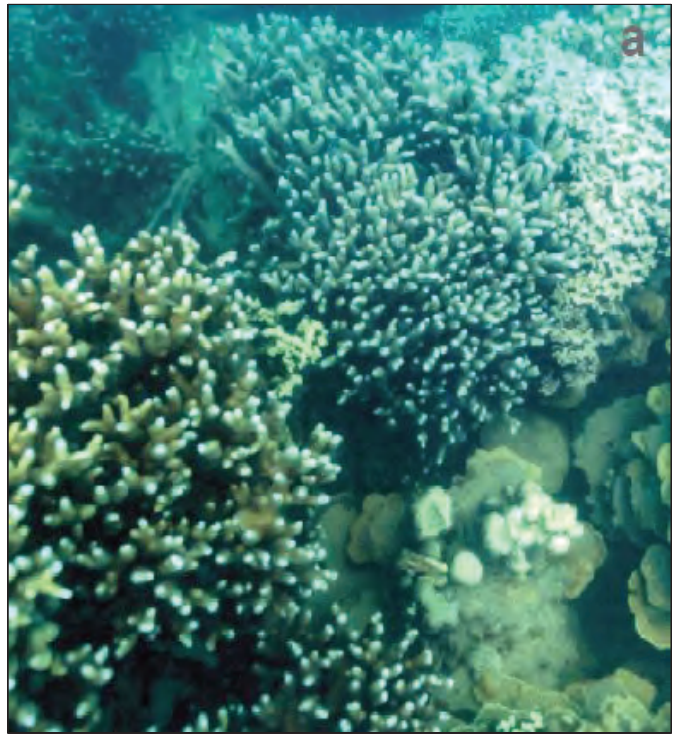
Quality, Relevance, Performance

Quality	Relevance	Performance

- For first time, waveform surfaces used in our modeling
- Prediction accuracy improved with waveforms
- Identified pathway to increase readiness level
	- Leveraged multiple funding sources & in-kind contributions
	- Addressed capabilities gap
	- Products intended to improve management of branching corals
		- Decision makers plan to use these products to better manage benthic resources, specifically branching corals
		- Products align with NCCOS goals:
		  - 1b: Habitat Mapping
		  - 1d: Research in Coral Reef Ecosystems
		  - 3a: Facilitating Resilience to Climate Impacts

Lesson Learned

- *Successes*: New processing workflows, software & waveform products developed.
- Waveforms increased model performance.
- *Challenges*: Need industry to make exporting waveforms universally available in their software.
- Approach CPU/GPU intensive. Solve technical issues to deploy in cloud.



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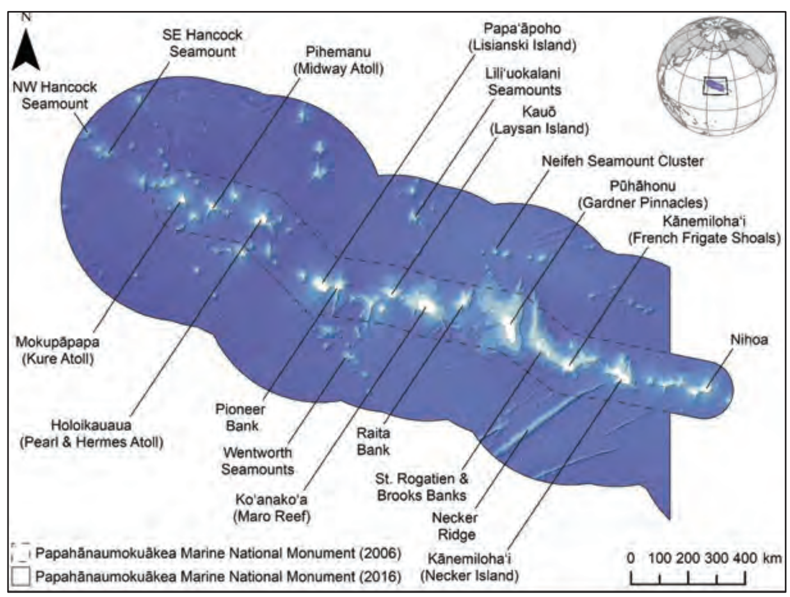
Case Study 2

Predicting and Characterizing Deep-Sea Coral Habitats within the Papahānaumokuākea Marine National Monument

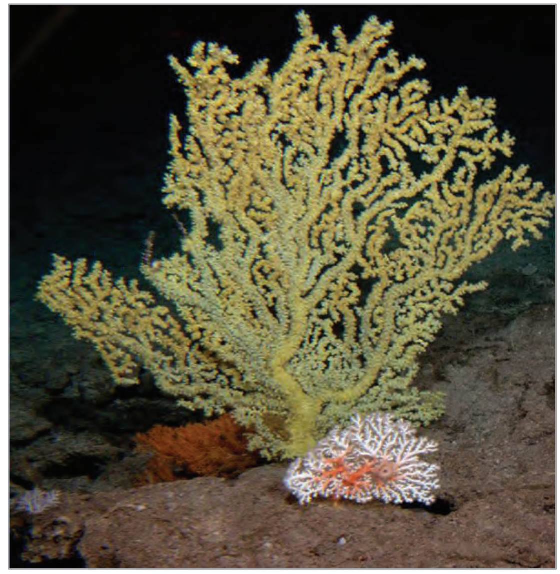


Why this case study?
Exemplifies team's core values (collaborative, innovative, multi-use)
Dates: July 2019 - December 2020
Funding: NOAA DSCRTP, NCCOS
Team: Matt Poti

Key Collaborators: NOAA Deep Sea Research and Technology Program, NOAA Pacific Islands Fisheries Science Center, University of Hawaii, Florida State University, U.S. Fish and Wildlife Service, NOAA Office of National Marine Sanctuaries

Problem and Impacts

What problems do deep habitats face?
Deep ecosystems face several threats, including bottom fishing, invasive species, ocean acidification and rising temperatures. They are also very slow growing, and take hundreds to thousands of years to recover.



How do these problem impact communities?
Loss of these habitats reduces the economic services they provide, including habitat for economically important species and unique compounds for new pharmaceuticals.

How do NCCOS's products help address these issues?
Our habitat models & maps establish baselines for the ecosystems. Baselines can be used to inform discovery, evaluate management scenarios, & track changes.

Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- *Geographic Extent:* PMNM, Hawaii - *Products:* 1. New modeling method 2. Deep sea coral and sponge (DSCS) predictions & maps	- *Users:* NOAA ONMS, NMFS - *Uses:* 1. Inform exploration 2. Justify designation as sanctuary
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- NOAA Biogeo/SEA - NOAA DSCRTP, PIFSC, ONMS, USFWS - U. Hawaii, Florida State U.	- *Status*: Complete - *Next Steps*: Develop DSCS predictions for other Pacific remote monuments

End Product #1

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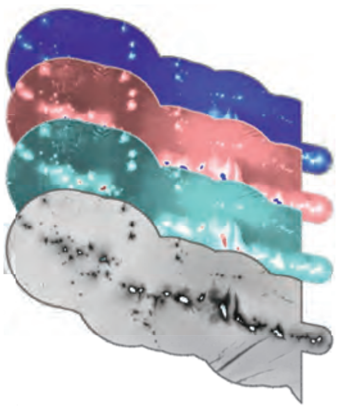
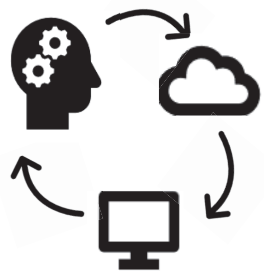
DSCS observations

+

Relevant Environmental Information



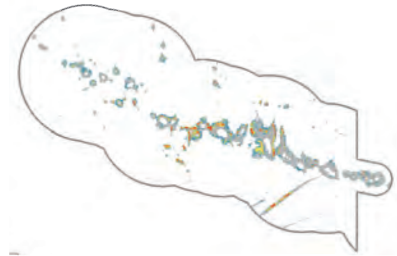
Human in the Loop Models



1. Boosted Regression Trees (BRT)
2. General Additive Models (GAM)
3. Maximum Entropy (MaxEnt)

=

Average of 3 Predictions



Variance among 3 Predictions

End Product #2

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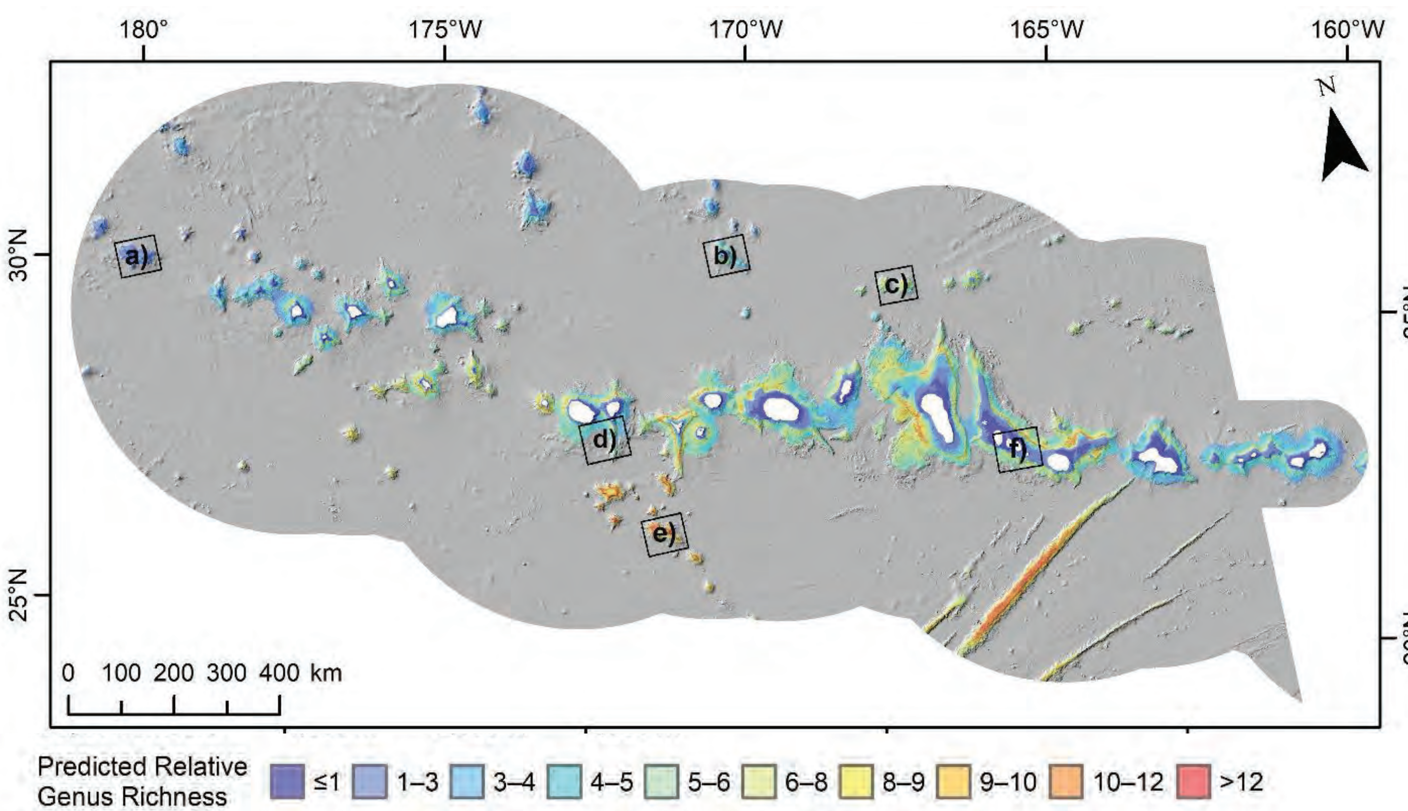

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Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- *Geographic Extent:* PMNM, Hawaii - *Products:* Deep sea coral and sponge (DSCS) predictions & maps	- *Users:* NOAA ONMS, NMFS - *Uses*: Inform exploration - Justify designation as sanctuary

NCCOS Organization Units Involved Key Partners	Synopsis Current State of Product/Service Next Steps
- NOAA Biogeo/SEA - NOAA DSCRTP, PIFSC, ONMS, USFWS - U. Hawaii, Florida State U.	- *Status*: Complete - *Next Steps*: Develop DSCS predictions for other Pacific remote monuments

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Quality, Relevance, Performance

Quality	Relevance	Performance
- New modeling method reduced data biases - Model performance same or better than previous methods - Increased # tools in modeling toolbox	- Leveraged in-kind contributions from partners - Products used to: 1. Prioritize future exploration 2. Justify sanctuary designation	- Decision makers plan to use these products to better manage benthic resources - Maps to support designation of Papahānaumokuākea Marine National Monument - Products align with NCCOS goals 1b & d

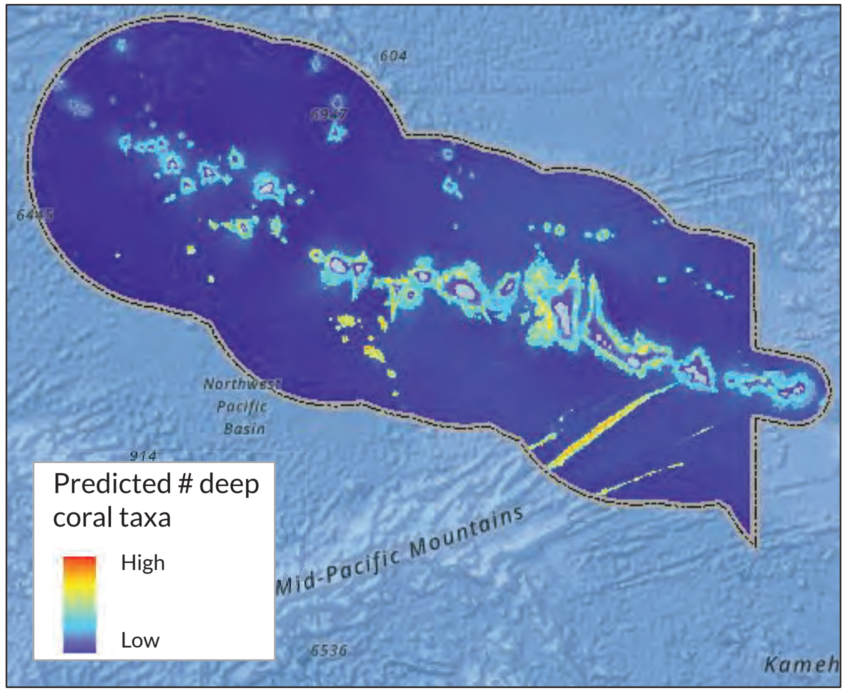
Lesson Learned

Successes:

- New approach validated, products applied by clients

Challenges:

- Approach CPU/GPU intensive. Technical issues prevent us from deploying in cloud.
- No independent data available for model validation. Challenging to collect observations in deep-sea.
- Decrease costs

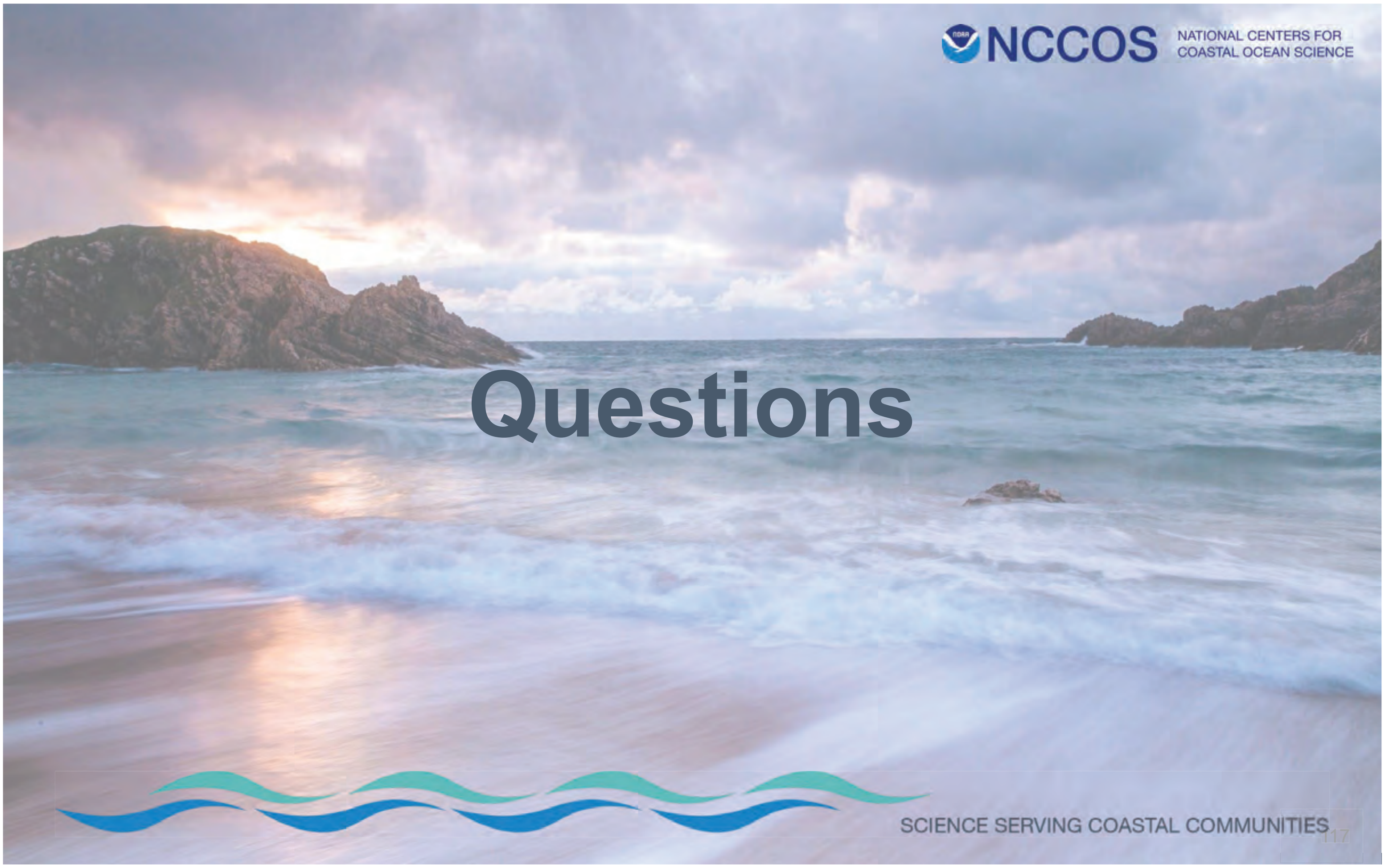


Conclusions

1. Benthic habitats, from shallow to deep, are facing unprecedented threats.
2. Predictive maps are critical for mitigating these threats, & maintaining the ecosystem services they provide.

Looking ahead

1. SEA should further automate the production of predictive maps.
2. SEA should also test methods to predict changes to habitat distributions in the future.


NCCOS
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Questions
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NCCOS
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Lunch
Return by 1:30pm
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Uncrewed Systems for Mapping

Chris Taylor & Mike Bollinger

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Overview

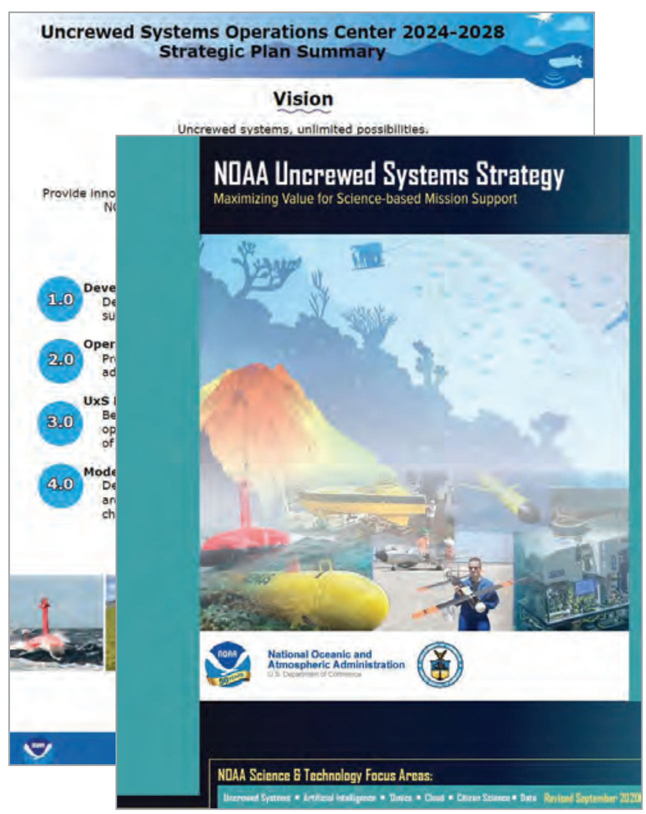
Uncrewed Systems (U<u>x</u>S) help NCCOS achieve growing calls for seabed and lakebed maps with

1. **BROADER** extent
2. **FINER** resolution
3. **RICHER** detail

Operationalizing UxS meets NOAA UxS Strategy and UxS Operations Center Strategic Plan Objectives

Achieves NCCOS Priorities in:

a. Ecosystem Science - Habitat Mapping
b. Developing and Implementing Advanced Observation Technologies and Ecological Forecasts



Comments from 2019 Program Review

"…there seems to be a significant opportunity to ***utilize unmanned systems and artificial intelligence*** *to speed the processing of this work and expand the area of coverage possible per day at sea" (2019 Biogeography Panel Review, Page 10)."*

"...ensure that field surveys that are conducted are ***as cost effective as possible****, and employ spatial analysis and field collection tools that are now available" (2019 Biogeography Panel Review, Page 7).*

"...consider a ***small dedicated funding line*** *that can be used … to encourage staff to utilize some time and resources to keep* ***pushing their innovative ideas****" (2019 Biogeography Panel Review, Page 5).*

Overview

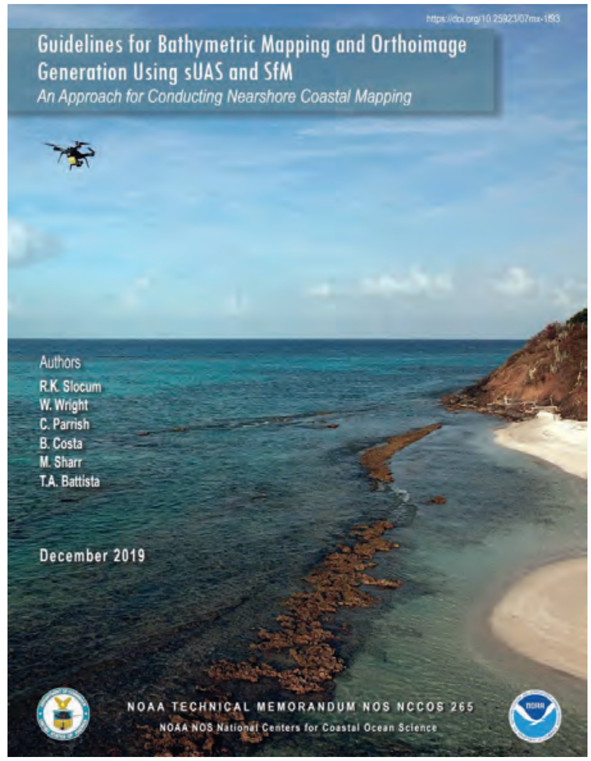
NCCOS UxS Mapping - A Multi-Modal Approach Weighing Cost, Risk and Benefit

- **Academic -** Partner with organizations with (expensive/large/complex) assets and engineering capabilities
  - Where we are early in research and development
  - Where collaboration is key to *developing operational scenarios*
- **Industry** - Defined requirements and SOW for contracted data as a service
  - Where we have *clearly defined requirements and industry standards*
- **Government** - Procure UxS assets and develop internal capacity
  - For small platform and assets and working in remote areas
  - Where we still need to *develop requirements and industry standards*
- **Hybrid -** Procure UxS assets, operate with Gov-Gov partnership
  - Where a *key government partner has capacity to offset overhead costs*

History - Developing UxS

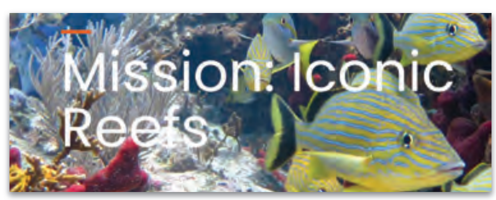
- Industry standard did not exist for shallow/coastal mapping using UAS imagery
- NCCOS habitat mapping team partnered with Oregon State University for acquisition and processing workflows
- Ideal in shallow, clear, structured submerged or emergent habitats

But where water depths exceed light and clarity, we need to go underwater with uncrewed maritime systems (UMS)...



Evolution of UMS in NCCOS Mapping

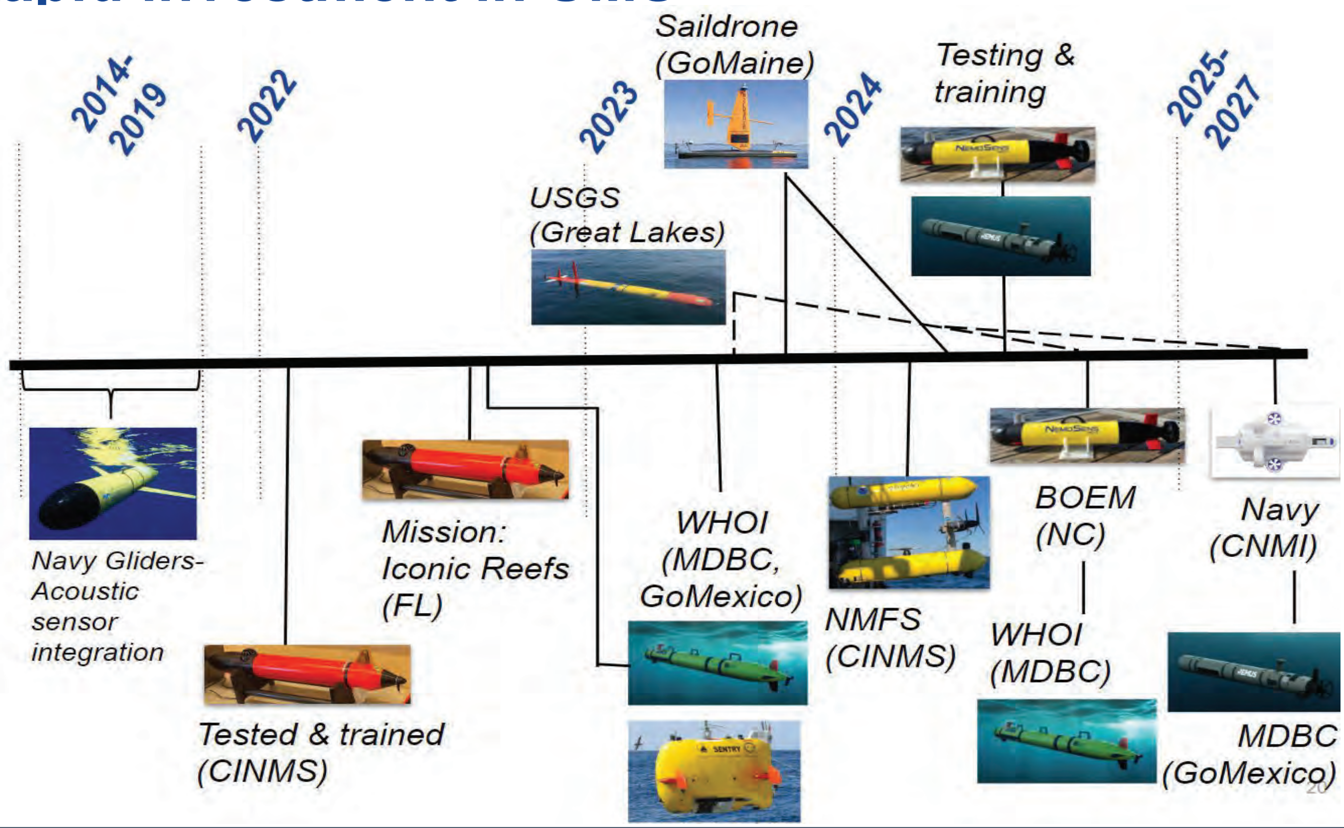
- Leveraging 3 large restoration programs to accelerate UMS mapping operations
  - Mission: Iconic Reefs
  - Great Lakes Restoration Initiative
  - Natural Resource Damage Assessment (NRDA) Open Ocean Restoration: Mesophotic and Deep Benthic Communities
- Multi-year programmatic funding commitment from NCCOS “UxS Readiness”



Great Lakes RESTORATION

Deepwater Horizon NRDA Open Ocean Restoration

Rapid investment in UMS



Case Studies

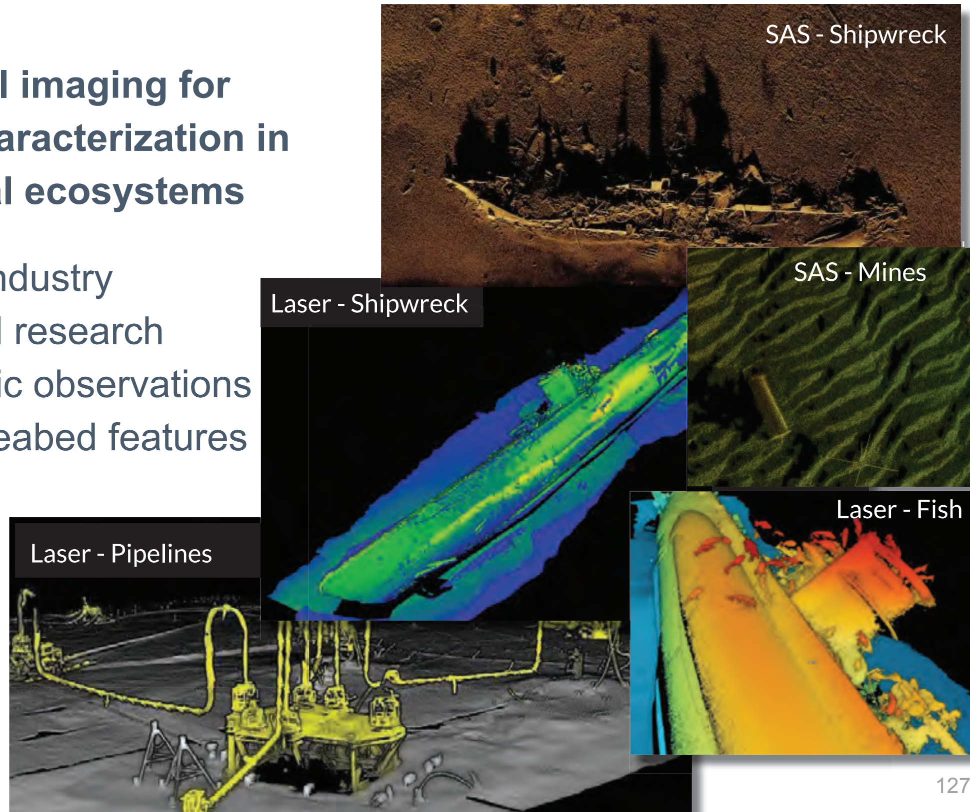
1. Autonomous underwater vehicles (AUVs) for high-resolution acoustical and optical imaging for benthic characterization

2. Maintenance, operations, and advancing Technology Readiness Levels of UMS in NCCOS mapping enterprise

Case Study 1

AUV acoustical and optical imaging for high-resolution seabed characterization in mesophotic and deep coral ecosystems

- Transition military and industry technology to ecological research
- Broader extent of benthic observations
- Increase resolution of seabed features

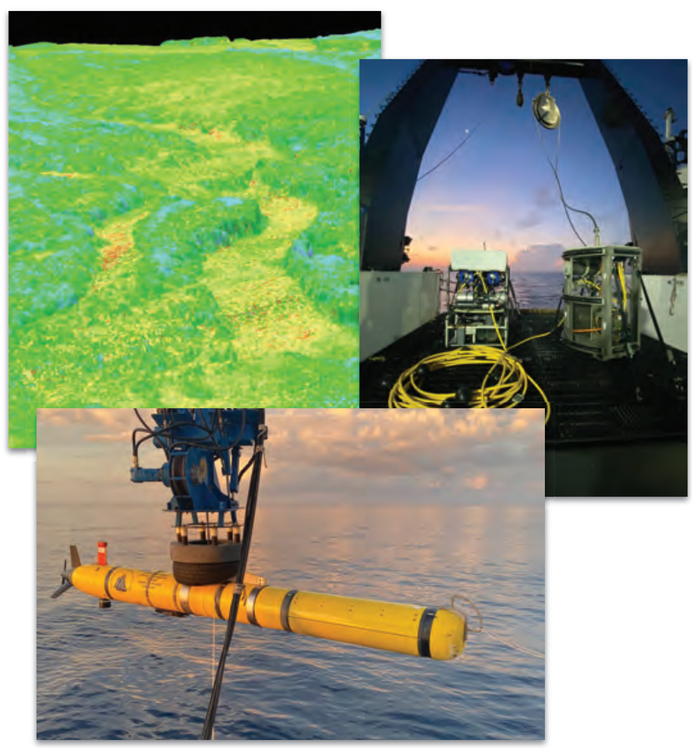


Challenge

Challenge: Predictive habitat modeling is limited by ship-based seafloor multibeam echosounder (MBES) resolution (>8m, especially at depths greater than 100m)

Ground-truth observations with remotely operated vehicles (ROVs) and drop cameras are costly and slow at depth

Solution: Operationalize AUVs with integrated acoustic and imaging sensors to increase resolution, and expand coverage for ground-truth observations



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Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
Geography: Gulf of Mexico Products/Services: - High-resolution and efficient ground-truthing method to feed predictive habitat models - High-resolution large-area imagery mosaics to guide resource assessments	Users: - DWH OORP MDBC - Fishery Management Agency Partners Intended Use: - Inform predictive habitat modeling - Guide resource assessments
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- (A) Penn State University - Applied Research Lab - (A) Woods Hole Oceanographic Institute - (G) US Navy Surface Warfare Center - (I) AUV sensor manufacturers	Current State: - Benthic imagery at high resolution guiding next level assessments/observations Next Steps: - Develop SAS deep-learning tools to characterize seabed substrates - Develop laser/imaging “coral counter” as recon tool for visual census and habitat assessments

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Timeline

OECI - WHOI Partnership (2022 - pres)

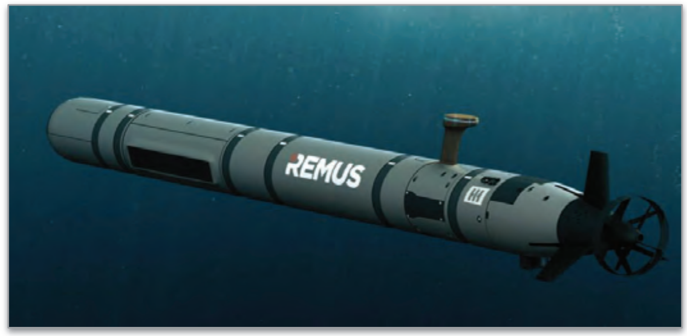
- Evaluated operational scenarios for mapping Mesophotic and Deep Benthic Communities (MDBC) with Remus 600
- Navy loaned Kraken Synthetic Aperture Sonar
- Integrated NOAA VOYIS laser-imaging payload
- 30 days at sea per year survey effort
- Critical interface between NOAA science and manufacturer, technical support

Woods Hole Oceanographic Institution 1930
Oceanographic Systems Lab
Ocean Exploration Cooperative Institute oeci

Timeline

Navy NSWC IA-A (2025 - 2027+)

- Procured two Remus 620 vehicles
- Factory-Integrated Kraken SAS
- WHOI-integrated VOYIS laser imaging payload
- NAVY Surface Warfare Center shop, pilot and engineering support 45-60 days/year
- WHOI partnership retained for continued engineering support

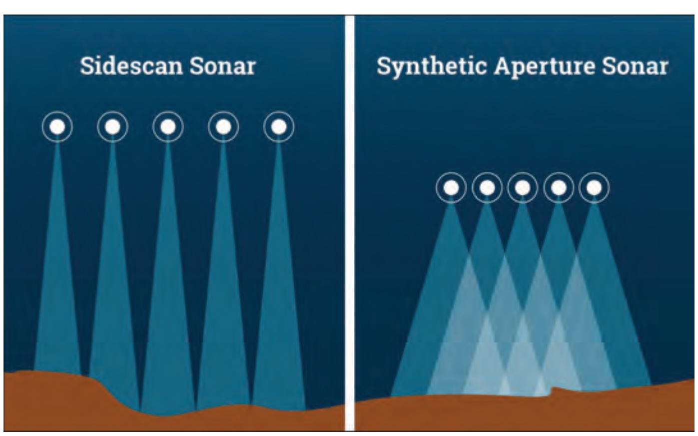


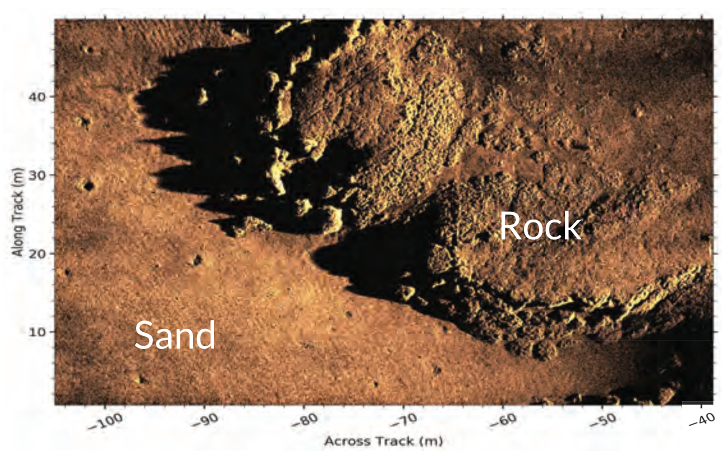
NAVSEA
WARFARE CENTERS
Panama City

Remus 620 Press Release 9/10/2024

Synthetic Aperture Sonar

- Advanced signal processing of imaging sonar provides constant high-resolution (3cm) across the entire swath (about 300 meters wide)
- Geospatial data products are acoustic reflectivity from seabed features
- Penn State Applied Research Lab providing Gov-License processing software and custom tools for quick-look imagery to share with MDBC project partners

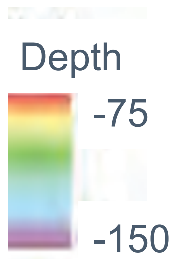


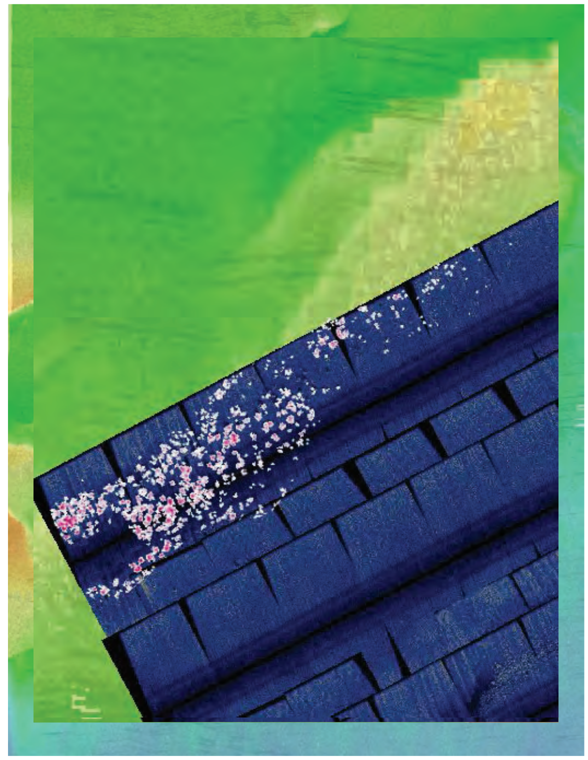


Synthetic Aperture Sonar Example

- MBES best resolution 8 meters, showing large-scale ridges and ledges
- Backscatter intensity suggests rough or textured seabed
- SAS 3cm resolution reveals emergent hardbottom like relic patch reefs or rock outcrops/boulders
- (A) Penn State ARL developing machine learning algorithm to detect seabed features suitable for mesophotic and deep coral communities

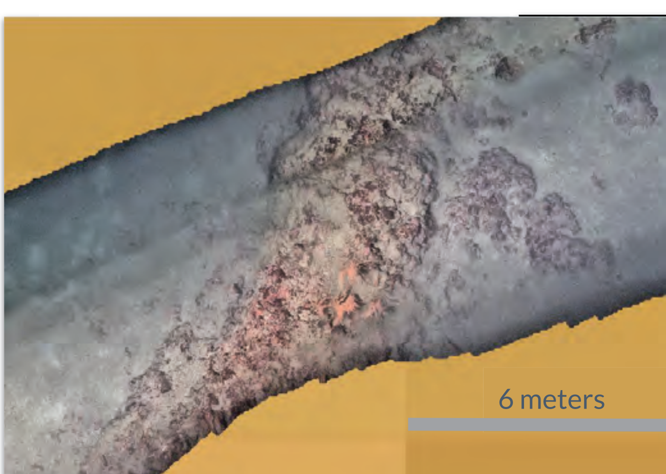
PennState
Applied Research Laboratory

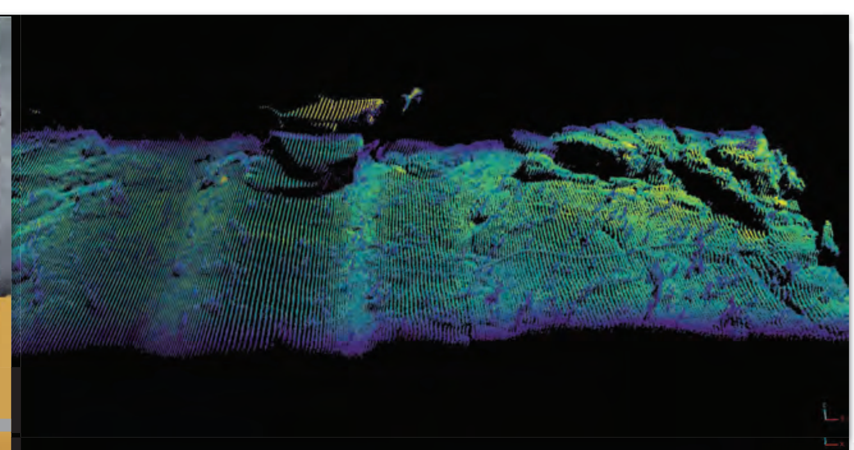




Seabed imaging and laser profiling

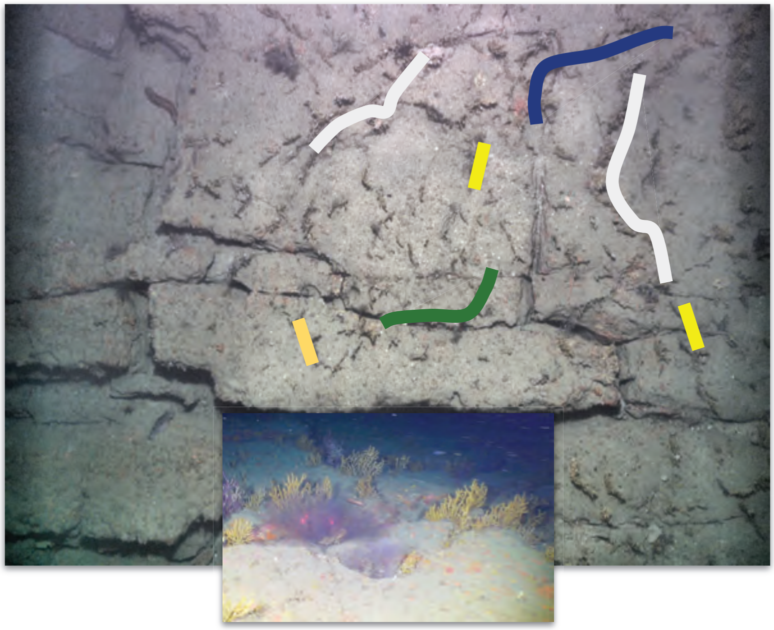
- Illuminated seabed images at 2 Hz - Laser profiles at 50 HZ
- Ground-truth coverage increased orders of magnitude above ROV*
- Imaging and orthomosaics resolved through photogrammetry/SfM
- Laser “microbathymetry” resolves substrate structure sub-cm
- Indications of low-reflecting features, possibly attached biota

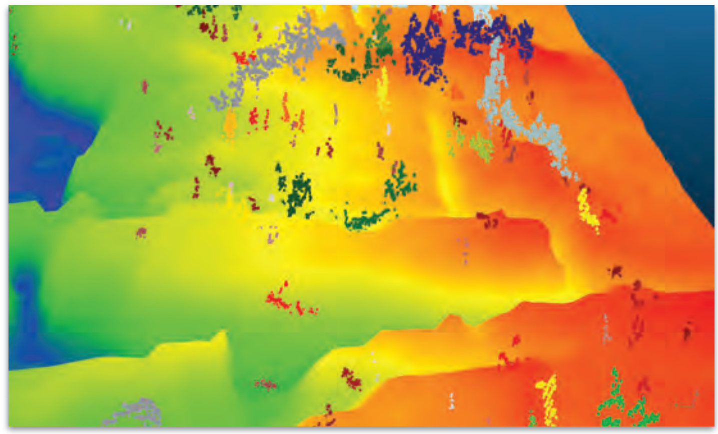




AUV imagery and laser profile example

- Mesophotic and deep corals can be difficult to resolve in downward imaging
- Automated filtering and segmentation may resolve relative coral abundance





Laser microbathymetry DEM and biota

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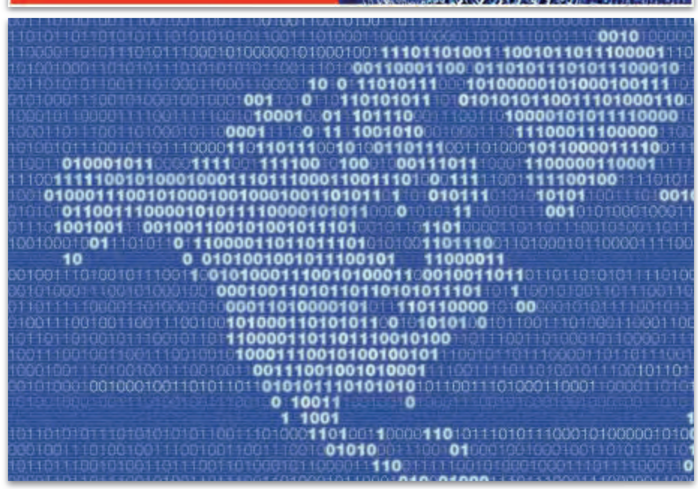
Lesson Learned

- High Technology Readiness Level (TRL) in industry/military does not always translate to high TRL in NOAA or our applications
- Challenges managing and processing very large datasets **!!TBs/day!!**
- Unfamiliar data types creates barriers to sharing visual products to collaborators/partners



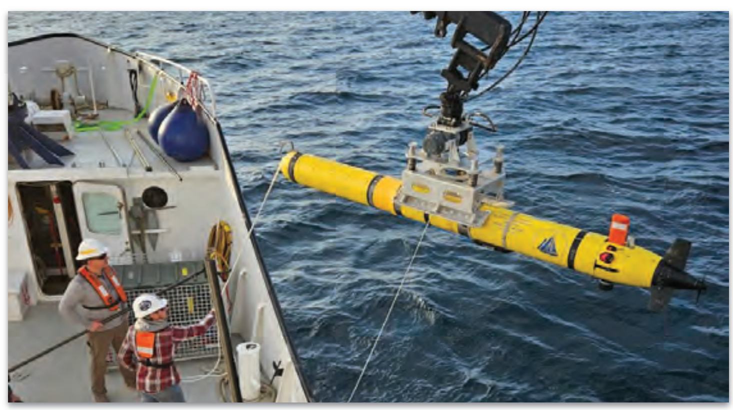
Quality, Relevance, Performance

Quality	Relevance	Performance
- New sensors and acquisition via AUVs demonstrate transition from industry/military to ecological applications - AUVs extend coverage for ground-truth observations several fold over ROV*	- Academic and industry partnership key to evaluating operational scenarios - Coordination with project partners ensures data products meet requirements and expectations	- Advanced tools leading to improved resolution of seabed features, broader extent supporting predictive models - Automation leading to richer detail in detection and mapping of mesophotic and deep coral communities

Case Study 2

Maintenance, operations, and advancing Technology Readiness Levels of UMS in NCCOS mapping enterprise

- Development of an internal operations dashboard
- Building a business and cost model for UMS in NCCOS mapping



Challenge

Challenge:

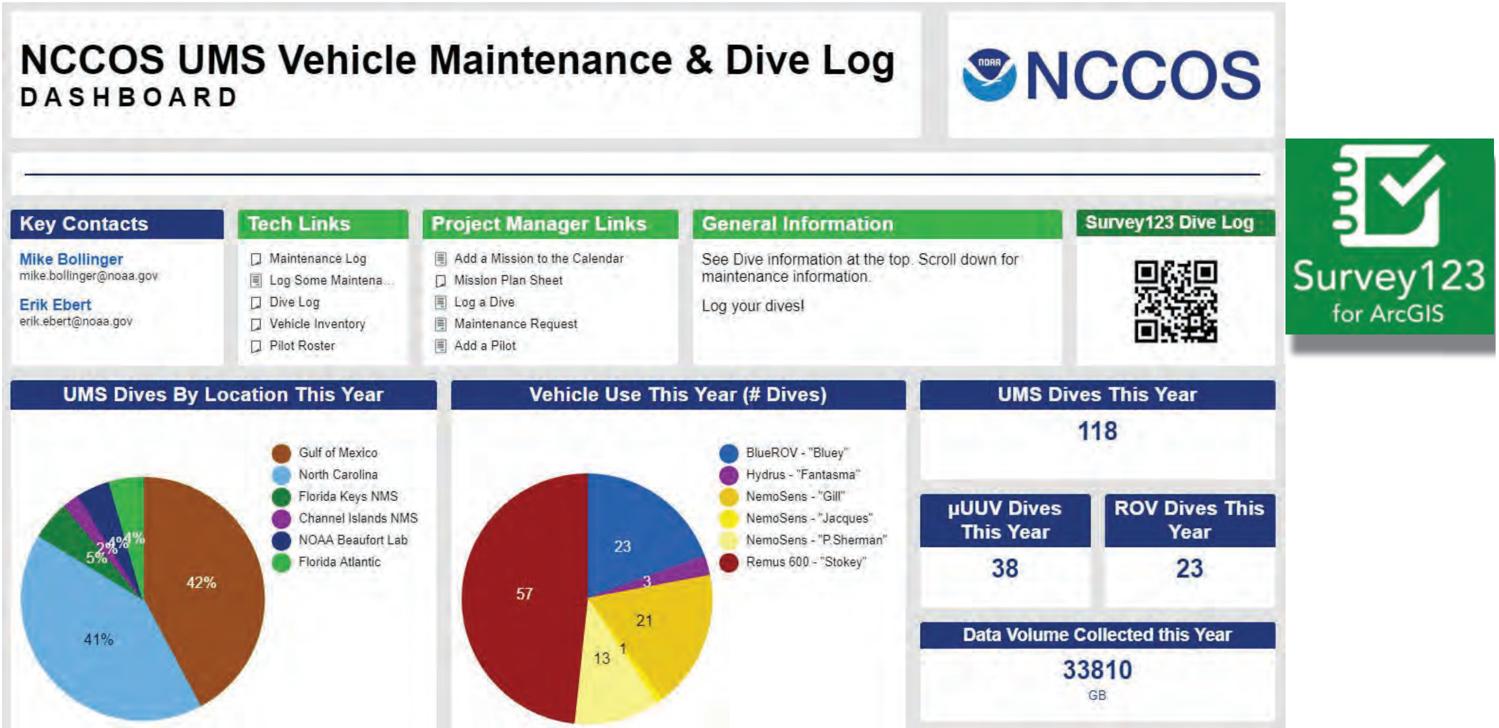
- Maintain vehicle performance and operational readiness
- Maintain operator proficiency
- Increase Technology Readiness Level and accelerate transition to operations
- Provide UMS effort metrics to higher-level NOAA UMS strategies

Approach:

- Create internal NCCOS UMS operations dashboard within Smartsheet
- Formalize development of UMS SOPs for various operations/applications
- Develop cost models for maintenance

Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
Geography: U.S. Products/Services: - Internal tracking of UMS assets and activity	Users: - NCCOS Mapping Team Intended Use: - Track UxS use, maintenance and readiness
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- NCCOS IT - NCCOS Facilities - (A) Duke University Marine Robotics and Remote Sensing (MARRS) Lab - OMAO UxS/UMS Operations Centers	Current State: - Operational Dashboard Next Steps: - Revisit data calls from UxS OC

NCCOS UMS Dashboard



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NCCOS UMS Dashboard

Select or enter value

Pilot *

Who's driving or creating the mission plan?

Select or enter value

Team

Who else is helping with the dive? Deck crew, Captain whomever is applicable.

Select or enter value

Dive Date *

Pilot Proficiency

Primary	Column2	Column3
Proficiency		
# of Dives by Vehicles by Pilot	Mike Bollinger	Erik Ebert
BlueROV - "Bluey"	8	3
NemoSens - "Gill"	21	
NemoSens - "Jacques"	1	
NemoSens - "P.Sherman"	13	
Hydrus - "Fantasma"	0	
ProSquid3	0	
Riptide - "Bert"	9	
Riptide - "Ernie"	15	

NCCOS UMS Dashboard

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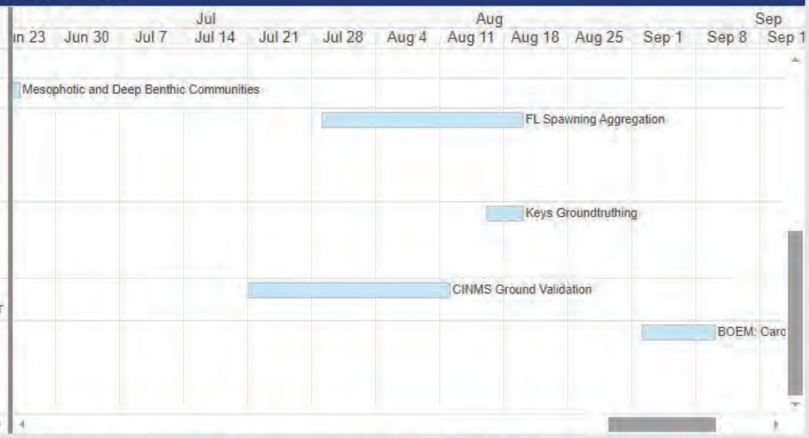
Operations

Mission Plans

Project	Location	Vehicle	Platform
		BlueROV - "Bluey" ProSquid3	
Mesophotic and Deep Benthic	Gulf of Mexico	Remus 600 - "Stokey"	NOAA Ship Pisces
FL Spawning Aggregation	Florida Space Coast	NemoSens - "Gill" NemoSens - "Jacques" NemoSens - "P.Sherman" BlueROV - "Bluey"	
Keys Groundtruthing	Florida Keys NMS	NemoSens - "Gill" NemoSens - "Jacques" NemoSens - "P.Sherman"	
CINMS Ground Validation	Channel Islands NMS	NemoSens - "Gill" Hydrus - "Fantasma"	CINMS R/V Minke CINMS R/V Shearwater
BOEM: Carolina Long Bay	North Carolina	NemoSens - "Gill" NemoSens - "Jacques" NemoSens - "P.Sherman" ProSquid3	UNCW R/V SeaHawk



RTsys NemoSens Quicklinks
- Manuals and Documentation
- CONOPS
- Mission Planning Checklist
- Order of Operations

Blue Robotics BlueROV2 Quicklinks
- Manuals and Documentation
- CONOPS
- SOP
- Pre-Dive Checklist

AdNav Hydrus Quicklinks
- Manuals and Documentation

BAE Riptide Quicklinks
- Manuals and Documentation
- CONOPS
- Bench and Staging Checklist
- Pre-Dive Checklist

NCCOS UMS Dashboard

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Maintenance

Report Something Broken or Feature Request

NOAA

Maintenance Request

Put in a request if you notice malfunctioning on any vehicle.

Vehicle *

Select or enter value

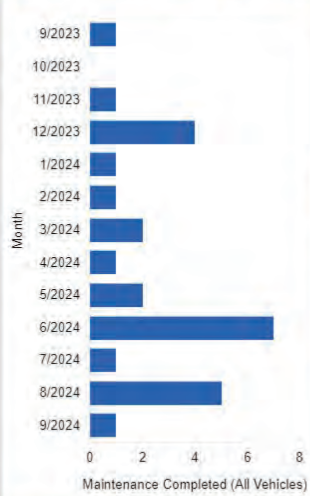
Issue Description *

Describe the issue in detail

Field Readiness Estimate *

On a scale of 0-100 how functional is the vehicle?

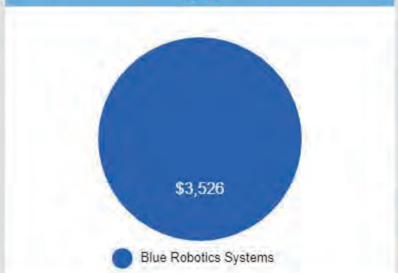
Maintenance Completed



Maintenance Status

Completed this Year	In Progress	Past Due	Future Task
12	2	0	0

Logged Maintenance Expenses This Year



Logged Spend this Year
$3,525.92

Proposed Upcoming Spend
$0.00

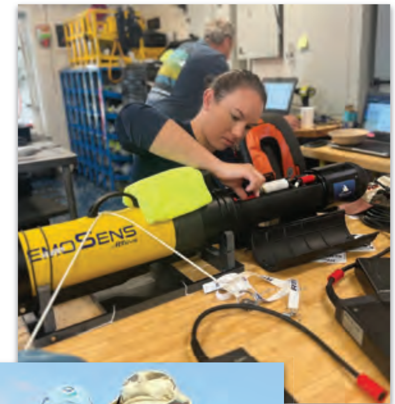
Last Year Logged Spend
$20,718.00

Vehicle Inventory

Vehicle	Last Logged Dive	Current Location	Due Back	Field Readiness Estimate	Most Recent Vehicle Configuration
BlueROV - "Bluey"	06/17/24	Beaufort, NC	Home	100	Bluey, ?, DWE exploreHD, Lumen Forward and Benthic Lights, Water Linked DVL A50, Orca Dive Lasers, Blue Robotics Batter
NemoSens - "Gill"	08/26/24	Beaufort, NC	Home	90	NemoSens_2309001, SDA14_0410254, Arctic Rays Swordfish w remora SN1, Remora Lights, NorTek Nucleus1000 DVL, No L
NemoSens - "P.Sherman"	08/28/24	Beaufort, NC	Home	100	NemoSens_2309003, SDA14_0410254, Arctic Rays Swordfish w remora SN3, Remora Lights, NorTek Nucleus1000 DVL, No L
Hydrus - "Fantasma"	08/19/24	Santa Barbara, CA	Home	100	Hydrus SN001, HydrusOS v1.4, Hydrus Cam, Hydrus Lights, Hydrus DVL, No Lasers, Built in Lithium Batteries, Advanced Nav

Lesson Learned

- Smartsheet tool box creates easy data entry, visual representation for shared resources
- “Offline” mission and survey-level metadata (Survey123) supports near-real-time asset monitoring
- Difficulty deciding on granularity of components and inventory, tedium of small parts
- Still challenging to plan outyear budgets for unanticipated repairs or losses



Quality, Relevance, Performance

Quality	Relevance	Performance
- Committing to UMS for mapping required new tools to managing inventory, assets, repairs and data	- Academic partnership (with Duke and Woods Hole Oceanographic Institute) key to identify initial components of UxS programming maintenance and tracking to develop business and cost models	- Project partners expect mission readiness of UMS - Tracking systems provides metrics to develop system “life cycles” costs and a robust business model for UMS operations

UxS for Mapping - Conclusion

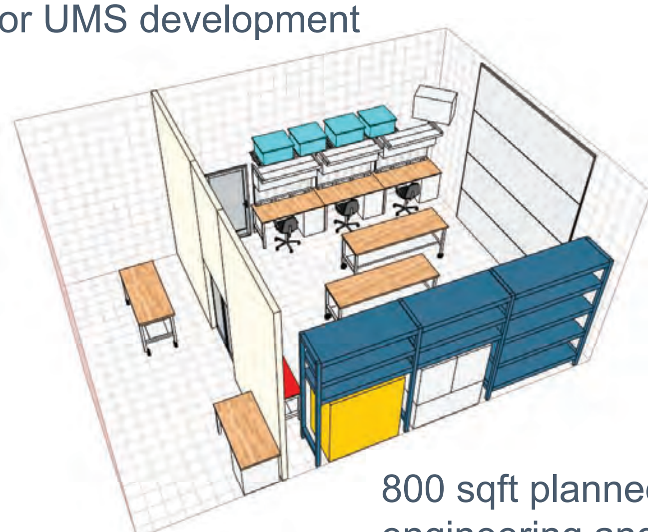
- Leveraging large projects and A-I-G partnerships key to **rapidly** advancing UMS in NCCOS habitat mapping
- Staffing to meet the next demand for increased data loads, data fusion and further sensor engineering
  - AI and data management
  - Data and systems engineer (**coming soon!**)
- Continuing to refine and balancing business model for UxS
  - Transition R&D to internal operations
  - Refine data product and operational requirements
  - Continue interfacing with NOAA UxS OC to share requirements and services available through existing IDIQ contracts

UxS for Mapping - Conclusion

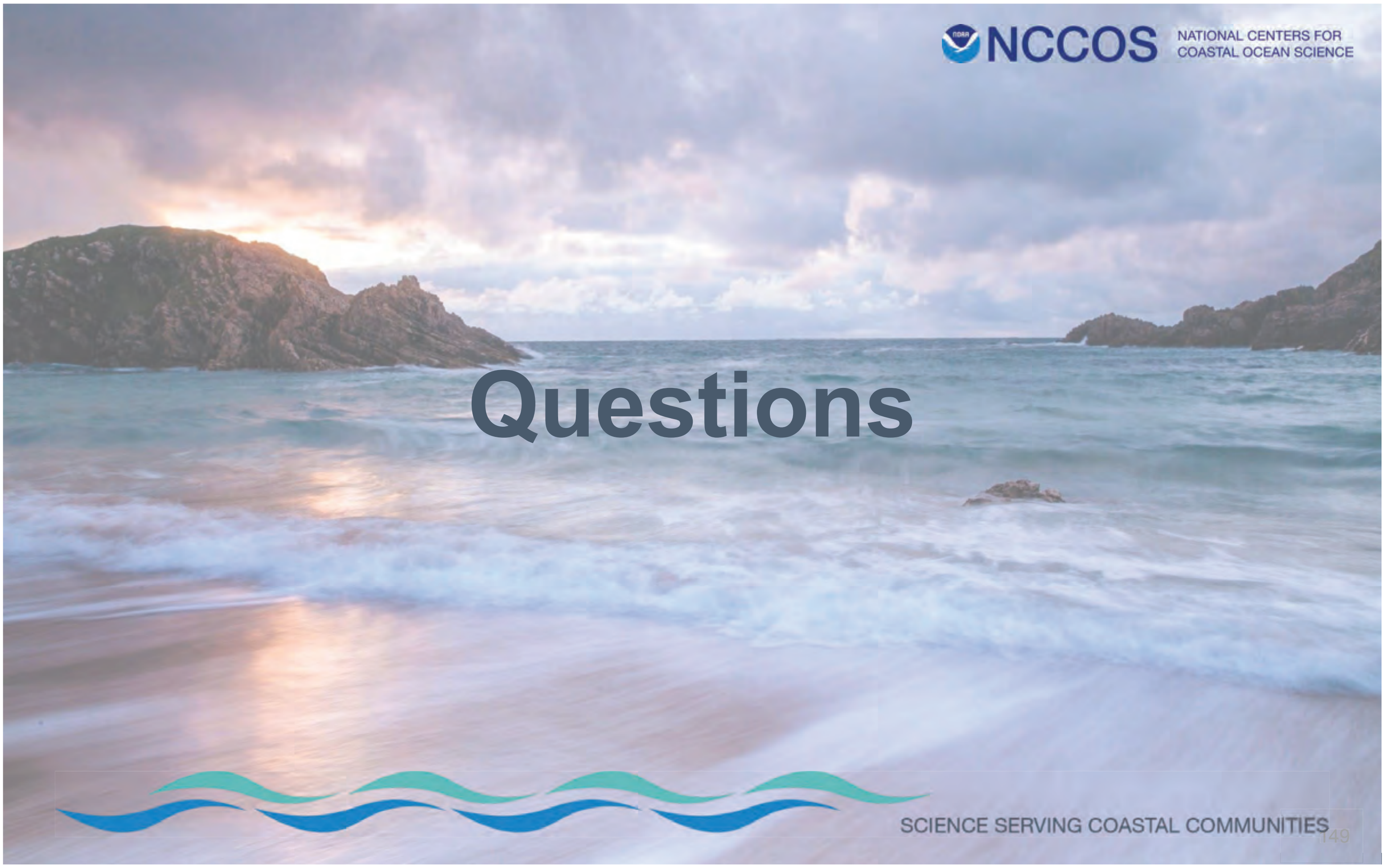
Supporting and Protecting our Investment!

- FY25 NCCOS Facilities priority to upfit UxS Facility at Beaufort Lab
- Continue use of local ocean test bed for UMS development

NOAA Beaufort Lab, ca. 2024



800 sqft planned engineering and fabrication shop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Questions
SCIENCE SERVING COASTAL COMMUNITIES
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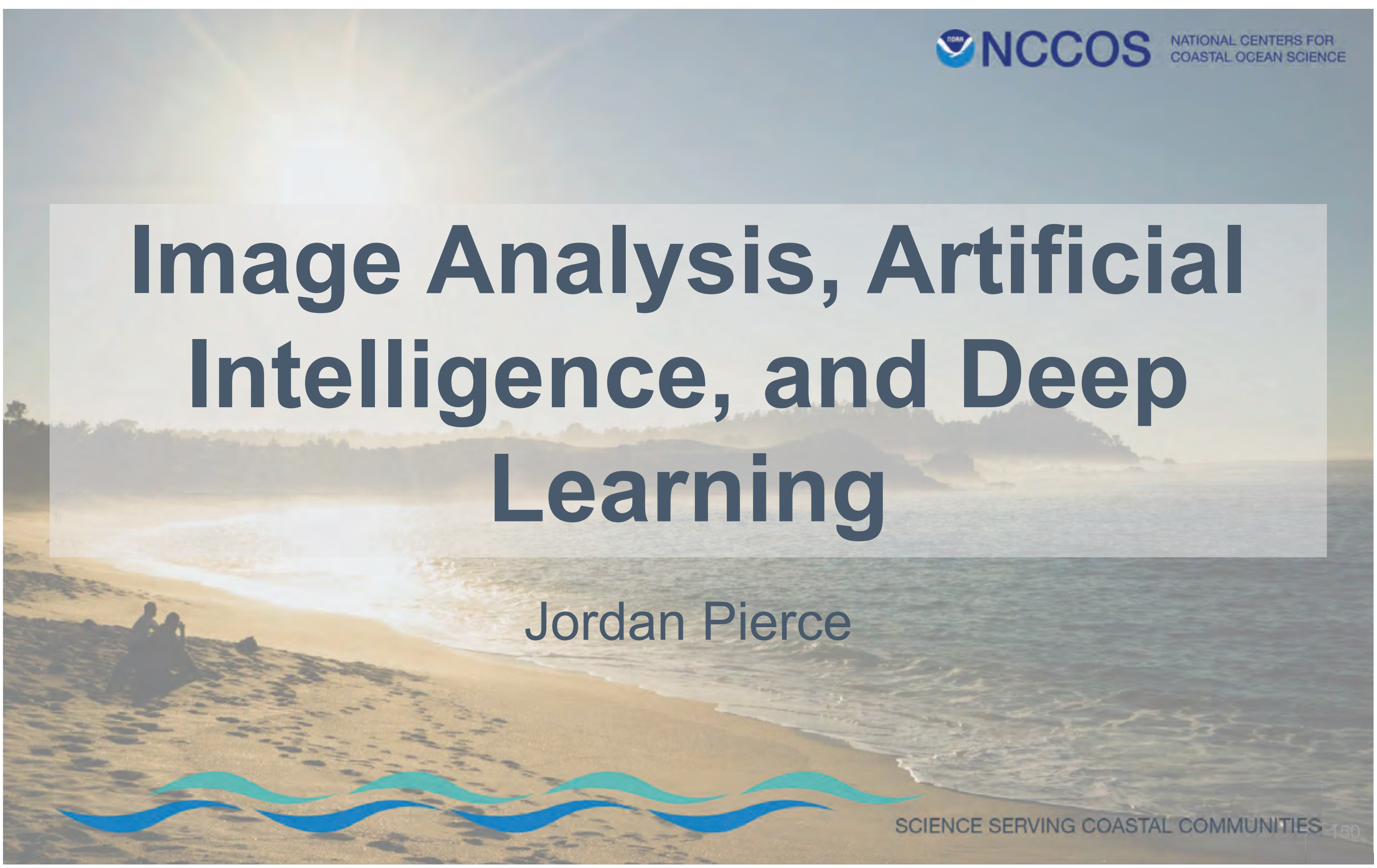
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Image Analysis, Artificial Intelligence, and Deep Learning
Jordan Pierce
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150

Overview

Using remote sensing platforms like satellites, underwater drones (UxS), and SCUBA, HMT analyzes **imagery** to characterize underwater habitats at various levels, from species to community. 📸

However, **manual** analysis of this imagery data is expensive, time-consuming, and subjective. Moreover, important yet subtle patterns may remain undetected when analyzing **large-scale** data.

Fortunately, recent developments in Artificial Intelligence (AI) and affordable computation resources offer an opportunity to **automate** various processes, including **annotation**. 🤖

Case Study 1: Mesophotic Deep Benthic Communities

The Mesophotic and Deep Benthic Communities (**MDBC**) portfolio focuses on restoring Gulf of Mexico ocean floor ecosystems impacted by the **Deepwater Horizon oil spill**.

The portfolio consists of multiple components involving **seafloor mapping**, coral propagation, and habitat assessment.

Mapping efforts are facilitated through the use of manned and unmanned vehicles, including **remotely operated vehicles** (ROVs), collecting video data from downward and forward facing cameras.

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Forward-facing ROV Video Data

Forward-facing ROV video data

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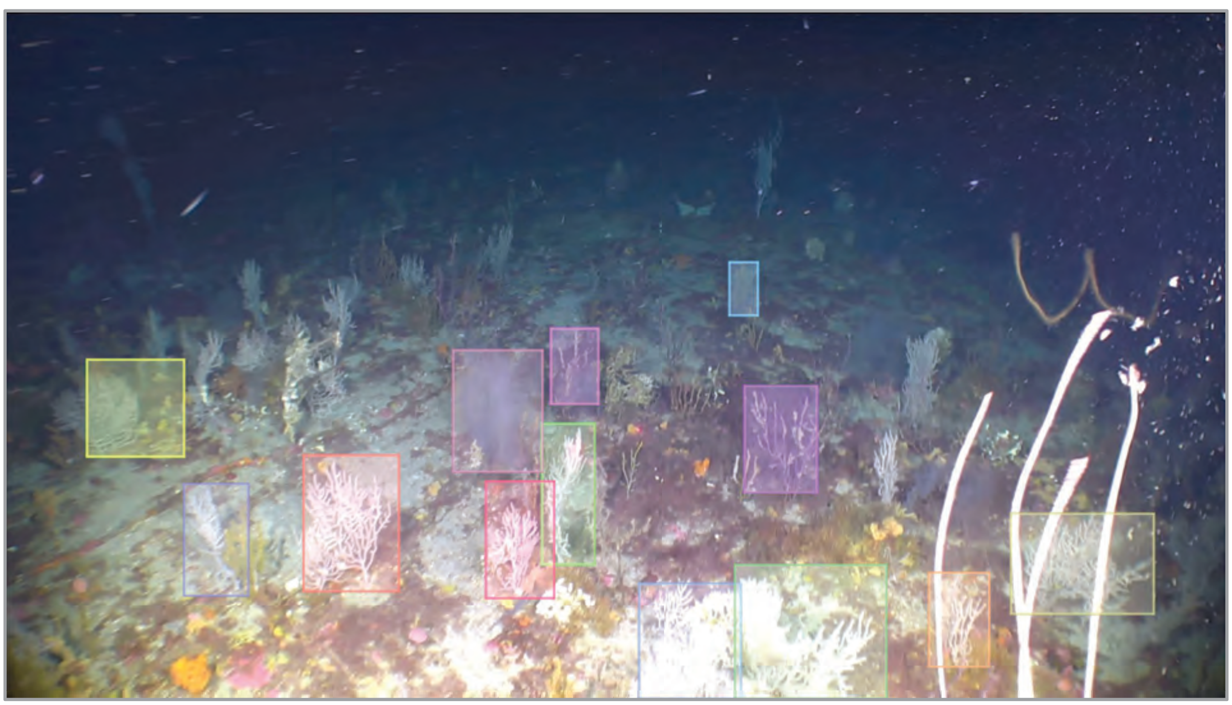
Annotating Frames from ROV Video



Annotating organism of interest with bounding box localizations in TATOR, cloud-based annotation platform by CVision.

Challenge

To facilitate robust analysis, ideally all individual organisms of interest are identified, localized, and tracked.

However, MDBC collects ~N hours of ROV video running at 24FPS, per field season (annually).

Annotating at this fidelity **manually** and in a timely manner is *unrealistic*. However, when done with an algorithm a majority of it can be done in *real-time**.

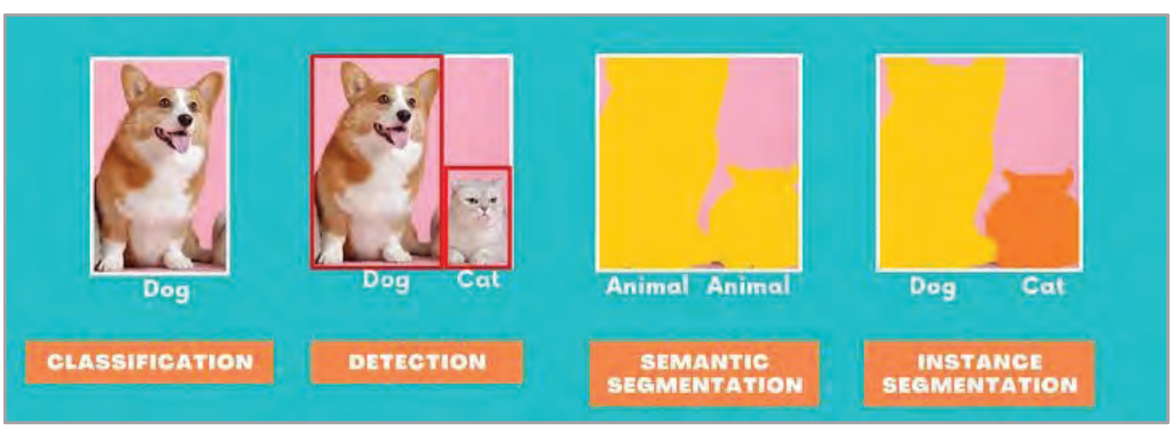
Objective

In an effort to reduce cost, time, and manual effort performed by scientists, we explore the development and implementation of Computer Vision algorithms to assist in automating the annotation process.

Computer Vision

Computer vision is a *field* of AI that enables computers to **interpret** and **understand** visual information from the world.

It involves techniques and algorithms that allow machines to recognize objects, identify patterns, and make decisions based on **images** or **video** feeds.



Common Computer Vision tasks.

Roadmap

Model Development

Generic "Object" detector

"Coral", "Fish", "Sponge" detectors

Genus/Species detectors*

Iterative Progress (continued training on ground-truth)

Assessment
Model hosted and running inference locally

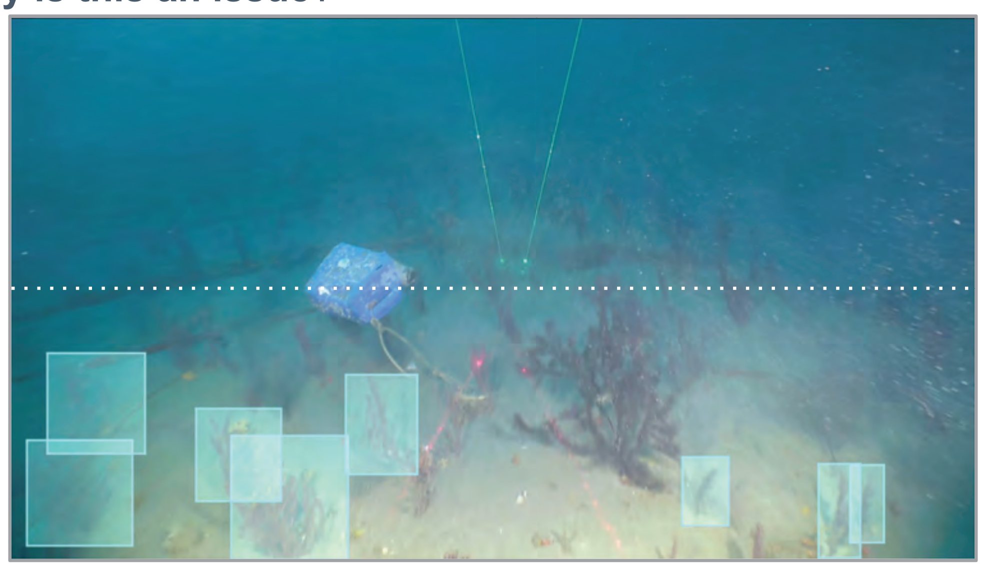
Operational
Model hosted locally, uploading predictions to TATOR

Production
Model hosted and running inference to TATOR in cloud

Implementation

Problems with Annotations

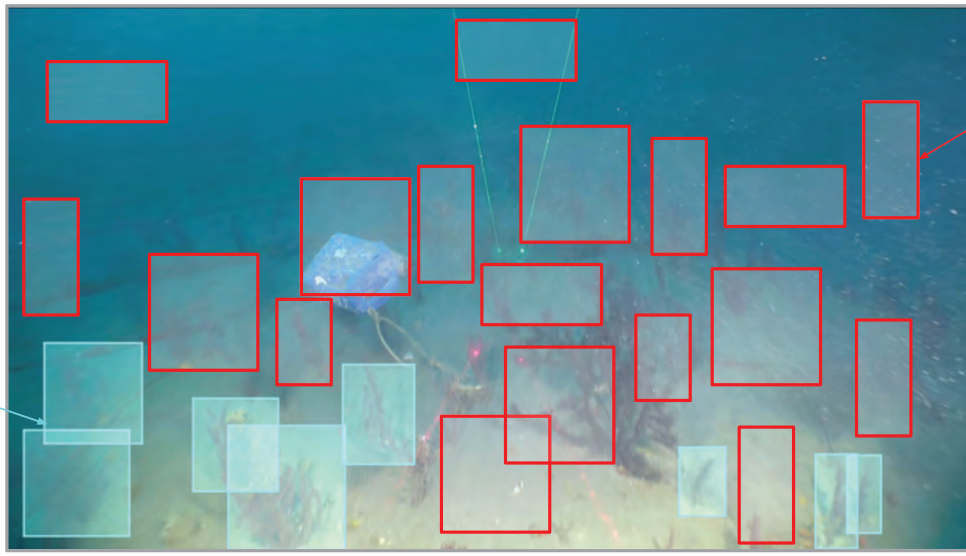
Scientists create bounding boxes (i.e., localizations) in a specific way to facilitate *analysis*; **why is this an issue**?



Localizations are made below an approximated horizon, and only when they are initially "seen" within.

Problems with Annotations

Scientists create bounding boxes (i.e., localizations) in a specific way to facilitate *analysis*; **why is this an issue**?



Negative examples are sampled outside of positive (ground-truth) examples.

Creating a New Datastream

- Asking scientists to change how they label for their analysis is **not recommended**.

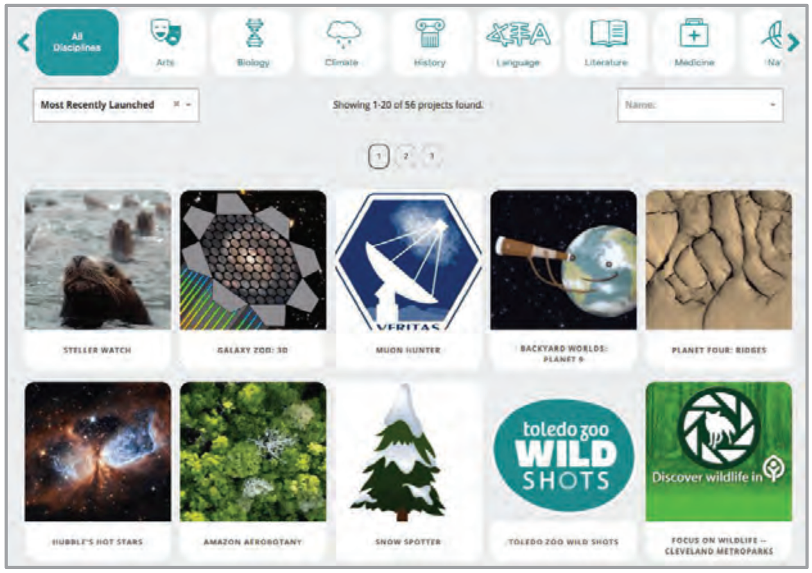
- Instead, we created a new datastream to obtain annotations specifically for training a object detection model.
    - These annotations are only used to train a model, *not for analysis*.
    - However, the model will / is being used to assist in annotating for analysis.

- To facilitate this new datastream, we used **Zooniverse.**

Zooniverse

- **Web-based** platform for scientists to leverage the time and interest of citizen scientists to assist in research projects.

- Free, open-sourced, and a great tool for community outreach that increases transparency to the public on what NOAA's mission involves.



Zooniverse Logistics

- **We create a Project** ("Click-a-Coral") and control everything within it: data, education resources, tutorials, field guides, community forum.
- **We create a workflow** (e.g., game) consisting of multiple tasks: identity a coral, create bounding box around it, provide species / genus classification.
- **We populate** the workflow with frames pulled from ROV videos.

- **They perform the workflow** in their web-browser, providing us with labeled data for training AI.
  - At the time of writing, Click-a-Coral had *2,705* registered volunteers (and growing).

Frontend

Code for generating results created by intern **Kira Kaplan**

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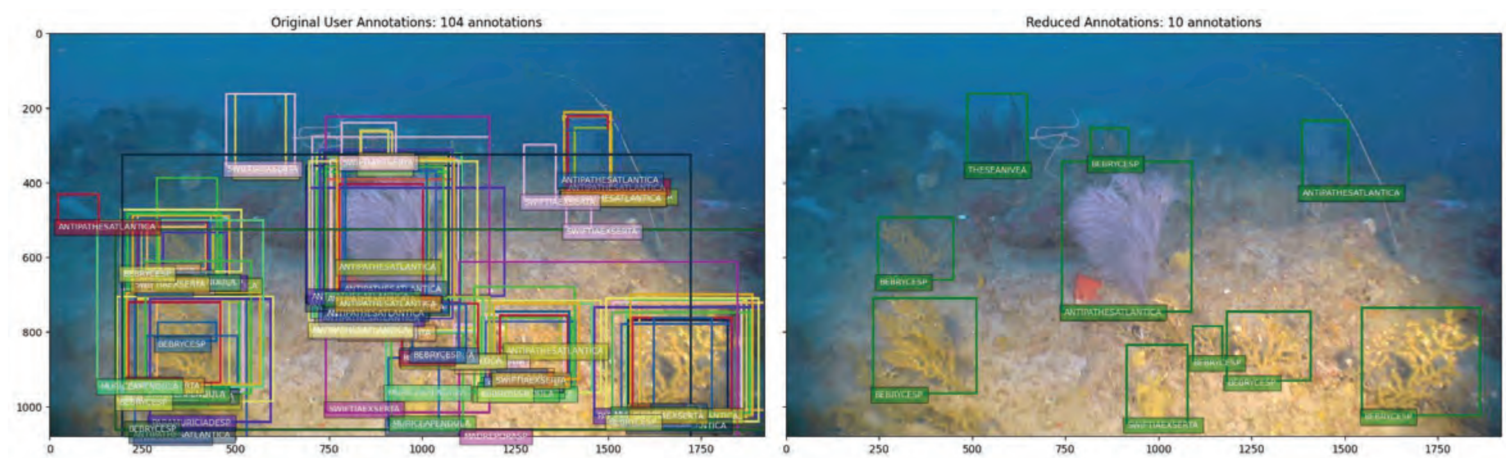
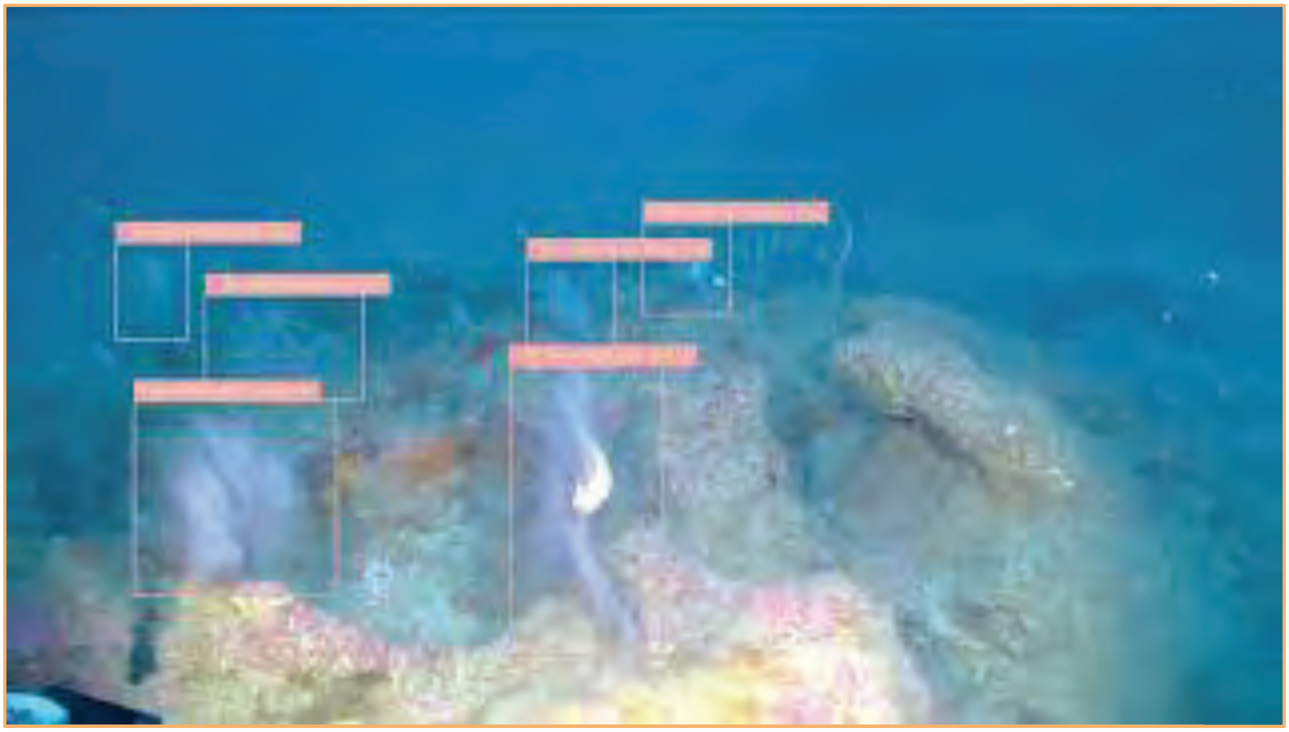
Visualizations: Raw & Reduced



Programmatically “reducing” the raw users’ annotations into a **consensus**, making them useful for training AI.

Model Inference - Novel Video



Results after training on *just* Season 1

Current Status

- Continuous iterations of Zooniverse, and model development 🤗
- In the process of operationalizing the model in TATOR, accessible to users to use at their discretion.

- Python code available on **GitHub** and ready to be used. 🚀
  - GitHub.com/Jordan-Pierce/Click-a-Coral
  - GitHub.com/Jordan-Pierce/Benthic-Mapping

Lesson Learned

- "Annotations" made (for analysis, or otherwise) do not always lend themselves for machine learning.
  - If a project hopes to use AI, conversations need to be had at the beginning of the project.
  - Annotation → Analysis → Machine learning ❌
- It may be beneficial to create separate datasets: one for training a model, another for analysis.
  - Who annotates, and why they are annotating, will affect the results.
- Crowdsourcing (Zooniverse) takes some time to set up, but afterwards, is low maintenance.
  - Results are good enough to train a useful model.

Desired End Products	Target User Group
• AI model, fine-tuned on specific MDBC target species of coral, fish, and sponges found in GoM (may generalize to other environments); • AI-ready dataset (object detection).	• Researchers of coral / sponges / fish in mesophotic / deep benthic regions in GoM; • Machine Learning / Computer Vision engineers / researchers.
Key Partners	**Synopsis Current State of Product**
• SEA Branch; • Southwest Fisheries; • Cvision; • Zooniverse volunteers.	• Continuation of annotations, and iterations of model development; • Operationalize model in TATOR; • Open source data / models.

Quality, Relevance, Performance

Quality	Relevance	Performance
- Transitioning from manually annotating images (costly), to using modern / cutting-edge deep learning algorithms. - Helps to remove "human" bias from annotation. - Allows for the complete annotation of videos, opposed to spot-checking every N frames.	- Helps to address the "big data" bottleneck with regards to pre-processing MDBC imagery data for species localization / analysis. - Reusable models and AI-ready datasets for future projects.	- Allows for faster, automated annotation with scientist-in-the-loop. - Pre-labeling data in real-time becomes a possibility. - Helps to addresses issues with unannotated data in archives, backlogs.

Case Study 2: Great Lakes

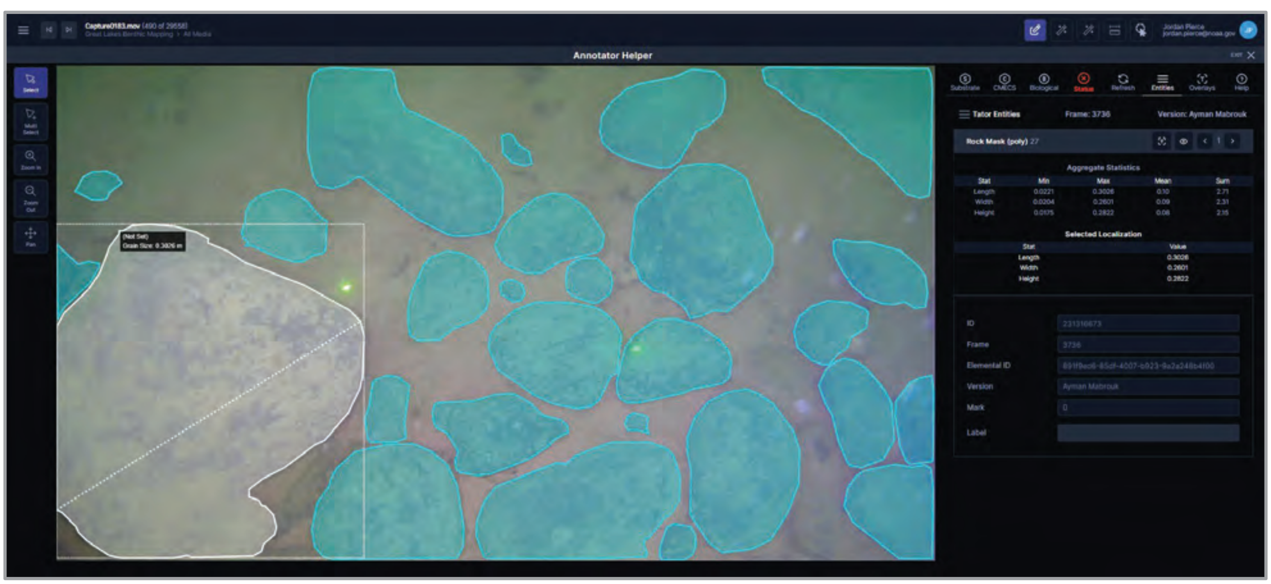
The project is led by NOAA's Office for Coastal Management, and funded by the Great Lakes Research Institute, with many partners participating.

The campaign seeks to address diverse emerging ***littoral* management issues** (i.e., invasive species, habitat degradation, coastal erosion).

The campaign is also meant to inform **restoration priorities and resource management.**

DropCam Video

Generating Ground-Truth for CMECS



AUV and DropCam video footage are being collected in Great Lakes, and annotated in TATOR for CMECS classification. TATOR provides tools for creating instance masks (e.g., polygons), and approximating size for each mask given scale.

Challenge

To facilitate robust analysis, ideally enough individual “rocks” are annotated within sampled frames.

Doing this **manually** and in a timely manner is expensive. However, when done with an algorithm, a majority of it can be done in *real-time**.

Objective

In an effort to reduce cost, time, and manual effort performed by scientists, we explore the development and implementation of Computer Vision algorithms to assist in automating the annotation process.

Roadmap

Model Development

Generic “Rock” detector

Iterative Progress (continued training on ground-truth)

Assessment
Model hosted and running inference locally

Operational
Model hosted locally, uploading predictions to TATOR

Production
Model hosted and running inference to TATOR in cloud

Implementation

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Generating Training Data

Why

Without existing masks to **train** a supervised model with, we rely on **foundational models** to assist us in creating training data automatically.

What

A Foundational Model is one previously trained on **billions** of samples from various domains, allowing it to generalize and identify a large number of categories; **Rock** is one of them.

How

Using a technique called **AutoDistill**, we use a foundational model to label our images containing rocks; these labels are then used to **fine-tune** a smaller model to our specific task.

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Generating Training Data

Why not just use the foundational model?

The foundational model is large (i.e., slow / expensive) and cannot be fine-tuned without extensive computational resources and data samples.

Although it can find rocks, it’s not tuned to find **our rocks** specifically.

Generating Training Data

First, we extract frames from videos, and then split them into two categories: **With Rocks**, and **Without Rocks**.

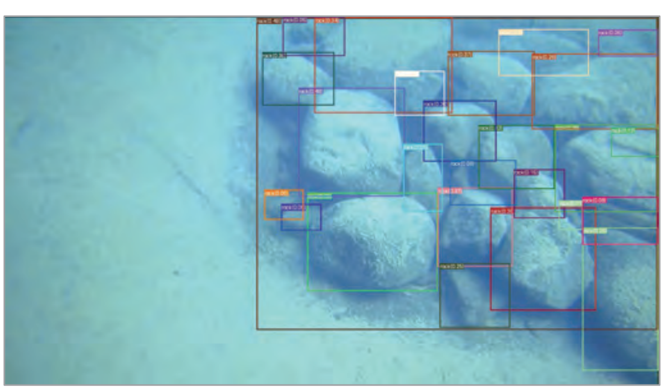
With Rocks
N ~= 8000

Without Rocks
N ~= 3000

Generating Training Data

We then use foundational models (DINO and SAM) to create bounding boxes and masks for each image **With Rocks.** Those **Without Rocks** serve as negative sample, containing no labels.

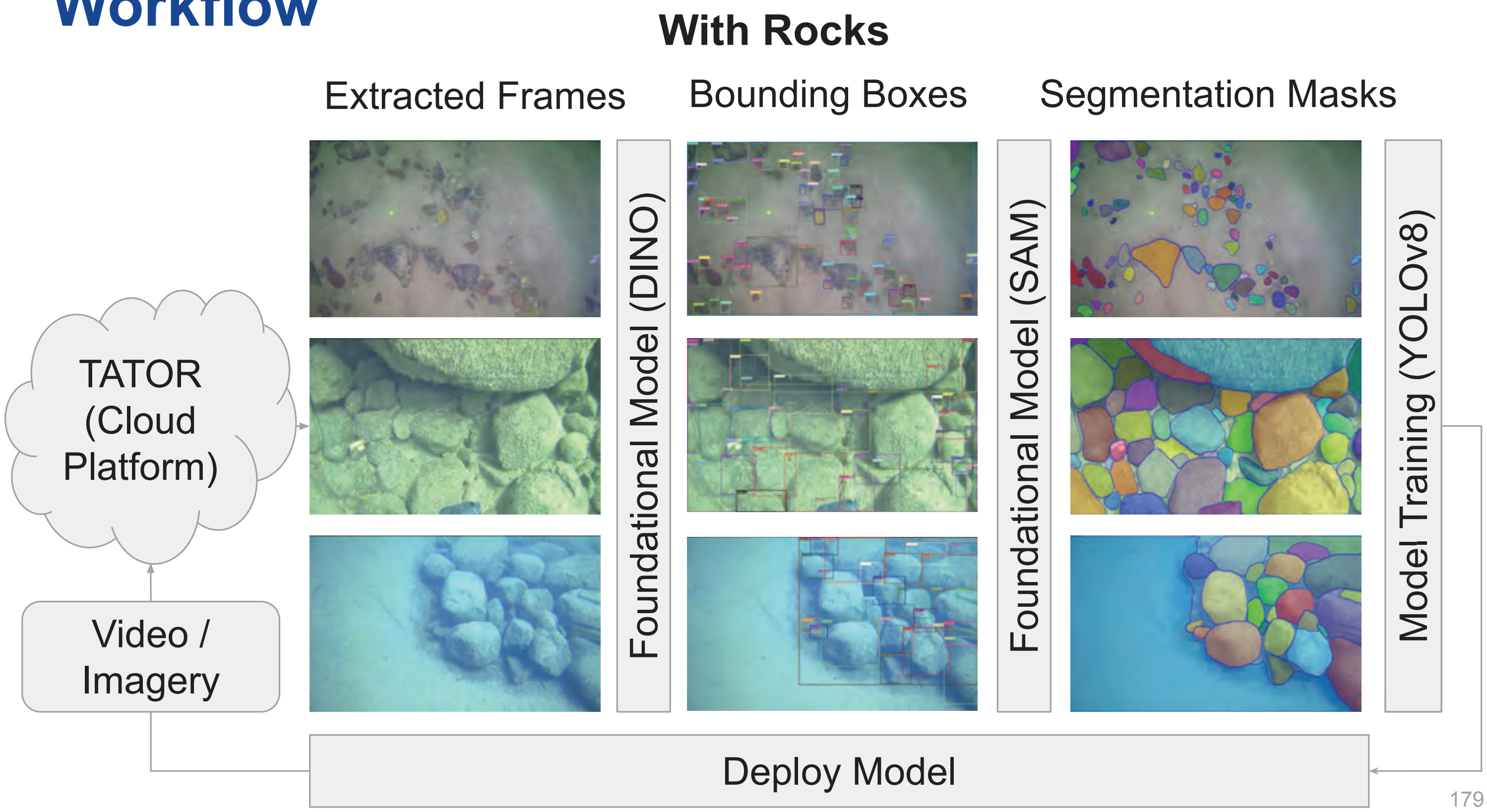
With Rocks



Bounding Boxes

Masks

Workflow



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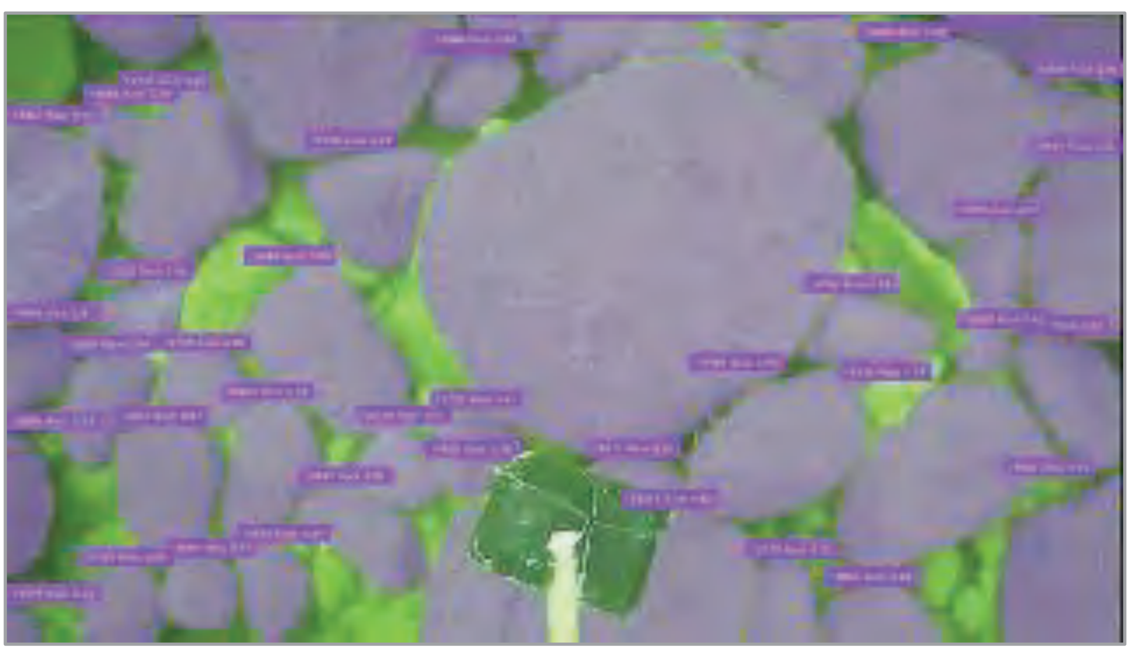
Current Model



RT-DETR fine-tuned on AutoDistill labeled data

Current Status

- Continuous iterations of model development 🤗
- In the process of operationalizing the model in TATOR, accessible to users to use at their discretion.

- Python code available on **GitHub** and ready to be used. 🚀
  - GitHub.com/Jordan-Pierce/Benthic-Mapping

Lesson Learned

- AutoDistill is a useful technique for automatically generating labeled data, however, it requires heuristics and “hand-holding”
  - Not applicable for domains outside of a foundational model’s training set.

Desired End Products	Target User Group
• AI model, fine-tuned on specific GL rocks (may generalize to other environments); • AI-ready dataset (instance segmentation).	• Great Lake / geology researchers; • Machine Learning / Computer Vision engineers / researchers.
Key Partners	**Synopsis Current State of Product**
• Great Lake Research Institute Partners (many); • CVision.	• Continuation of annotations, and iterations of model development; • Operationalize model in TATOR; • Open source data / models.

Quality, Relevance, Performance

Quality	Relevance	Performance
- Transitioning from manually annotating images (costly), to using modern / cutting-edge deep learning algorithms. - Helps to remove “human” bias from annotation. - Allows for more precise analytics (w/ scale), as opposed to visual assessment.	- Helps to address the “big data” bottleneck with regards to pre-processing Great Lake imagery data for CMECs classification / analysis. - Reusable models and AI-ready datasets for future projects.	- Allows for faster, automated annotation with scientist-in-the-loop. - Pre-labeling data in real-time becomes a possibility. - Helps to addresses issues with unannotated data in archives, backlogs.

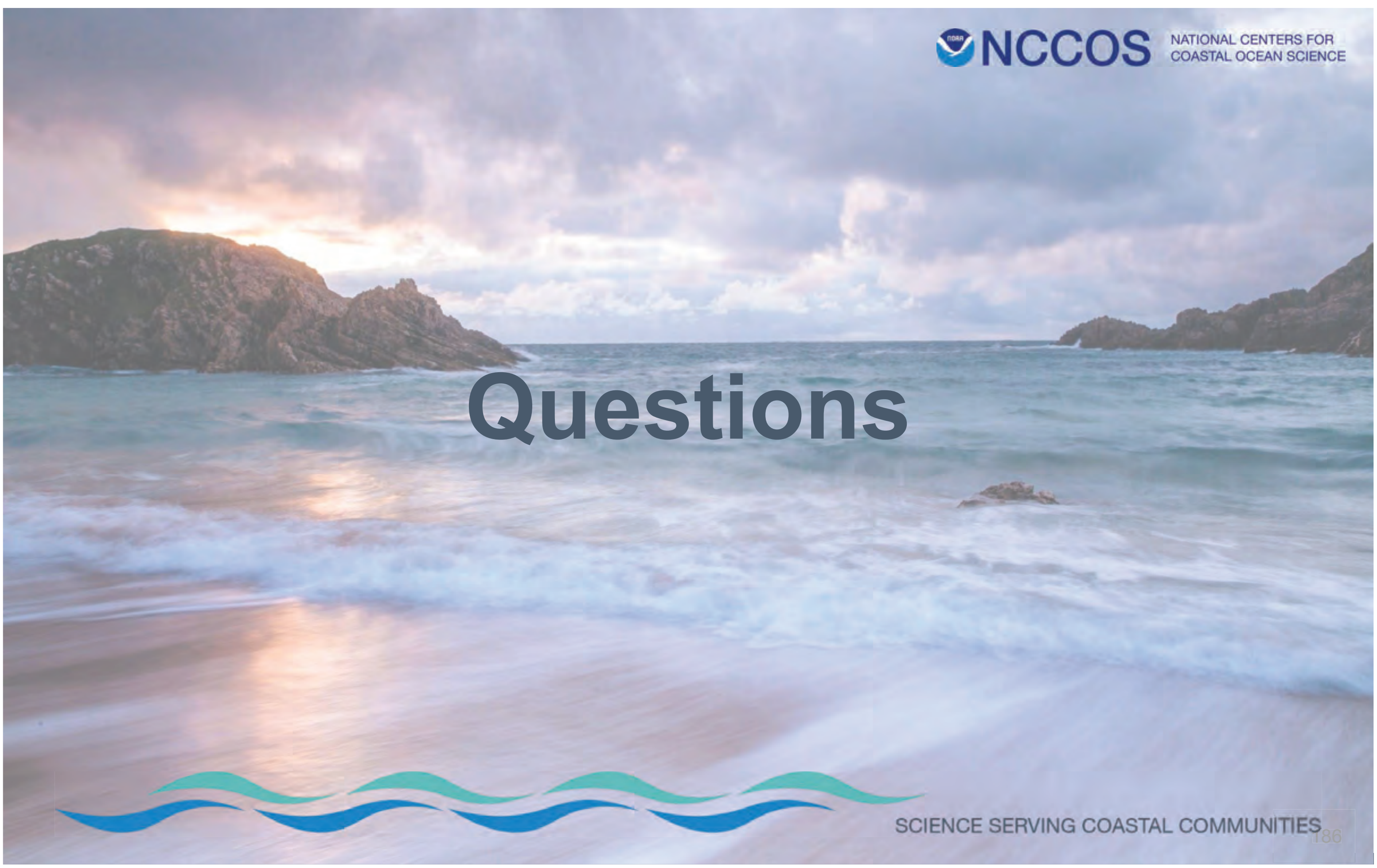
Conclusion

Continued efforts in SEA branch to:

- Automate the annotation of imagery data;
- Open-source code, make available in platforms such as GitHub.

Future goals are to:

- Open-source models, and AI-ready datasets to geoscience researchers, and the machine learning community;
- Staffing up on more “Jordan”s, creating an internal NCCOS Data Science team.



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BREAK

Return by 3:00pm

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Data Management, Visualization, and Dissemination

Asmita Shukla

Overview

Data management is usually an afterthought and leads to:

- Inefficient at-sea operations
- Data unreliability
- Data losses
- Fragmentary data analyses
- Poor decisions
- **Lack of trust in organization's ability to conduct data-driven science**

Enterprise Data Management System

Asmita Shukla

Collaborators: Kristin Chader-Bostick, Kirk Yedinak, Ben Wade (Information Technology Branch)

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From 2019 Biogeography Branch Review: *Develop a more holistic and sophisticated approach towards managing observational and geospatial data (with support from IT)*

Challenges:
- Unstructured data
- Multiple collectors
- Lack of standards
- Data volume
- Segregated storage

Needs:
- Collaboration with IT to create, manage, and back-up a centralized database
- Develop data standards per data type
- Cloud data processing

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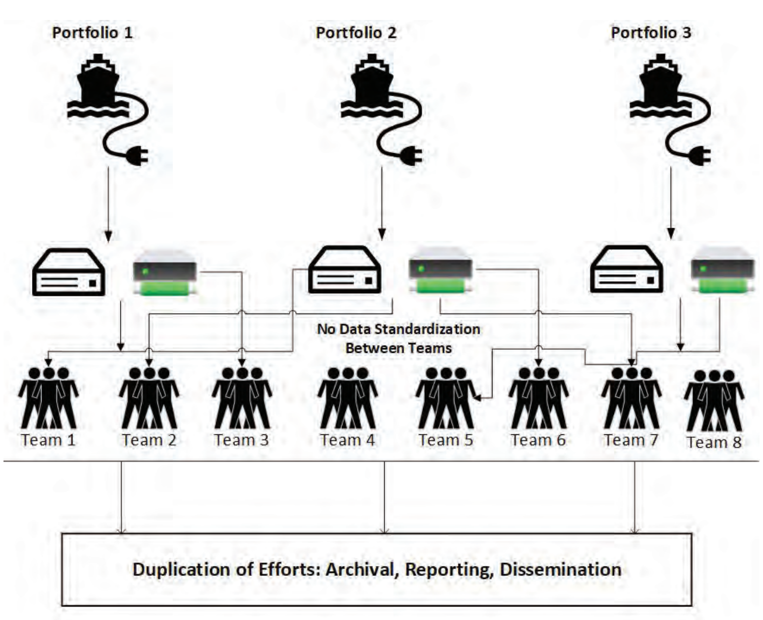
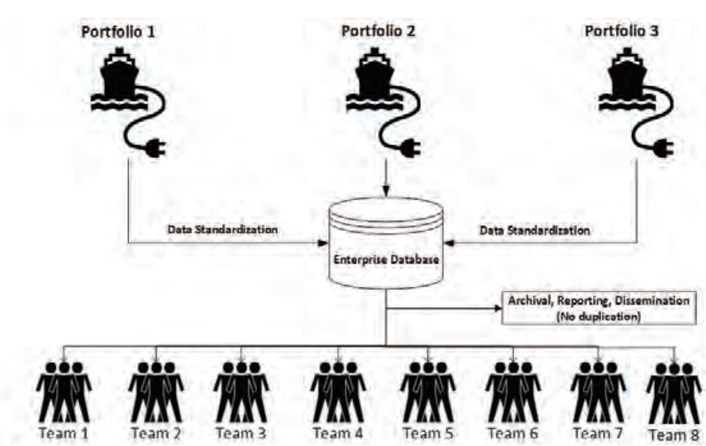
Data Management Approach

Previous



Current



Enterprise Data Management Approach: Concept

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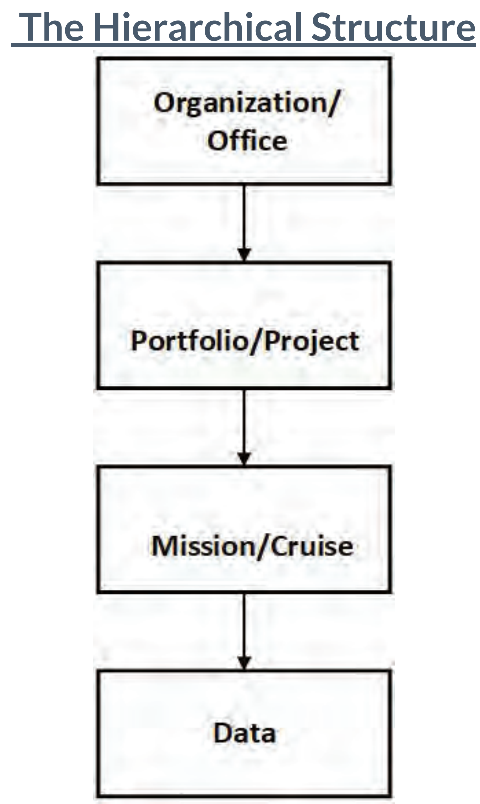
- Collaboration with IT
- Structured Query Language (SQL) Server Database in Azure
- Database schema designed based on collection types and implemented
- Test project: Mesophotic and Deep Benthic Communities Restoration (MDBC)
- Scalability



Enterprise Data Management Approach: Concept

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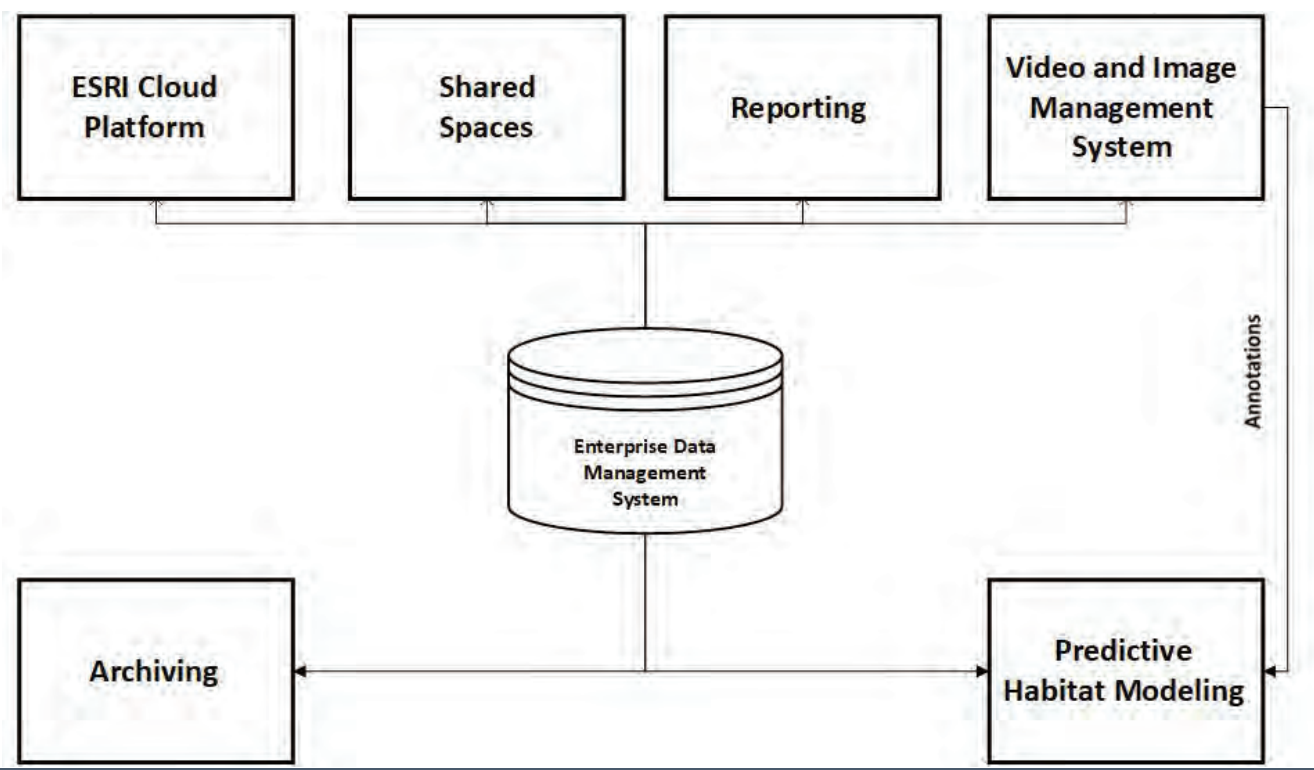
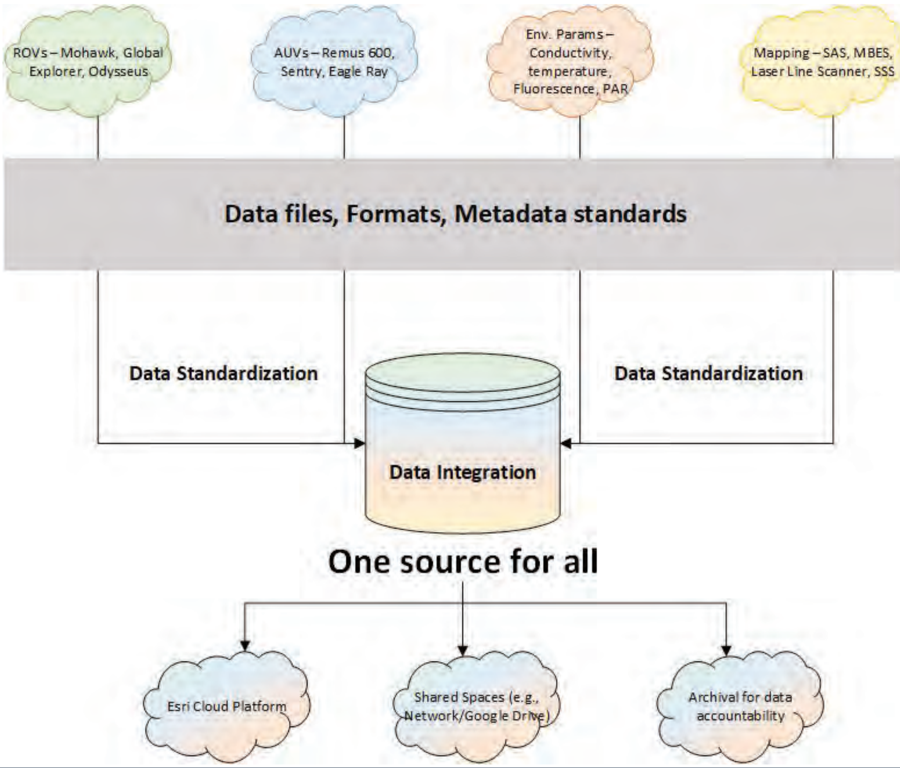


Efficiencies Achieved (Demo Through Examples)



Data Standardization, Integration and Versioning

- Data from a spectrum of vehicles/equipments/sensors standardized and integrated
- Facilitates big data analytics (volume, variety, and velocity)
- Allows for data versioning/quality tracking

Efficiencies Achieved (Demo Through Examples)

Cost-efficient Data Management

- File management vs developing a data standardization protocol
  - Average 80% ROI per data type (time)
- Developing and managing data visualization applications
  - Manage one data source - automatic transition of changes to downstream applications
  - Greater data visibility given the integration of data from multiple sources
- Eliminating the need for keeping local copies; save space on network drives
  - Expensive on premise storage ($500/TB)
- Authoritative, quality assured products
  - Reduces data errors

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Efficiencies Achieved (Demo Through Examples)

Ease of Querying

- Example: Where do we have data from Benthic Landers on West Florida Escarpment at a Depth > 1500 m

  SELECT * FROM [dbo].[LANDERINFO] INNER JOIN LAUNCHSITEINFO
  ON LAUNCHSITEINFO.CruiseID = LANDERINFO.DeploymentCruise AND
  LAUNCHSITEINFO.SiteID = LANDERINFO.DeploymentSite
  WHERE LAUNCHSITEINFO.GeneralLocation = ‘West Florida Escarpment’ and
  LANDERINFO.DeploymentDepth_m > 1500

Results | Messages

	LanderID	LanderName	LanderAlias	LanderOwner	DeploymentCruise	DeploymentSite	DeploymentDive	RecoveryCruise	RecoveryDive	LanderType	DeploymentLat	DeploymentLon	DeploymentDepth_m
1	ARM-01	ARMS1	ARM-01	Lehigh	NF2306	S027	ROV-11	NULL	NULL	Autonomous Reef Monitoring System	27.99692	-86.36301	1506
2	ARM-02	ARMS2	ARM-02	Lehigh	NF2306	S028	ROV-11	NULL	NULL	Autonomous Reef Monitoring System	27.99692	-86.36301	1506
3	ARM-03	ARMS3	ARM-03	Lehigh	NF2306	S031	ROV-12	NULL	NULL	Autonomous Reef Monitoring System	27.99559	-86.35497	1505
4	LND-04	Benthic Lander 4	URILND014	OECI	NF2306	S017	ROV-07	NF2306	ROV-07	Benthic Lander	27.67272	-85.6295	1710
5	LND-05	Benthic Lander 5	URILND015	OECI	NF2306	S024	ROV-07	NULL	NULL	Benthic Lander	27.99682	-86.36283	1512

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Efficiencies Achieved (Demo Through Examples)

Ease of Querying

- Example: Query all different resolutions of bathymetry data collected by NOAA Ship Pisces

  SELECT DISTINCT Resolution, Area_km2, CruiseID, DataType, Platform, Equipment, Analyst
  from MAPPINGMETADATA where CruiseID LIKE 'PC%' and DataType = 'Bathymetry' and
  Platform = 'Ship';

Results | Messages

	Resolution	Area_km2	CruiseID	DataType	Platform	Equipment	Analyst
1	16.0m x 16.0m	1038.128296	PC2302L1	Bathymetry	Ship	MBES EM2040	Geodynamics
2	4.0m x 4.0m	1034.207031	PC2302L1	Bathymetry	Ship	MBES EM2040	Geodynamics
3	8.0m x 8.0m	1037.322632	PC2302L1	Bathymetry	Ship	MBES EM2040	Geodynamics

Lessons Learned

- An enterprise/central database is necessary for a cost-efficient, data-driven analysis
- Collaboration with IT is required
- Data standards need to be developed and accepted by all
- Using a standard field data collection system adds efficiency to the data management and processing
- Every project requires a dedicated data manager

Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
• Standards (including those for metadata) for collected data types • Azure SQL Server database in Production environment • Near-real time update of data sourced by visualization and dissemination applications	• Data standardization • Data dissemination • Data visualization • Data integration • Quality assurance • NCCOS staff and external collaborators
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
• Seascape Ecology and Analytics (SEA) Branch (Development) • Information and Technology (IT) Branch (Support) • Biogeography Branch (Data contributor)	• Schema designed • Database (Development environment) in use • Database connected to data visualization and dissemination applications • Ingest data from non-Mesophotic Deep Benthic Communities projects (next step)

Quality, Relevance, Performance

Quality	Relevance	Performance
• Standardized, quality assured, reliable data • Data versioning • One data source for all applications	• Ease of data visualization and dissemination • Data integration for complex analytics • Data accountability and tracking • Ease of collaboration with external stakeholders	• Streamlined operations • Scalability potential • Increased productivity and cost-efficiency • Data security • Improved prioritization of future operations

ArcGIS Online Hub

Asmita Shukla

Collaborators: Madeleine Gallop, Rabiya Dar (SEA Branch)

From 2019 Biogeography Branch Review:

"Feasibility of developing a single portal for accessing all of the program's data"

"Portal to portal collaboration (e.g., Digital Coast or the NOAA Geoplatform)"

Challenges:

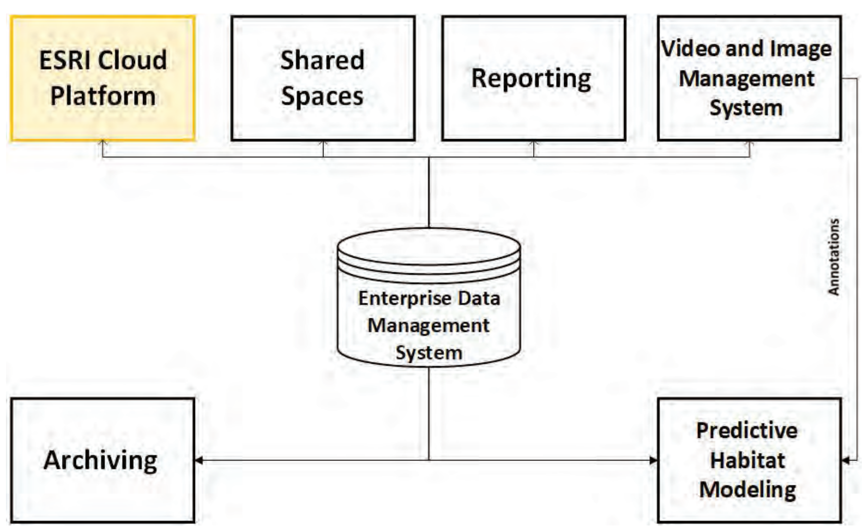
- Segregated resources
- Disconnected information and data access management
- Stakeholder communication
- Number of data product types (web maps, dashboard, imagery and feature layers, etc.)

Needs:

- Single platform to
  - Aggregate resources
  - Enable collaboration among stakeholders
  - Enable data sharing

ArcGIS Online Hub

- Cloud-based engagement platform
- Easy to configure
- Segregates resources
- Enables hosting of all ArcGIS Online item types
- Connect to external pages



- **Web Maps**
- **Hosted Feature Layers**
- **Hosted Imagery Layers**
- **Dashboards**
- **Mission Plans**
- **Reports**
- **SOPs**
- **Data Catalogs**

https://mdbcmgmhub-noaa.hub.arcgis.com/

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Lessons Learned

- Compiling project resources including data provides greater visibility
- Hub facilitates better communication facilitates enhanced stakeholder communication
- Leads to greater transparency
- Helps stakeholders identify authoritative data sources
- Enhances transparency

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Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
• A functional Hub website containing links to authoritative geospatial data on AGOL, applications (dashboards, web maps), and frequently used information. • Website shared with internal and external stakeholders	• Project team members, stakeholders • Operation planning • Data analysts/modelers • Communication
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
• Seascape Ecology and Analytics (SEA) Branch (Development) • Biogeography Branch (Data contributor)	• Website framework ready • Embedding data links (in progress) • Compiling and embedding links to important documents (in progress) • Actively manage and share with the stakeholders (next step)

Quality, Relevance, Performance

Quality	Relevance	Performance
• One source for all project resources including data	• Increased stakeholder communication • Enhanced project visibility • Authoritative dataset increases data transparency	Ease of: • Website development and management • Navigation through project data and documentation • Providing data access

Conclusion

- Data standardization and integration is imperative for maximizing the value of data we collect
- An enterprise database reduces potential data errors, protects NCCOS from data loss, and helps scale up analyses
- Enterprise data management system can lead to considerable cost savings (staff time and data storage) in addition to unrealized gains such as better data quality
- A one stop shop for all project resources such as a Hub website facilitates enhanced stakeholder communication, and data visibility and reliability while identifying duplication of efforts

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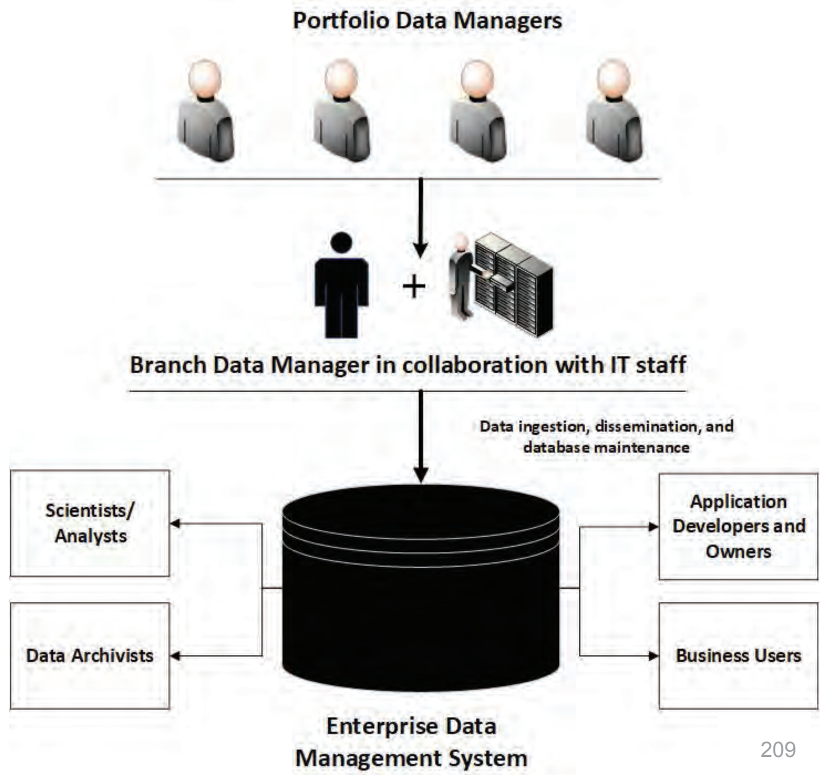
Conclusion (Resources Required)

Leveraging the SQL Server database as an enterprise solution

- Portfolio data managers with detailed understanding of portfolio requirements
- Branch data manager with understanding of the enterprise system and ability to reconcile portfolio requirements with those of the schema
- IT staff for database maintenance, backups, data pumps



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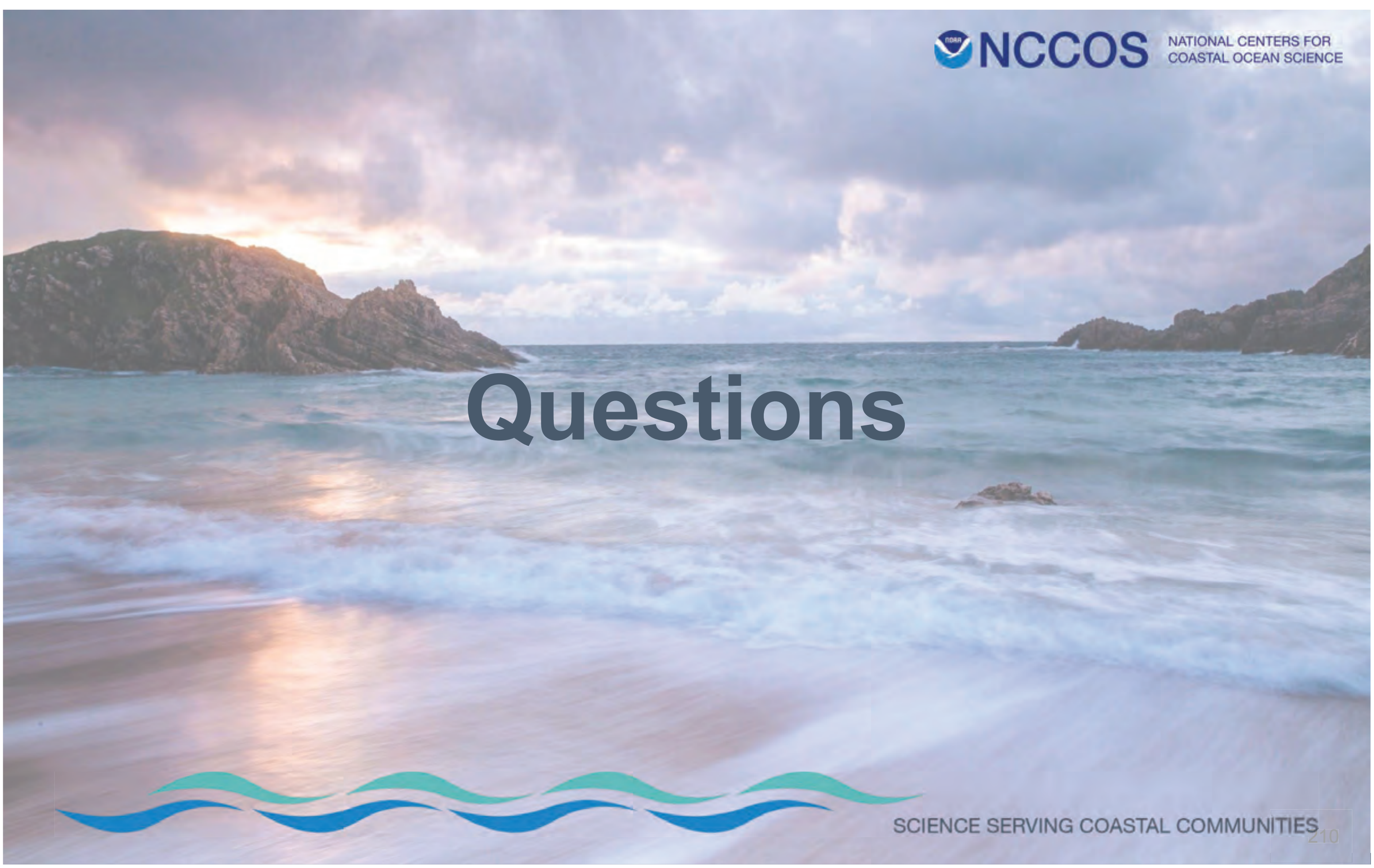

SCIENCE SERVING COASTAL COMMUNITIES


NCCOS
NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE
Question and Answer Session
Review Panel Members and Session Leads
SCIENCE SERVING COASTAL COMMUNITIES
211


NCCOS
NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE
Executive Session
Closed Session
Followed by Steering Committee/Review Panel
Dinner at Copper Canyon Grill
6:00PM
(928 Ellsworth Drive, Silver Spring, MD)
SCIENCE SERVING COASTAL COMMUNITIES
212

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DAY 2

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

NCCOS Annual Science Review: Habitat Mapping and Characterization

Silver Spring, Maryland
22-23 October, 2024

SCIENCE SERVING COASTAL COMMUNITIES

NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

Welcome Back and Day 2 Agenda

Terry McTigue

SCIENCE SERVING COASTAL COMMUNITIES

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Schedule

Day 1	Day 2
Welcome, Introductions, Purpose, & Charge	Welcome Back
Organizational Context, History, & Ethos	Reflections
Overview of Feedback from 2019	"By the Numbers"
Program Review Structure, Schedule, & Roles	Species Predictive Modeling
Session Presentations 1-3	Partner Attestation (1.5 hours) **CLOSED***
Lunch	***Lunch***
Session Presentations 3-6	Overview of Report Format and Submission Process
Question/Answer	Executive Session (50 minutes) **CLOSED***
Executive Session (1.5 hours) **CLOSED***	Panel Presentation and Summary
	Final Remarks
	Panel Reception

*Closed sessions will only include the review panel and select members of the planning team.

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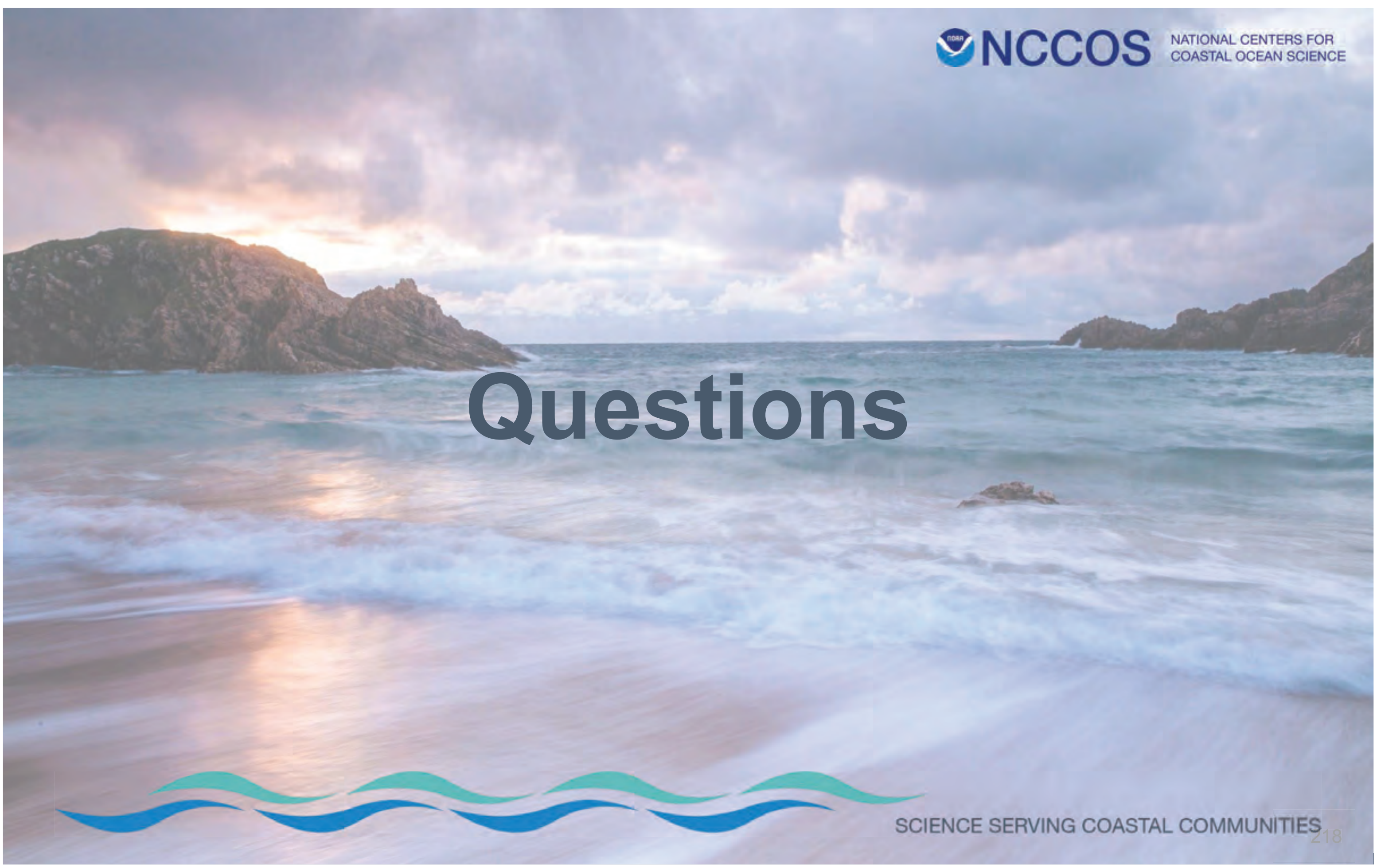
Group Norms

- Participate actively.
- Listen deeply.
- Ask questions to increase understanding.
- Share your perspective.
- Disagree without being disagreeable.
- Maintain confidentiality.

Online Participants:

- To respect the facilitator and your fellow participants, please mute yourselves when you are not speaking.
- Review panel questions will be prioritized during Q&A, but we will do our best to get to all questions.



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Reflections and Outstanding Questions from Day 1

John Christensen, *MSE Division Chief*

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Habitat Mapping ‘By the Numbers’

Tim Battista, SEA Branch Chief

SCIENCE SERVING COASTAL COMMUNITIES

Overview

- Who we are and where we are located
- Financial “Snapshots”
- The geographic distribution of our science support
    - Co-Development model
- Cloud migration efforts

Staffing

Habitat Mapping (14)

- Federal Staff *(5, $959k*)*
- Contract Staff *(9*, $1.42M)*

- 20+ yrs experience *(5)*
- 10–19 yrs *(4)*
- 5–9 yrs *(2)*
- <5 yrs *(1)*

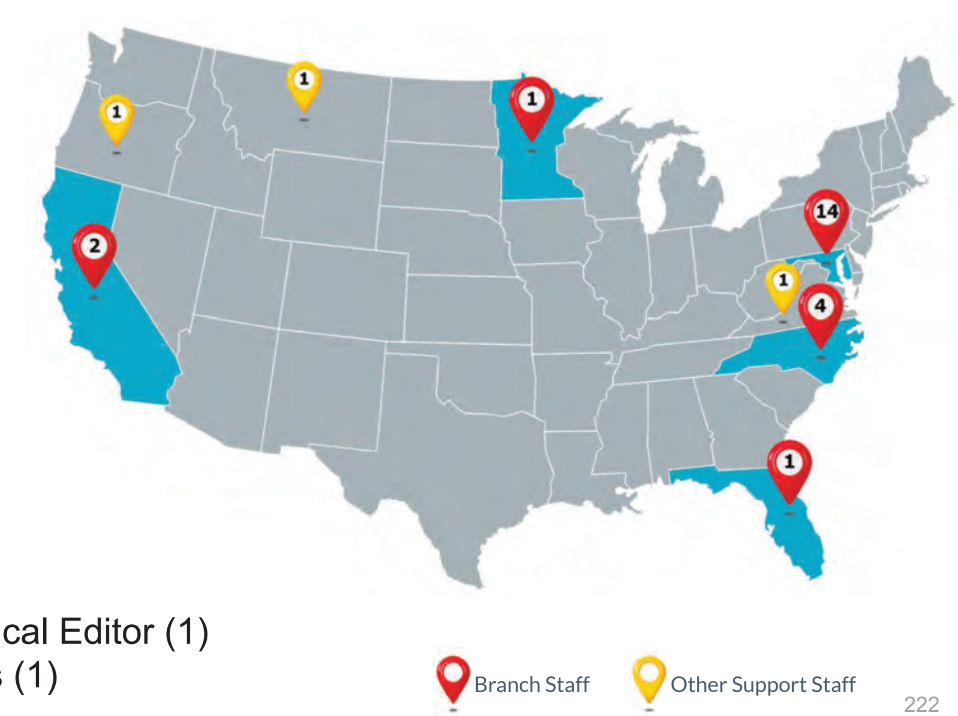
- Ecologist/Biologists *(6)*
- Spatial Scientists *(4)*
- Data Scientists *(2)*

- States *(4)*

Other Support Staff (3):

- Ecologist/Biologists *(2),* Technical Editor (1)
- 20+ yrs experience *(2),* 5-9 yrs (1)

SEA Branch (23)



‘Mapping’ Staffing

Tim Battista
Silver Spring, MD
Branch Chief
25 years of experience

Bryan Costa
Santa Barbara, CA
Sr. Marine Ecologist
20 years of experience

Charlie Menza
Silver Spring, MD
Sr. Marine Biologist
21 years of experience

Chris Taylor
Beaufort, NC
Sr. Marine Ecologist
20 years of experience

Karina Urquhart
Silver Spring, MD
LT JG
5 years of experience

Term Position
TBD
Program Coordinator

‘Mapping’ Staffing

Mike Bollinger
Beaufort, NC
Geospatial Scientist
10 years of experience

Erik Ebert
Beaufort, NCz
Geospatial Scientist
15 years of experience

Noah Hunt
Silver Spring, MD
Spatial Ecologist
2 years of experience

Ayman Mabrouk
Silver Spring, MD
Sr. Marine Spatial Ecologist
29 years of experience

Jordan Pierce
Silver Spring, MD
Data Scientist
7 years of experience

Asmita Shukla
Tampa, FL
Data Scientist
10 years of experience

Ed Sweeney
Santa Barbara, CA
Marine Spatial Ecologist
12 years of experience

Piper Kurtz
Remote
Data Scientist (PMF Fellow)

‘Mapping’ Staffing – TBD and Other Support

Backfill
TBD
Spatial Ecologist

Backfill
TBD
GIS Manager

New Recruitment
TBD
System Engineer

Non-SEA Branch staff that support mapping projects

Sarah Hile
Portland, OR
Biogeography Branch
Sr. Marine Ecologist
22 years of experience

Kimberly Edwards
Galax, VA
Biogeography Branch
Sr. Marine Biologist
22 years of experience

Ginger Shoup
Hamilton, MT
Biogeography Branch
Publication Specialist
6 years of experience

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‘Species Predictive Modeling & Climate’ Staffing

Matt Poti
Silver Spring, MD
Spatial Ecologist
14 years of experience

Bethany Williams
Silver Spring, MD
Research Ecologist
6 years of experience

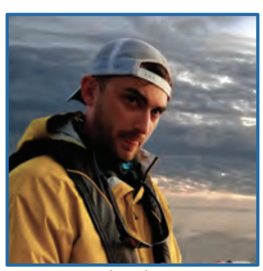
Camryn Blawas
Silver Spring, MD
Spatial Ecologist
1 year of experience

Michael Coyne
Durham, NC
Sr. Data Scientist
25 years of experience

Chandra Goetsch
Silver Spring, MD
Spatial Ecologist
5 years of experience

Jessica Hill
Silver Spring, MD
Spatial Modeler
1 year of experience

Klaus Huebert
Silver Spring, MD
Sr. Quantitative Ecologist
20 years of experience



Steven Lambardo
Silver Spring, MD
Spatial Modeler
2 years of experience

Jeff Leirness
Minneapolis, MN
Wildlife Statistician
12 years of experience

Arliss Winship
Silver Spring, MD
Sr. Marine Ecologist
24 years of experience

Projects by Geography

We are a national program

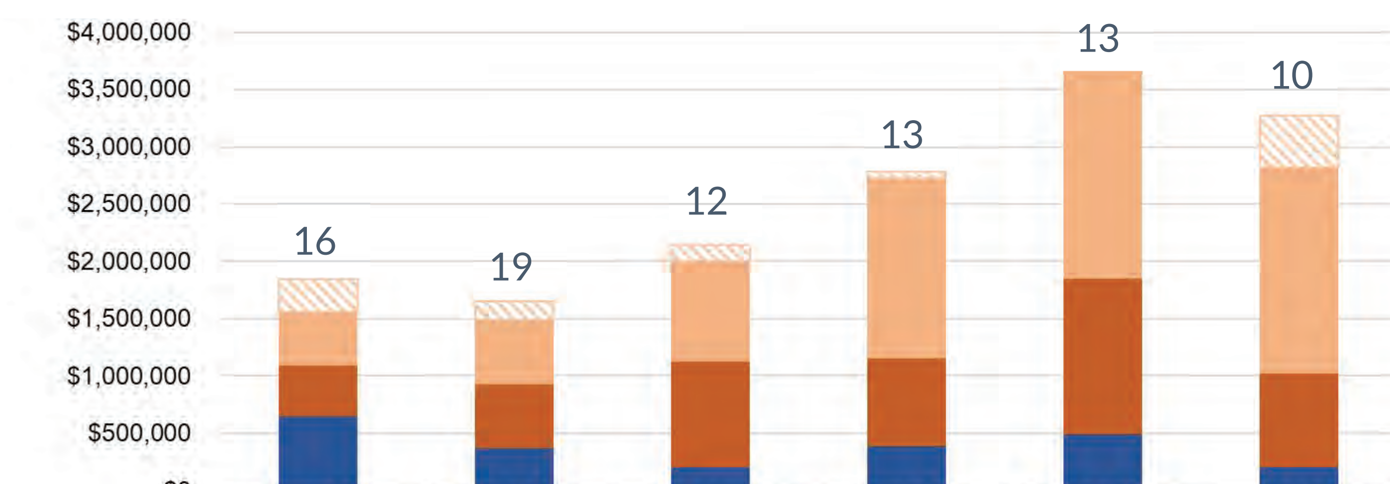
49 active or completed projects since 2019

Multi-year efforts not reflected (e.g., US Caribbean 2004–2023, MDBC)

Funding Source

PROJECT FUNDING SOURCES & AMOUNTS: MAPPING (2019-2024)

6-Year Total: $ 15.3M | Annual Average: $2.56M



	2019	2020	2021	2022	2023	2024
External | Others	$284,132	$159,000	$137,000	$55,000	$0	$453,500
NOAA | Others	$471,595	$565,663	$878,007	$1,580,735	$1,817,376	$1,799,485
NOS | Others	$445,475	$559,523	$923,385	$759,261	$1,355,242	$814,176
NCCOS	$646,000	$369,000	$205,000	$389,000	$492,000	$204,000

Program Investment

AVERAGE ANNUAL PROGRAM INVESTMENT (2019-2024)

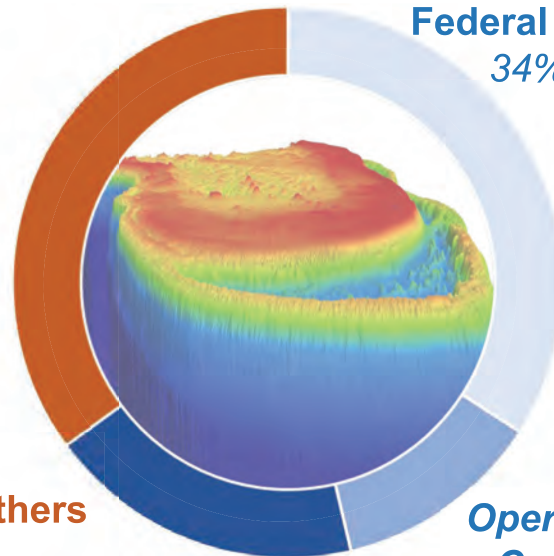
Federal Staff Cost *(2024 Dollars)*
$705k (incorporates $254k offset by NRDA MDBC)

Operating Costs: Space & IT Logistics (N=14)
$255k *($18K per year, per person)*

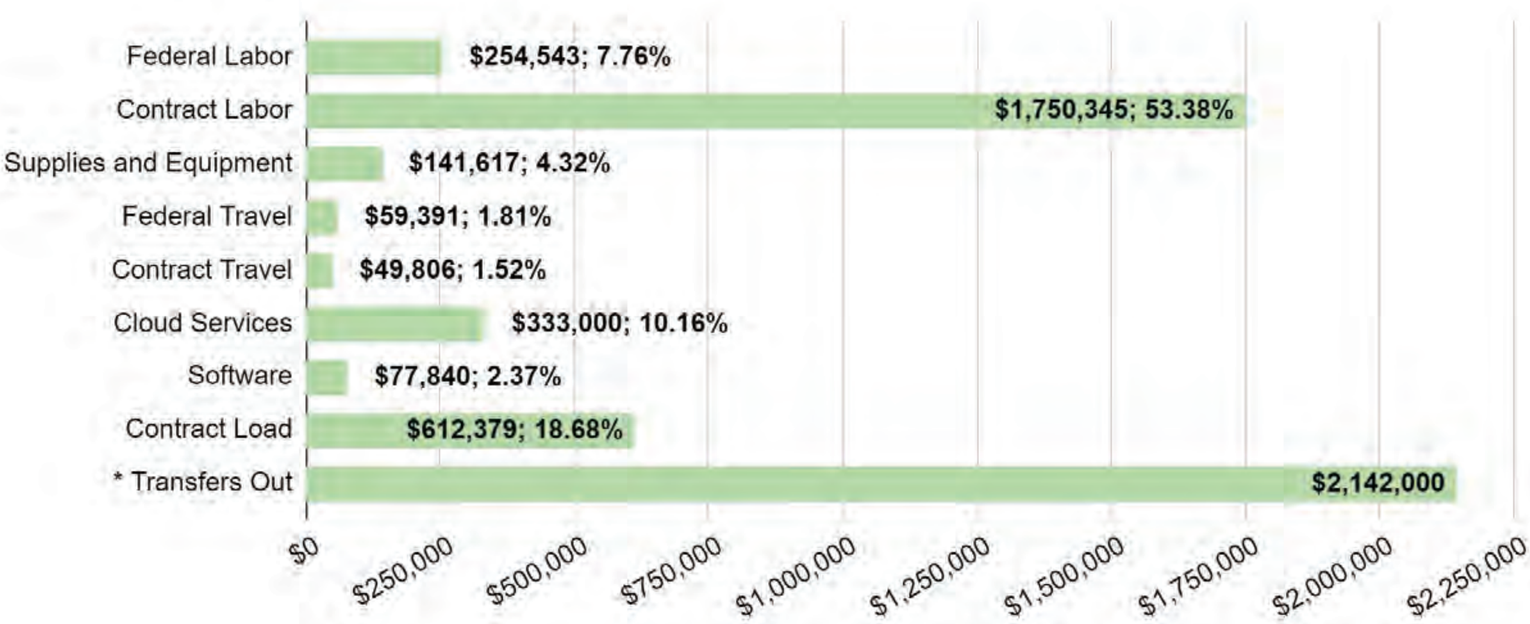
Base Funded Science (6-yr Avg)
$*384k*

Science Funded by Others (6-yr Avg)
$725k

TOTAL: $2,069,770



Distribution of FY24 Science Funding ($3.27M)



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Partners

NAVFAC Naval Facilities Engineering Systems Command

NOAA

U.S. INDO-PACIFIC COMMAND

NOAA OFFICE FOR COASTAL MANAGEMENT

BOEM Bureau of Ocean Energy Management

NOAA MARINE & AVIATION OPERATIONS

NOAA HIGH PERFORMANCE COMPUTING & COMMUNICATIONS

NATIONAL PARK SERVICE

Great Lakes RESTORATION

BSEE

NOAA CORAL REEF CONSERVATION PROGRAM

NORTH CAROLINA MARINE FISHERIES

NATIONAL MARINE SANCTUARIES

NOAA FISHERIES

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

GLERL Great Lakes Environmental Research Laboratory

NOAA Uncrewed Systems Research Transition Office

USGS science for a changing world Great Lakes Science Center

NOAA Office of Coast Survey The Nation's Chartmaker

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Co-Developers

PennState Applied Research Laboratory

CVision

GeoDynamics

Dewberry

ORBTL AI

JAXON.AI AI for AI

UNDERSEA VEHICLES PROGRAM UNIVERSITY OF NORTH CAROLINA WILMINGTON

NV5

Michigan Tech 1885

solmar hydro Marine Engineering & Surveying

CASCADE SPATIAL Hydrographic Consulting Services

AKS ENGINEERING & FORESTRY

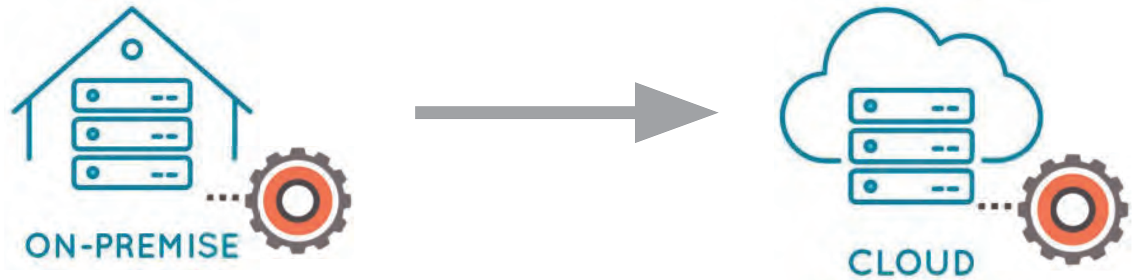
WOOLPERT ARCHITECTURE | ENGINEERING | GEOSPATIAL

Oregon State University

OCEAN EXPLORATION COOPERATIVE INSTITUTE oeci

NAVSEA WARFARE CENTERS

Transition to Cloud Services



Hardware:
- 14 " Uber" workstations
  - E.g. Precision Tower 7910
- Only 2 with GPUs
  - NVIDIA RTX 2080

Software/Storage:
- Local and network software
- NAS server data storage

Azure Virtual Desktop (AVD):
- 1 dedicated "Mapping pool" with 3 Virtual Machines (VMs)
- 4 shared pools, 2 specialized
- 90% software ported to cloud
- GUI focused

Azure Machine Learning (ML) Studio:
- Web-based platform coding
- ML-Operations deployment
- "Coder and developer" focus

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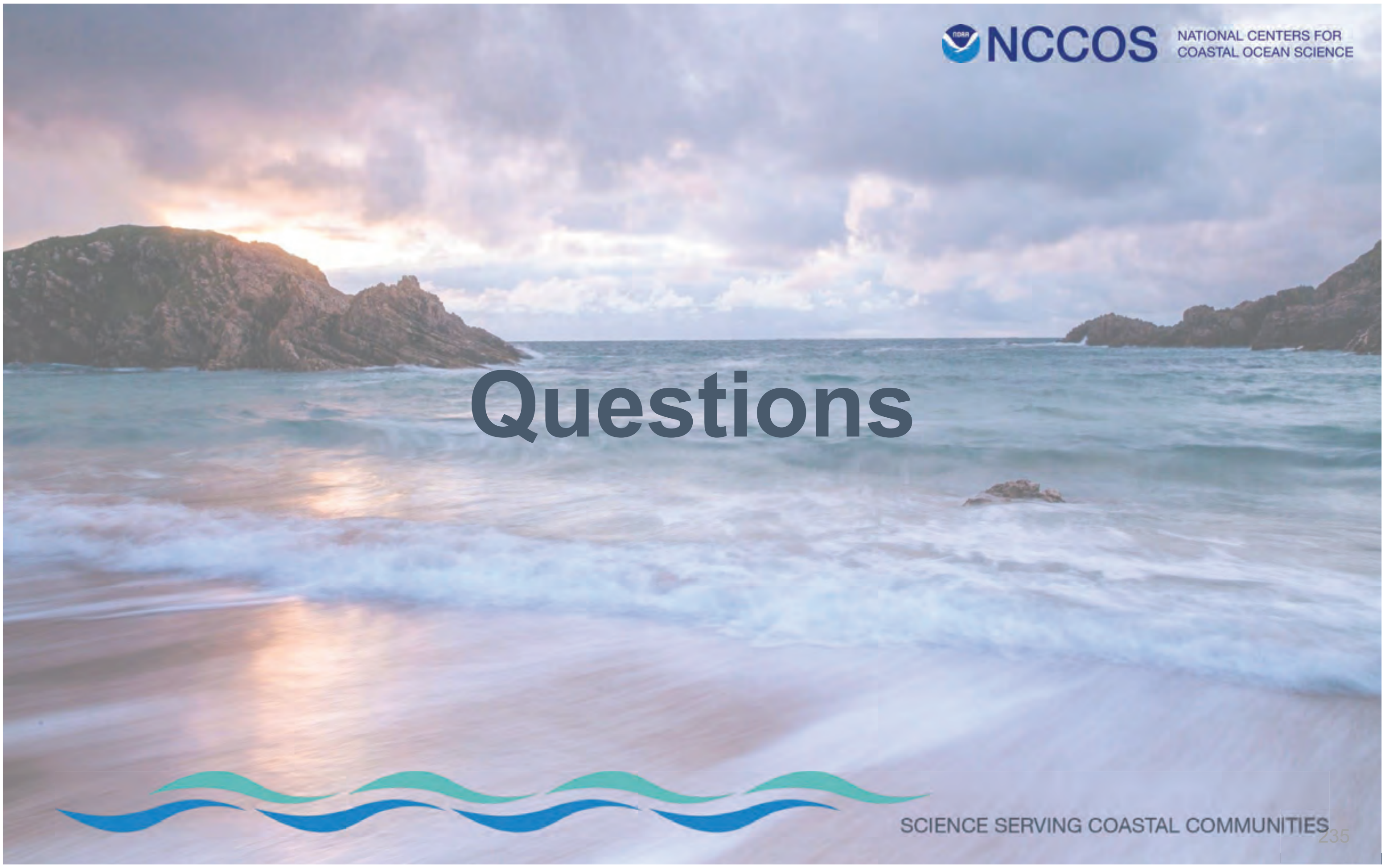
Future Priorities

➢ Continuing to build, grow and solidify the Data Sciences paradigm:
  - Enterprise Data Management, particularly AI-ready data
  - Data dissemination and delivery
  - Data sciences for object detection & Identification, feature segmentation, and Computer vision
  - Professional and technological training (i.e. '24 NCICS Data Science in the Cloud)

➢ Emergent Technologies
  - Ecological application of UXS and sensor payloads; and edge computing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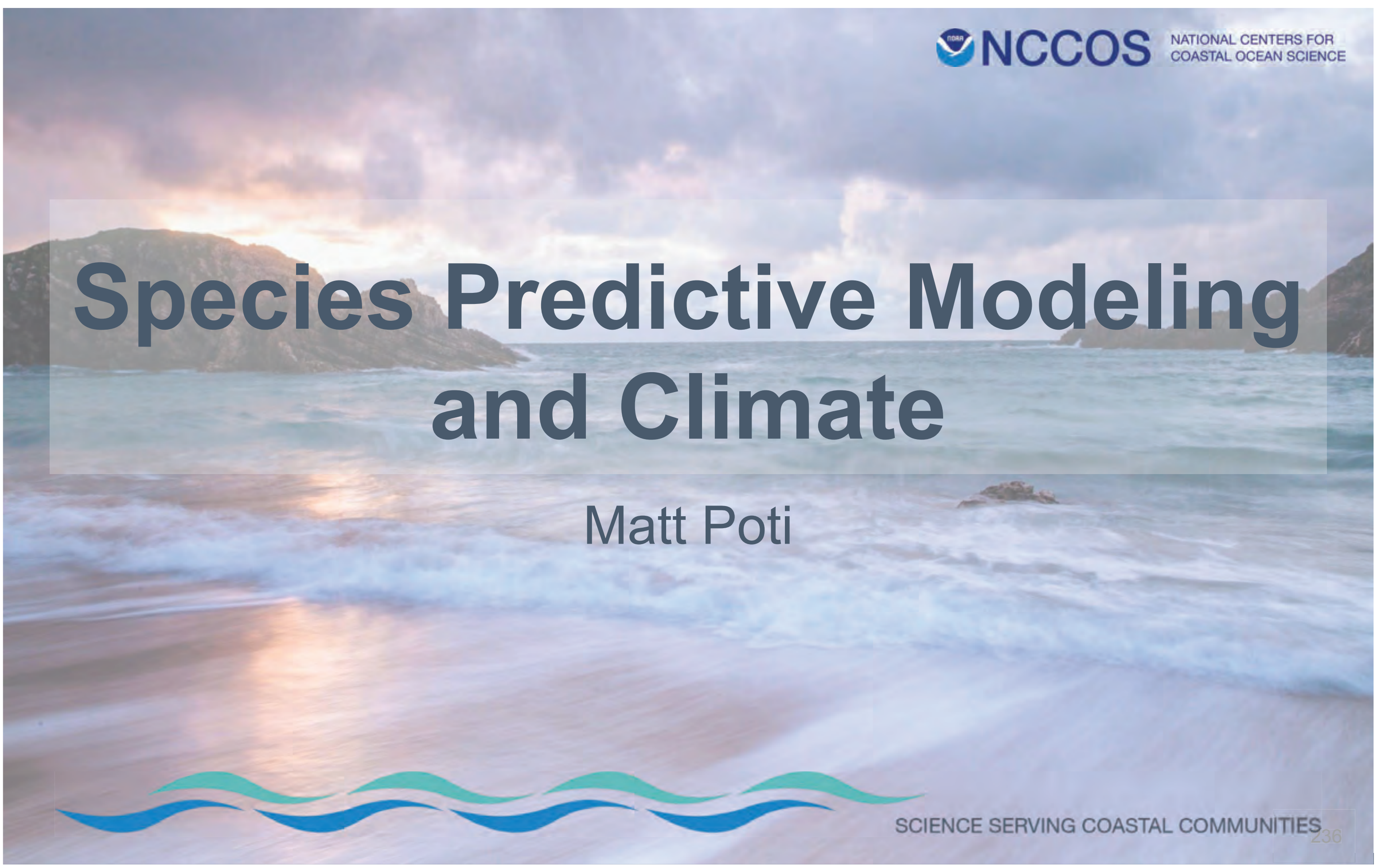
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Species Predictive Modeling and Climate
Matt Poti
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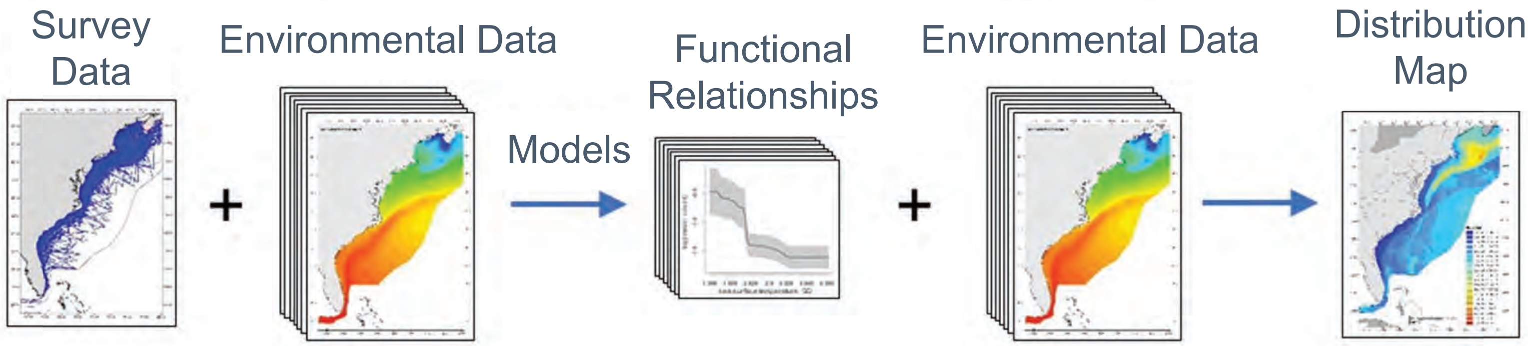
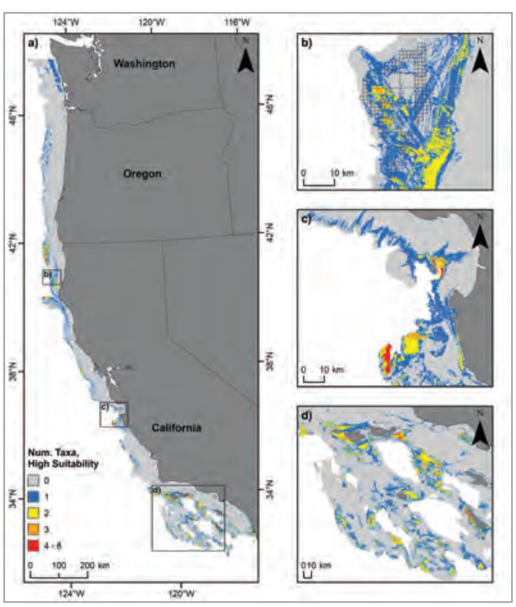
Overview

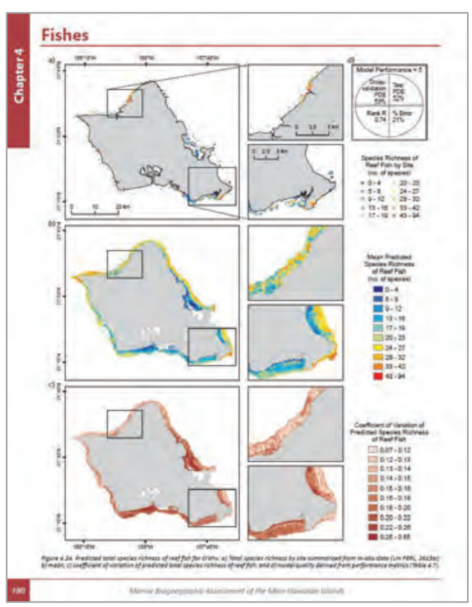
What is species distribution modeling?

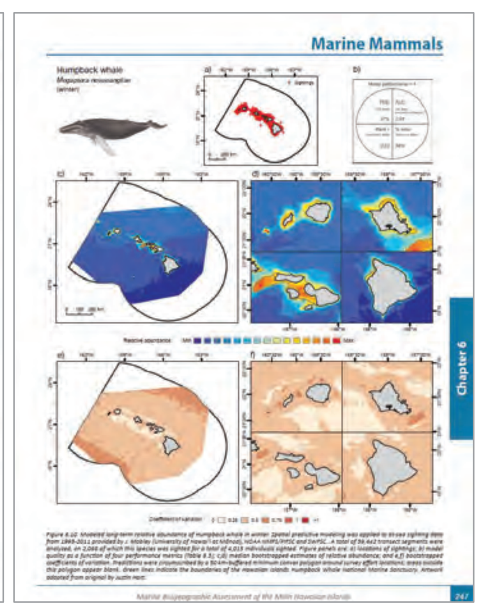


Recommendation from 2019 Biogeography Branch Review:
“Create product packages that deliver mapping and modeling cohesion”

Overview







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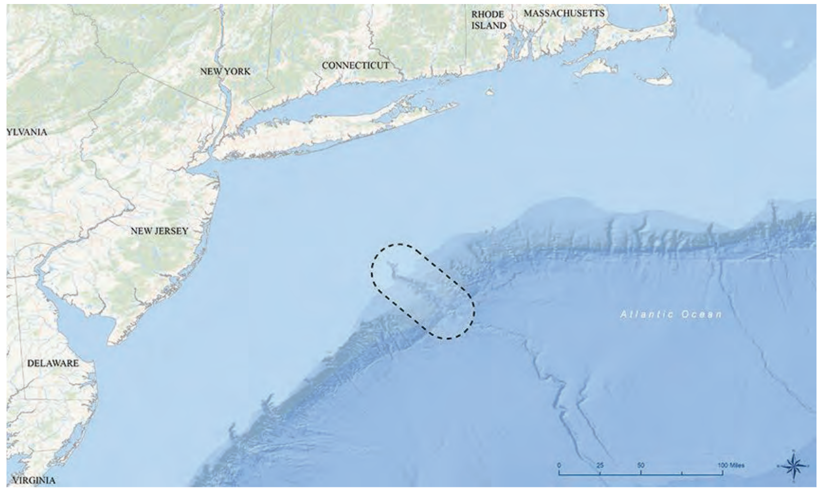
Overview

NOAA Climate, Ecosystems, and Fisheries Initiative (CEFI)

Climate-informed ecological assessments to support sanctuary designation

Operationalized support in developing sanctuary condition reports and climate vulnerability assessments

Proposed Designation of
Hudson Canyon National Marine Sanctuary



The map displays the general area under consideration for a new national marine sanctuary.

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Case Study 1

Gulf of Maine Seafloor Mapping and Deep-Sea Coral and Sponge Modeling

Dates: October 2023 — December 2026

Funding: Mapping – NOAA Office of Marine and Aviation Operations, NOAA Deep Sea Coral Research and Technology Program, NCCOS; Modeling – NCCOS

Team: Matt Poti, Arliss Winship, Tim Battista

Key Collaborators: NOAA Deep Sea Coral Research and Technology Program, NOAA Northeast Fisheries Science Center, NOAA National Systematics Laboratory, NOAA Greater Atlantic Regional Fisheries Office, NOAA Office of Ocean Exploration, NOAA Office of Coast Survey, NOAA Office for Coastal Management, U.S. Geological Survey, Bureau of Ocean Energy Management, Maine Department of Marine Resources, New England Fishery Management Council, Saildrone, Department of Fisheries and Oceans Canada, Dalhousie University

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Filling Data Gaps – Seafloor Mapping

Importance of hard bottom habitats in Gulf of Maine

Limited seafloor mapping and visual survey data

NCCOS and its partners are collecting high-resolution seafloor mapping data, conducting visual surveys, and using models to predict the distribution of deep-sea corals and sponges across the Gulf of Maine

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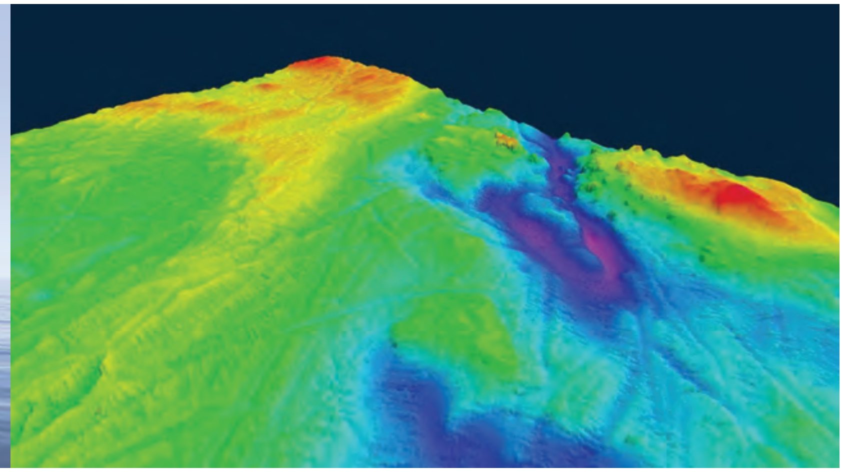
Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- Contiguous high-resolution **bathymetry and backscatter** data in the deeper waters of the Gulf of Maine - **Maps of predicted abundance** for key deep-sea coral and sponge taxa	- Bureau of Ocean Energy Management, Office of Renewable Energy Programs - Marine Spatial Planners - New England Fishery Management Council
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- SEA Branch - NOAA Deep Sea Coral Research and Technology Program - NOAA Northeast Fisheries Science Center - Saildrone	- Seafloor mapping data collected by Saildrone from Oct 2023 to July 2024 - Visual surveys conducted by NOAA Ship Henry Bigelow in July 2024 - Additional field work planned for 2025 - Species distribution models in 2025-2026

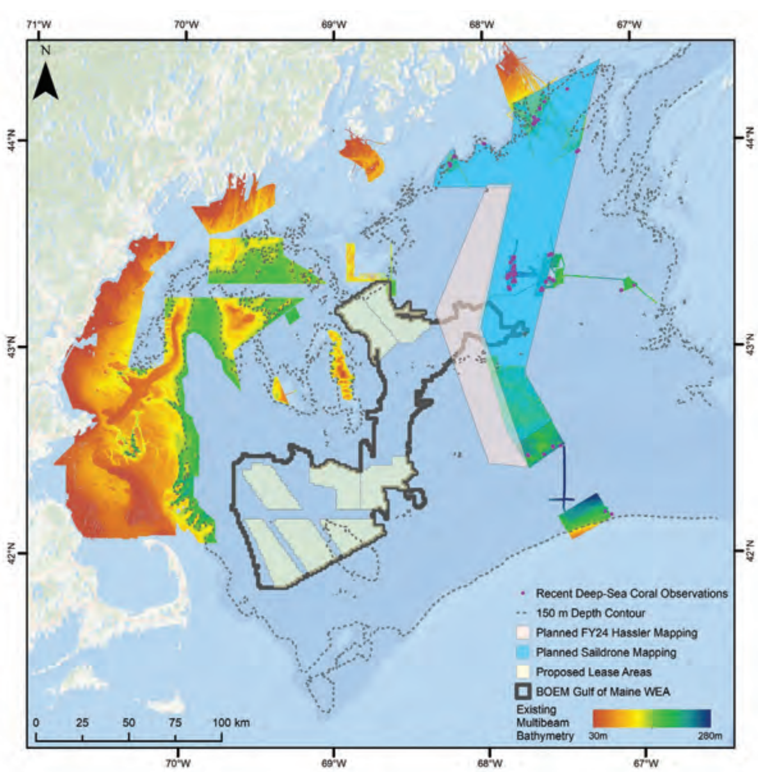
Supplementing NOAA’s Fleet

Assessment of uncrewed systems (Saildrone) to collect seafloor mapping data



Increasing Mapping Coverage

Coordination across NOAA offices and external partners to collect seafloor mapping data and conduct visual surveys



Case Study 2

Anticipating Shifts in Marine Bird Distributions for Planning, Leasing, and Assessment of Energy Development on the U.S. Atlantic Outer Continental Shelf

Dates: July 2020 – September 2023

Funding: U.S. Department of the Interior, Bureau of Ocean Energy Management

Team: Arliss Winship, Jeff Leirness, Michael Coyne

Key Collaborators: Bureau of Ocean Energy Management, NOAA Geophysical Fluid Dynamics Laboratory, U.S. Fish and Wildlife Service, Environment and Climate Change Canada

Filling Data Gaps – Marine Bird Distributions

Potential impacts from offshore wind

Bureau of Ocean Energy Management needs precise information on marine species distributions to guide planning and minimize ecological impacts.

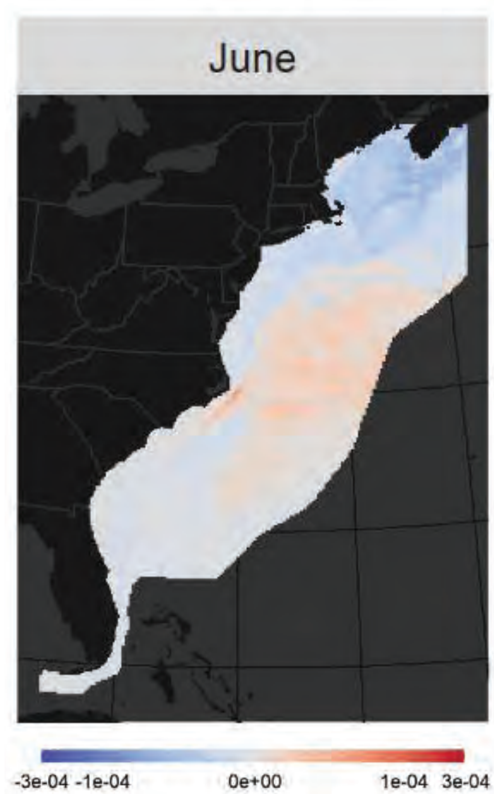
NCCOS developed species distribution models to characterize where and when different species of marine birds occur, including in the future.

Desired End Products/Services Geographic Applications	Target User Group Type of Use(s)
- **Maps of the predicted relative density** across the U.S. Atlantic Outer Continental Shelf for 49 marine bird species for a **retrospective** period (1993—2019) and a **future** period (next 30 years)	- Bureau of Ocean Energy Management, Office of Renewable Energy Programs - Marine Spatial Planners - U.S. Fish and Wildlife Service - Atlantic Marine Bird Cooperative
NCCOS Organization Units Involved Key Partners	**Synopsis Current State of Product/Service Next Steps**
- SEA Branch - Bureau of Ocean Energy Management - NOAA Geophysical Fluid Dynamics Laboratory - U.S. Fish and Wildlife Service - Environment and Climate Change Canada	- Report finalized September 2023 - Map products delivered to October 2023 - Additional marine bird predictive modeling for **U.S. West Coast currently in progress**

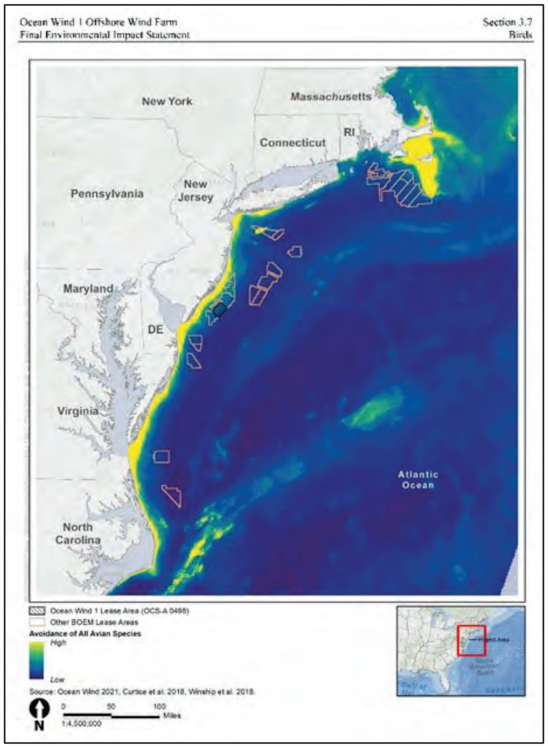
Future Projections of Distributions

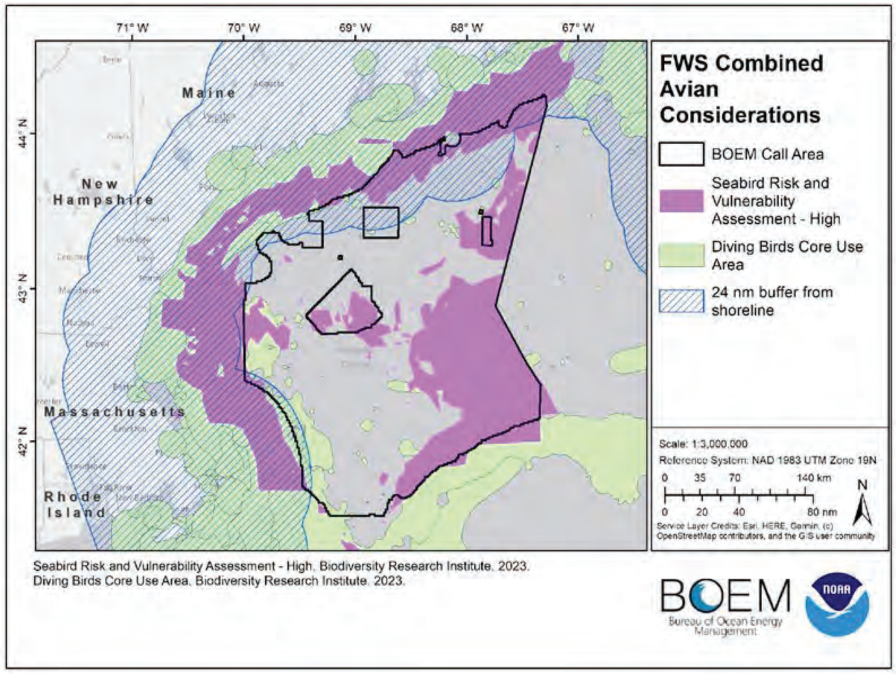
Expansion of species distribution modeling to include future projections

Measures of model fit and performance, as well as prediction uncertainty



Offshore Wind Energy Planning

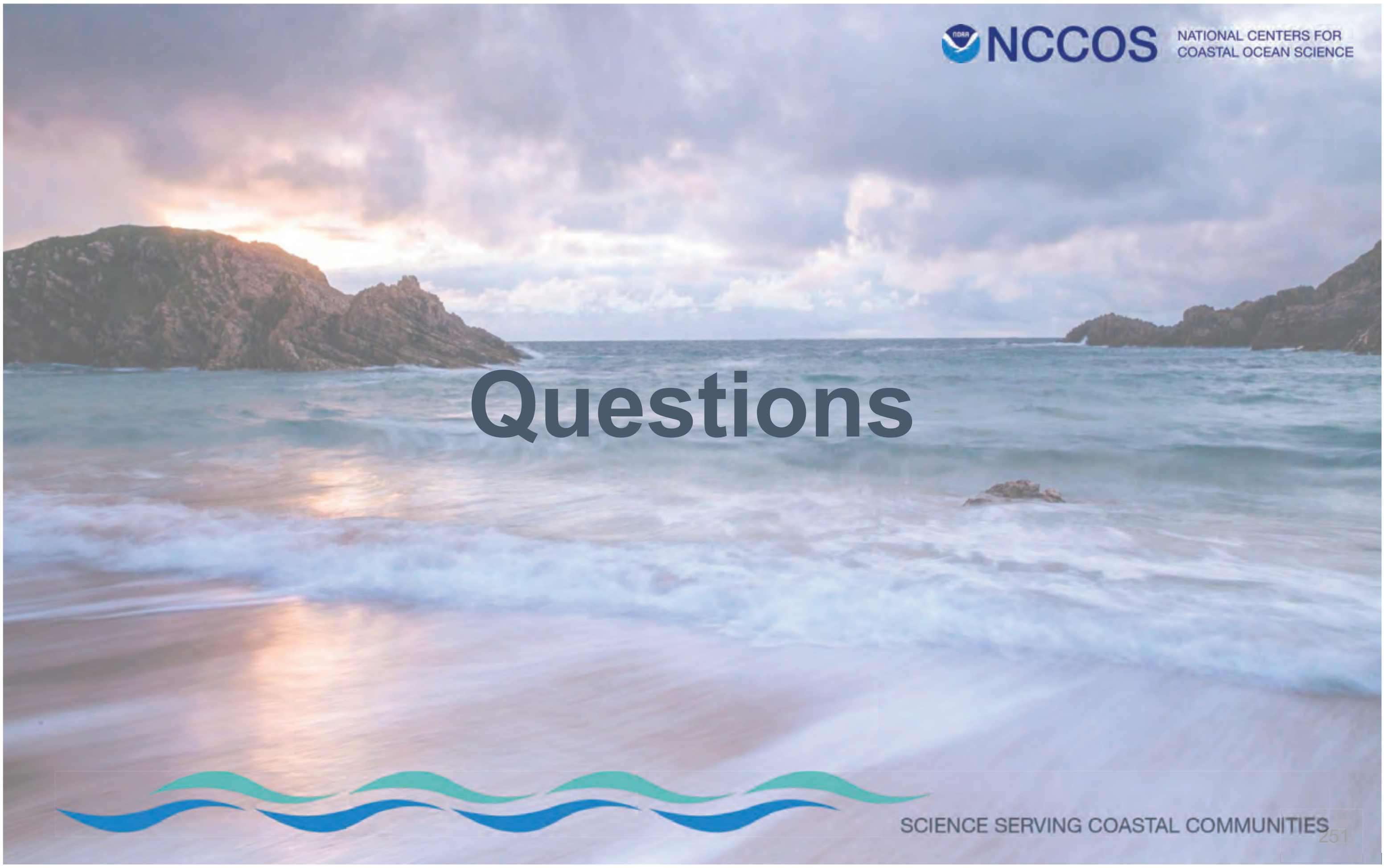




Conclusion – Looking Forward

Integration of seafloor mapping, collection of ground-truthing data, and species distribution modeling

Incorporation of climate forecasts and projections to predict future distributions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BREAK
Return by 10:30am
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Partner Attestation
Closed Session
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NCCOS
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Lunch
Return by 1:00pm
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Overview of Report Submission

Margo Schulze-Haugen, NCCOS Deputy Director

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Report Format and Submission

Individual written reports are due within 60 days after the review (December 23rd) .

- *Outline the reviewer's independent observations, evaluation, and recommendations on different aspects of the habitat mapping portfolio.*
- *Specifically address the quality, relevance, and performance criteria and associated questions outlined in the Charge to Reviewers*

Panel Chair may choose to write a consensus report to summarize important or common findings (also due 60 days after the review).

Format*:

1. Overview
2. Evaluation
   a. Quality
   b. Relevance
   c. Performance
3. Recommendations

*Format is somewhat flexible.

The 2019 Biogeography Reports have been provided as an example.

*Please email your completed report to Tim Battista (tim.battista@noaa.gov) and Josie Galloway (josie.galloway@noaa.gov).


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Executive Session:
Panel Discussion and Drafting Initial Recommendations
Closed Session
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BREAK
Return by 3:30pm
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Review Panel Presentation to NCCOS Leadership

Review Panel Members

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Thank You and Final Remarks

Sean Corsen, NCCOS Director

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Panel Reception

Open to All Participants

McGinty's Public House

4:30PM

(911 Ellsworth Dr, Silver Spring, MD 20910)

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