National Centers for Coastal Ocean Science

The National Centers for Coastal Ocean Science (NCCOS) is the focal point for NOAA's coastal ocean science efforts. NCCOS helps NOAA to meet its coastal stewardship and management responsibilities, and provides 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 that communities interact with coastal ecosystems. NCCOS major focus areas include coastal change: vulnerability, mitigation, and restoration; marine spatial ecology; social science, and stressor impacts and mitigation. NCCOS additionally funds external research through its Competitive Research Program. Included below are ten highlighted projects by NCCOS, NCCOS-supported researchers, and their partners.

Kachemak Bay Ecological Assessment: Supporting Alaska Coastal Resource Management

Kachemak Bay is a "natural laboratory" of Alaska coastal habitats, with sandy clam beds, seagrass meadows, and rocky, deep fjords lined with kelp forests. Image credit: Kris Holderied, NOAA

NOAA NCCOS has conducted a Kachemak Bay, Alaska ecological assessment project to knit together a broad range of spatial habitat and environmental data into new information tools for Alaska coastal resource management and planning. Kachemak Bay is a productive, subarctic estuary in southcentral Alaska that contains all the coastal habitats found in the Gulf of Alaska, with fish, shellfish, marine mammal, and bird populations that support recreational and commercial harvests. Kachemak Bay has seen an increase in ecotourism activities and tourism is a significant economic driver for the region. NOAA, along with federal, state, tribal, industry, and non-governmental organization partners, has produced a pilot "State of Kachemak Bay" report, developed online tools to improve public data access and visualization of spatial data, and is producing an ecological status report in 2021 to highlight regional coastal changes over the past two decades. The project's goal is to provide information tools that help Alaska communities deal with challenges from changing fish and shellfish populations, climate change, harmful algal blooms, and to explore opportunities in shellfish and kelp mariculture.

FY20 Accomplishment(s): As part of the assessment, the FY20 pilot "State of Kachemak Bay" report summarizes information on marine conditions and resources for state, Alaska Native and public coastal

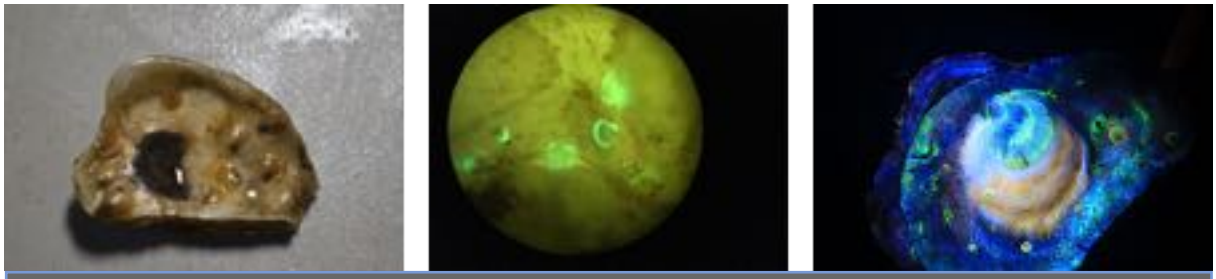
stakeholders. In addition, an updated online data visualization tool (BioMapper) improves access to spatial information on coastal habitats, environmental conditions and resources.

State of Kachemak Bay Report:
https://cdn.coastalscience.noaa.gov/projects-attachments/396/StateofKachemakBay_2019Highlights.pdf

State of Kachemak Bay Report News Item:
https://coastalscience.noaa.gov/news/state-of-kachemak-bay-report-highlights-long-term-monitoring-data/

Project URL:
https://coastalscience.noaa.gov/project/ecological-assessment-for-kachemak-bay-alaska-science-tools-to-inform-management/

Testing Alternative Oyster Restoration Strategies using Novel Chemical Marking Tools



Spat on shell produced by direct setting, as seen with the naked eye (left image).The calcein fluorescent dye "tag" is shown here, glowing under special light (right two images). Credit: Jason Spires, NOAA NCCOS.

NOAA NCCOS is leading research that uses novel chemical tagging tools to test alternative oyster setting methods. Oyster setting is the process in which larvae attach to a setting material such as shell. In partnership with the U.S. Naval Academy and the Maryland Department of Natural Resources, research divers used fluorescently-marked larvae to test releasing oyster (*Crassostrea virginica*) larvae directly onto planted oyster shells in the Chesapeake Bay. Oyster larvae are marked by placing them in a calcein (fluorescent dye) bath prior to release, after which the dye acts as a tag once absorbed by the oyster shell. NCCOS has been examining the utility of chemical markers in late-stage larval oysters to determine specific oyster recruitment and in evaluating oyster reef restoration strategies. The research shows that juvenile oysters can be established from larvae set directly at the site without using enclosures. The techniques developed in this portfolio may reduce the requirement for scarce shell or other setting material, and reduce the logistical and material handling costs associated with traditional spat-on-shell oyster practices in both restoration and aquaculture sectors. These reductions have the potential to avoid challenges commonly associated with publicly funded restoration projects using alternative substrate, and can make restoration and aquaculture seeding practices more economical. Tagging methods utilized for larval origin confirmation build on methods developed in the NCCOS funded Oyster Marking Methodology Study.

FY20 Accomplishment(s): Continued release and monitoring of deployed larvae onto shell-bag reefs in the study site and of observed oyster spat recruitment.

Project URL:
https://coastalscience.noaa.gov/news/new-technique-shows-oyster-shell-seeding-is-possible-in-open-water/

NCCOS-funded Research Evaluates Options for Managing Dune Systems in North Carolina

Sand fencing on Bogue Banks, NC. Photo: NOAA NCCOS

An NCCOS-funded observational and dynamic modeling study assessed possible beach and dune management actions to help coastal communities make informed decisions in the context of extreme storms and sea level rise. The project, led by researchers at Oregon State University and University of North Carolina, evaluated dune shape as a function of beach nourishment, dune grass planting, sand fencing, and treatment of the wrack line on the Outer Banks, NC. The team discovered that nourishing beaches prior to the storm season, planting dunes with certain species of dune grasses, and allowing a wrack line to remain on the beach all led to taller and wider dunes systems. In contrast, sand fencing created shorter but wider dunes. The models demonstrate how management actions influence dune shape, which has implications for coastal protection during storm events, flood protection capacity, and the resilience of beaches and dunes. This study was supported through the NCCOS Effects of Sea Level Rise (ESLR) Program.

FY20 Accomplishment(s): The NOAA funded research team delivered their findings on possible dune management actions to the management advisory group, composed by beach and dune managers and city managers in May of 2020.

Project URLs:
https://coastalscience.noaa.gov/news/the-effect-of-sand-fencing-on-the-structure-of-natural-dune-systems/

https://coastalscience.noaa.gov/news/grasses-shape-and-protect-coastal-dunes-in-different-ways/

https://coastalscience.noaa.gov/news/new-tool-informs-dune-recovery-after-storms/

Application of Quantitative Molecular Methods to Characterize Abundance and Distribution of *Alexandrium* cysts for NOAA's HAB Forecasting

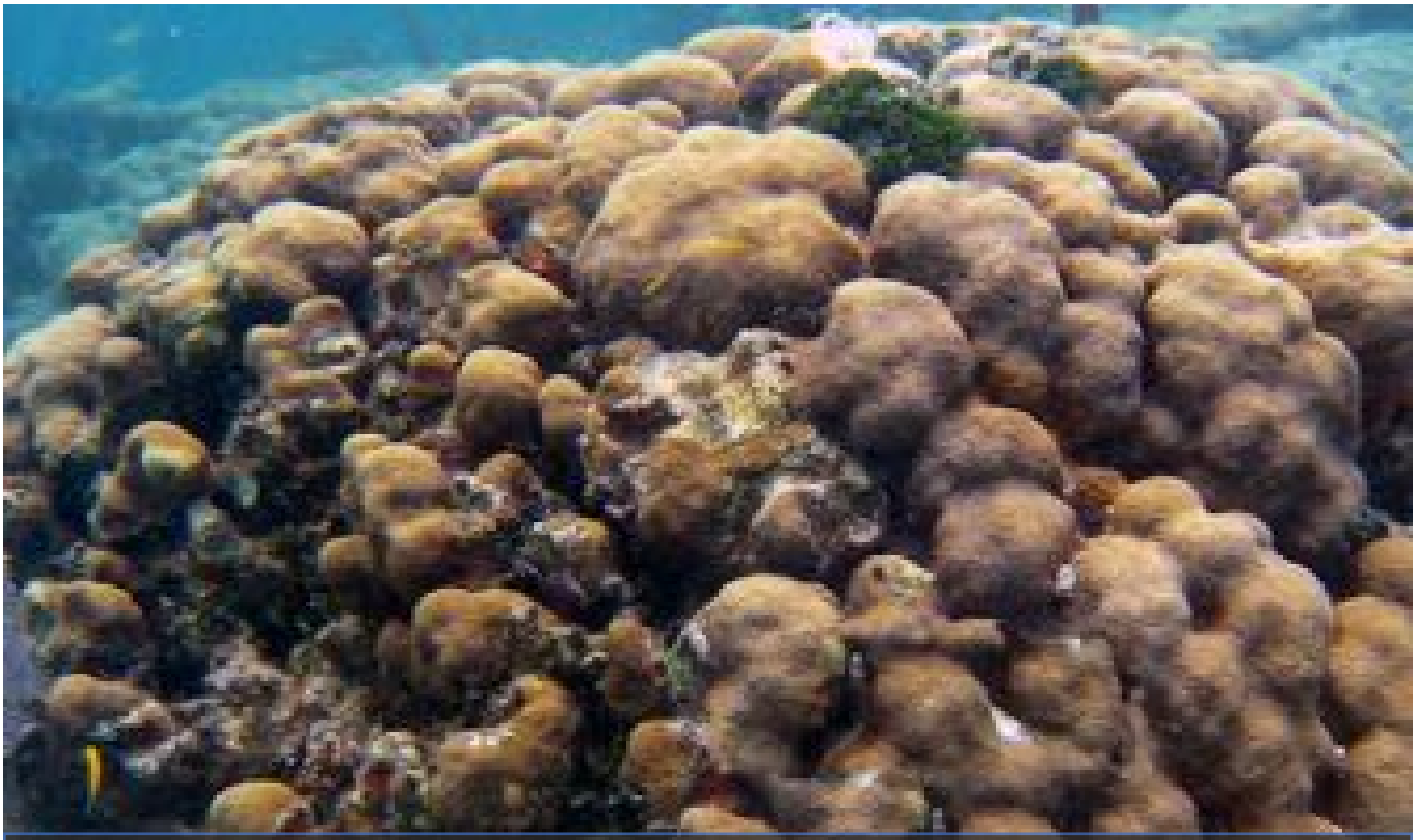
Light micrograph (left) of an Alexandrium resting cyst in the sediment. The same cyst (right) stained with a fluorescent stain for counting. Credit: S. Kibler, NOAA NCCOS.

NCCOS is developing new methods to better forecast blooms of *Alexandrium catenella*, a marine alga that causes paralytic shellfish poisoning (PSP) along the Pacific and Atlantic coastlines of the U.S. and Canada. This project supports development for two lab-based quantitative molecular methods for more rapid, accurate detection of *Alexandrium catenella* resting cysts in sediment. Scientists are working with the University of Washington Tacoma, the University of Alaska, and the Woods Hole Oceanographic Institution to map the distribution of *Alexandrium* resting cysts in the Gulf of Maine, Puget Sound, and the waters around Kodiak Island and Kachemak Bay, Alaska. Cyst distribution and abundance are used to forecast blooms of *Alexandrium* cells in the water column. Molecular detection methods and training is needed to advance research and HAB forecasting applications that reduce effort and turnaround time for cyst enumeration. New methods employing molecular-level analytical procedures known as quantitative polymerase chain reaction (qPCR) and fluorescent in situ hybridization (FISH) were developed to reduce the time and effort required for cyst identification and counting. These molecular tools are being tested to better characterize cyst distribution and speed up the forecasting process for *Alexandrium* blooms. The project will help expand NOAA HAB Operational Forecasting to new regions.

FY20 Accomplishment(s): First season of field sampling, initial design of quantitative PCR assay and in situ labeling method completed pending method refinement and validation.

Project URL:
https://coastalscience.noaa.gov/project/application-of-quantitative-molecular-methods-to-characterize-abundance-and-distribution-of-alexandrium-cysts-for-noaas-hab-forecasting/

Spatial Predictive Modeling for ESA-listed Corals



NCCOS is mapping predicted distributions of ESA-listed corals, such as this lobed star coral (Orbicella annularis), throughout the U.S. Atlantic. Image credit: NOAA Fisheries.

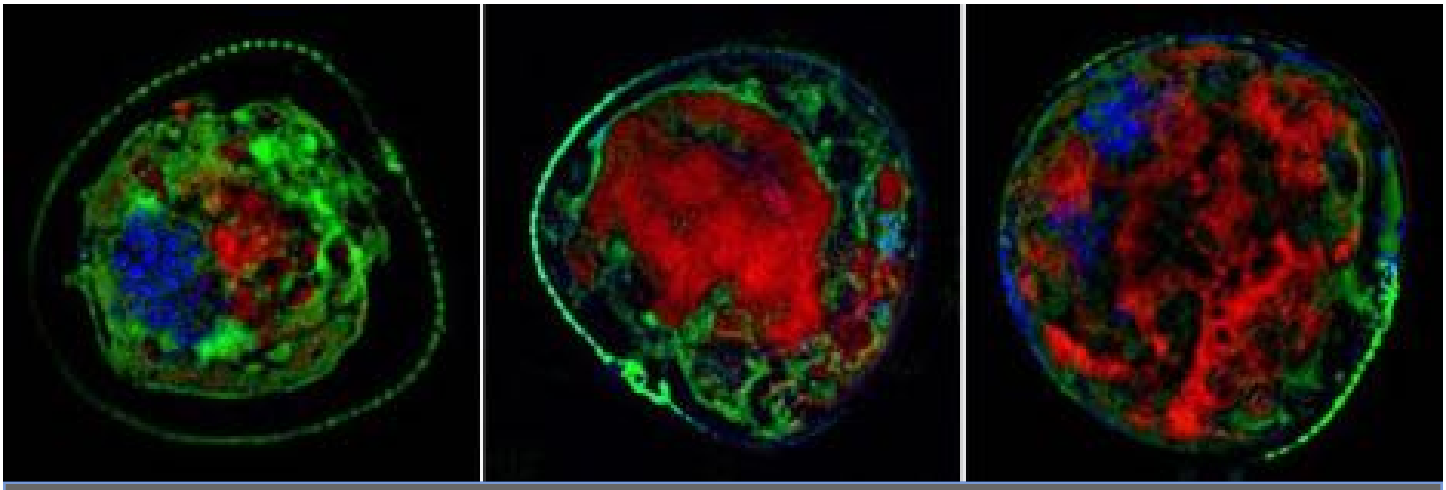
NCCOS uses spatial modeling to predict the distributions of threatened coral species in the U.S. Atlantic (Florida) and Caribbean (Puerto Rico, U.S. Virgin Islands). NOAA is partnering with scientists in academia and the federal government to develop new modeling approaches and interactive mapping applications that provide data-driven spatial predictions for the presence, absence, abundance, and population structure of multiple threatened coral species. These outputs also include associated estimates of predictive uncertainty, and a spatial database of Atlantic coral ecosystem monitoring, in accessible map formats. These products are used to inform management decisions that may affect coral species listed under the Endangered Species Act (ESA), such as spatial planning for coral restoration and place-based management.

FY20 Accomplishment(s): A coral model is in development for Puerto Rico and the U.S. Virgin Islands.

Project URL:
https://coastalscience.noaa.gov/project/spatial-predictive-modeling-threatened-esa-corals-u-s-atlantic-caribbean/

Promising HAB Control Method Builds on NCCOS-Funded Discovery of Natural Algicide.

An NCCOS funded project, led by University of Delaware marine scientist Dr. Kathryn Coyne, characterized an algicidal compound produced by the bacterium *Shewanella*, and confirmed the compound can selectively kill marine dinoflagellate phytoplankton known to produce harmful algal blooms. Using small-scale microcosm experiments, the team found the naturally occurring compound induces programmed cell death in dinoflagellates, while having no negative impacts on other phytoplankton, fish, or shellfish. Results pointed to the compound as an effective and environmentally safe natural algicidal agent, but additional research was needed to determine a cost effective and efficient method to deploy it in the environment. This project is supported by the NCCOS Prevention, Control and Mitigation of Harmful Algal Blooms (PCMHAB) Program.



Fluorescent images of a harmful dinoflagellate before (left) and after (middle and right) exposure to the Shewanella-derived algicide. Note the impacts on the nucleus, shown in blue. The research points to the nucleus as the primary organelle targeted by the algicide, with a loss of chromosomal structure in all species; cell division is inhibited. Credit: Kaytee Pokrzywinski (NOAA NCCOS) and Jeffrey Caplan (Delaware Biotechnology Institute).

FY20 Accomplishment(s): With additional funding by Delaware Sea Grant, the Coyne team is now testing a promising and novel delivery method using mesh bags filled with gel-like alginate beads temporarily deployed in coastal waters, where needed, to prevent algal blooms from occurring, or to shut down or mitigate blooms already underway.

Project URL:
https://coastalscience.noaa.gov/news/promising-hab-control-method-builds-on-nccos-funded-discovery-of-natural-algicide/

NCCOS Research Provides Scientific Foundation for U.S. Supreme Court Ruling

Maui County, Hawaii, wastewater treatment facilities at issue in Supreme Court litigation. Credit: Warren Gretz/NREL via E&E News.

A recent U.S. Supreme Court ruling found that pollution discharge into groundwater from a Maui County (HI) sewage treatment plant (County of Maui v. Hawaii Wildlife Fund) fueled macroalgal (seaweed) blooms along the west side of the Island of Maui. At this location, wastewater is injected into disposal wells, travels underground, and ends up in the Pacific Ocean, thereby violating the permitting program of the US Clean Water Act. The Act will now apply to pollution that funnels through groundwater before reaching a federally regulated waterway. Following a series of studies funded by NOAA in the 1990's, projects supported through the NCCOS Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) program and Hawaii Coral Reef Initiative (HCRI) focused research efforts on the link between increased nutrients from land-based sources of pollution and the decline in coral health. Results showed that all coastal waters near injection wells had high nitrogen values and were impacted by sewage effluent high in nutrients (but no pathogens) leaking from deep injection wells. These findings demonstrated that substantial nuisance macroalgal blooms in Maui coastal waters were linked to wastewater nutrient sources.

FY20 Accomplishment(s): Understanding of the causes and solutions to algal blooms in Maui was the result of research led by NOAA and the combined efforts of numerous federal and state agencies, institutions, and other contributors over the last 25 years. Thus, the far reaching SCOTUS ruling not only highlights the value of the NCCOS Competitive Research Program (CRP), it also points out the common occurrence of CRP research providing management outcomes years, and even decades, after project funding has ended.

Project URL:
https://coastalscience.noaa.gov/news/nccos-research-provides-scientific-foundation-for-u-s-supreme-court-ruling/

Ozone Impregnated Nano-bubble Technology Safely Eradicates Harmful Algal Blooms and Mitigates their Impact.

Field site before (left) and 24 hours after (right) nanobubble treatment. Credit: NOAA NCCOS.

A five-year cooperative research and development agreement (CRADA) with American Marine University completes is first year to develop and deploy ozone impregnated nano bubble technology as an algal/microbial/ nutrient remediation strategy. Unlike ordinary bubbles that rise and burst at the surface of the water, nanobubbles implode under the pressure of the water, releasing oxygen and ozone that help dissolve harmful algae. Referred to as "NBOT", this patented, precise generation of bubbles of less than one thousandth of a millimeter provides efficient transfer of ozone to attack microbes and shreds toxins with oxygen as a byproduct in hypoxic systems enhancing overall water quality. This powerful action can be implemented in a manner that is safe for humans and wildlife and when coupled with NBOT's ability to also remove nutrients, provides cleaner water for longer periods of time thus minimizing bloom retreatment regimens.

FY20 Accomplishment(s): This first year completed successful demonstration projects in Port Mayaca Lock of Lake Okeechobee, Lake Newport in Ohio, Constitution Gardens Pond, Washington DC and Loxahatchee River in Jupiter FL.

Project URL:
https://coastalscience.noaa.gov/news/nccos-validates-nanobubble-technology-for-remediation-of-harmful-freshwater-algal-blooms/

Assessment of Fish Habitat in Tidal Waters of the Choptank River (Chesapeake Bay, Maryland) to Inform Conservation, Restoration, and Fishery Management Decisions

The Choptank River complex is located on Maryland's eastern shore, and includes the Choptank River and its major tributaries. The watershed was selected as a NOAA Habitat Focus area in 2014. Image credit: NOAA Fisheries.

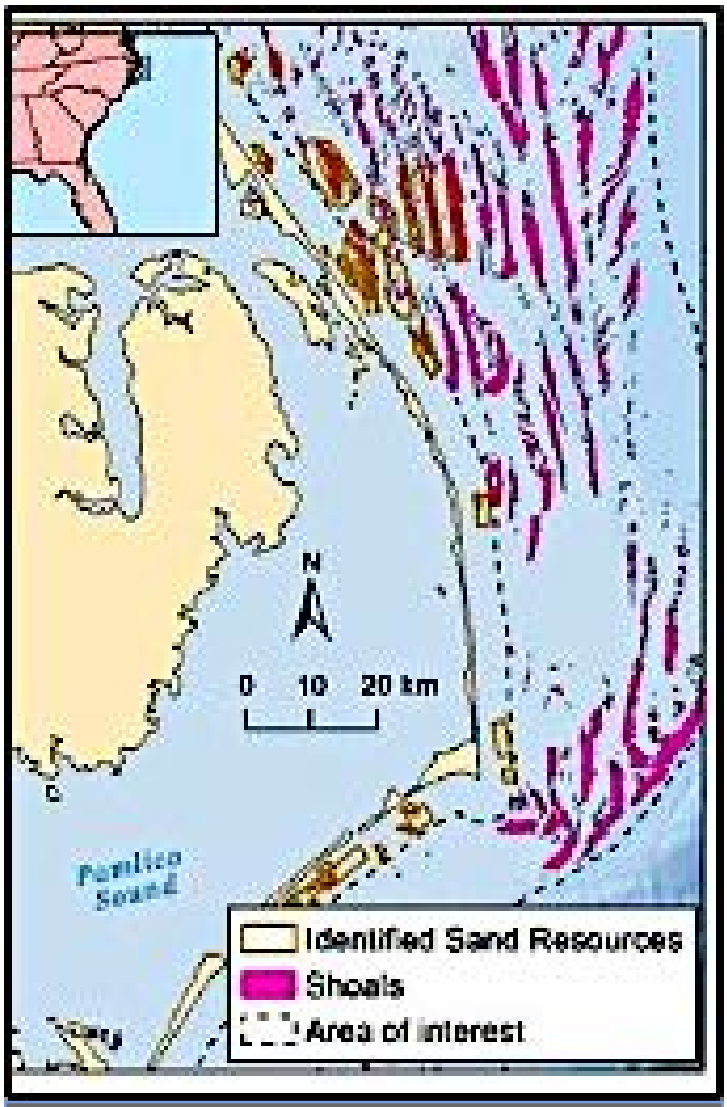
The Choptank watershed is an ecologically and economically valuable resource and one of NOAA's ten Habitat Focus Areas. NCCOS is collecting and synthesizing biological, chemical, and physical data to characterize the condition of the watershed and identify land use impacts on the environment. This project builds off previous ecological assessments of the Choptank watershed and Chesapeake Bay toward improving water quality, the health of estuarine and coastal habitats, conservation and restoration efforts, and fishery management decisions.

FY20 Accomplishment(s): A report of recommendations for extending the tidal analytical/statistical framework from candidate tributary (Choptank River) to Chesapeake Bay tidal areas is in development.

Project URL:
https://coastalscience.noaa.gov/project/ecological-assessment-choptank-complex-habitat-focus-area/

A Geospatial Assessment of U.S. Atlantic and Gulf of Mexico Essential Fish Habitat in Relation to Offshore Sand Features

Offshore sand resources, e.g., sand shoals, are increasingly being used for beach renourishment, barrier island restoration, and other uses to enhance resiliency of shorelines. However, the impact of sand dredging on fish and other marine resources is poorly understood. NCCOS is working with the Bureau of Ocean Energy Management (BOEM) and NOAA Fisheries to provide information on these effects and to develop a geospatial decision support tool that helps users determine the relative risk to fisheries species that are associated with extraction of these sand resources.As the demand for Outer Continental Shelf sand increases, BOEM is facing increasingly complex issues, such as resource allocation, cumulative impacts from repeated use, space/use conflicts, protection of archaeological sites, and Essential Fish Habitat (EFH) impacts. In particular, the Magnuson-Stevens Fishery Conservation and Management Act requires that any federal agency undertaking or authorizing an action that may adversely affect EFH or federally managed fish species consult with NOAA. Researchers are using and developing geospatial maps to investigate the link between geomorphological features (e.g., sand shoals) and EFH, to better analyze the potential impacts of sand relocation. These efforts will help to ensure that all necessary and effective precautions are taken to reduce impacts during sand dredging and conveyance to placement sites.



ShoalMATE (Shoal Map Assessment Tool for EFH) is a geo-spatial decision-support tool being used to guide wise use and dredging of North Carolina offshore sand shoals. Potential sand dredging impacts to resident fisheries species in this area are being examined in concert with available biological and oceanographic data, and in consideration of EFH. Credit: NOAA NCCOS.

FY20 Accomplishment(s): Development of a model and technical report with BOEM.

Project URL:
https://coastalscience.noaa.gov/project/geospatial-assessment-u-s-atlantic-gulf-mexico-essential-fish-habitat-relation-offshore-sand-features/