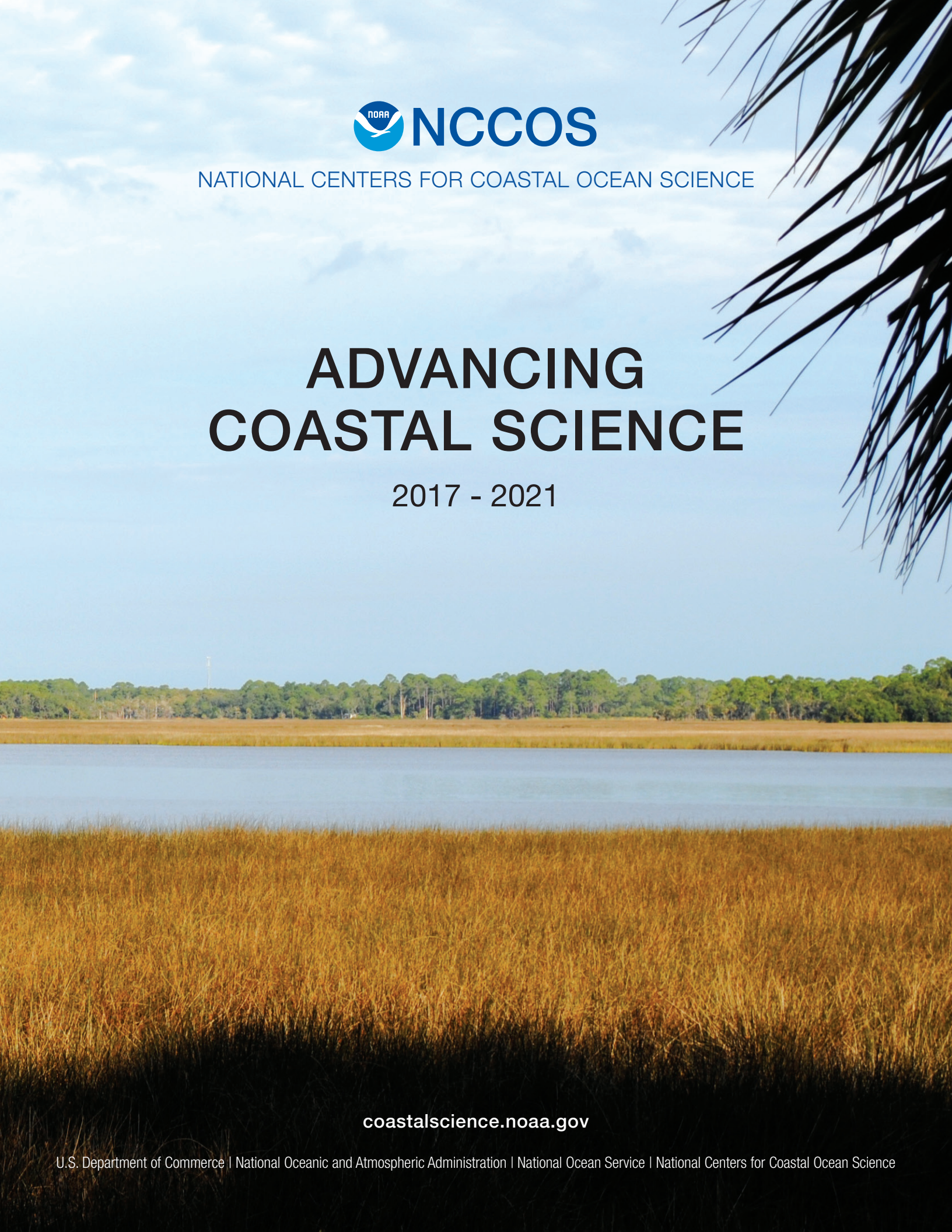

NCCOS

NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

# ADVANCING COASTAL SCIENCE

2017 - 2021

coastalscience.noaa.gov

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Ocean Service | National Centers for Coastal Ocean Science

*Steven Thur, Acting Director*
*Image credit: NCCOS*

# LETTER FROM THE ACTING DIRECTOR

The United States has been endowed with a tremendous asset: our ocean and coastal resources. The facts are incontrovertible. Coastal counties contribute over $6.6 trillion to our Nation's gross domestic product, which is nearly 50% of national output.[1] Approximately 40% of U.S. citizens live in these counties, attracted by both the natural beauty of the coasts and plentiful employment opportunities.[1] It is here that Americans live, work, recreate, and seek to reconnect with nature.

With such a concentration of human activity, there exists the potential for conflict between various uses of these resources. In addition, the coastal environment is a dynamic place; sea levels change, natural resources shift, patterns of human use vary, and industries wax and wane. Officials at the local, state, tribal, and federal level, along with those in the corporate and non-profit sectors, must use the best available information to make decisions that affect livelihoods, property values, human health, preparedness for disasters, management of our natural resources, and protection of special places for future generations.

Our role is to conduct the research and provide the information necessary to address these complex coastal challenges. The mission of the National Centers for Coastal Ocean Science (NCCOS) is to deliver ecosystem science solutions for stewardship of the Nation's ocean and coastal resources to sustain thriving coastal communities and economies. *Advancing Coastal Science* outlines how we shall accomplish that mission. It is the product of three years of engagement with stakeholders, which enabled us to refine our understanding of the most critical issues and how our scientific expertise could aid decision-makers.

*Image credit: NCCOS*

*Advancing Coastal Science* includes a section on what makes NCCOS unique - its federal employees, contractors, and other staff who work side-by-side to improve our collective understanding and provide science solutions. They are creative, dedicated, and focused on our role in serving the public interest through science. They are why I know we will be successful in accomplishing all that *Advancing Coastal Science* outlines.

Steven Thur, Ph.D
Acting Director
National Centers for Coastal Ocean Science

## VISION

*Science serving coastal communities*

## MISSION

*The National Centers for Coastal Ocean Science delivers ecosystem science solutions*
*~ for stewardship of the Nation's ocean and coastal resources*
*~ in direct support of NOS priorities, offices, and customers*
*~ to sustain thriving coastal communities and economies*

*Image credit: NCCOS*

*Advancing Coastal Science* lays out four priorities developed as a result of a lengthy stakeholder engagement process. These priorities will be our driving force over the next five years, and will guide NCCOS's science and competitive research investments. NCCOS will continue to use the National Ocean Service Coastal Science Board to understand and prioritize coastal management science needs around the nation. NCCOS will continue to serve Gulf of Mexico communities through management of the NOAA RESTORE Act Science Program.

# STRATEGIC SCIENCE PRIORITIES

## 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.

*Divers around the open-ocean aquaculture cage at the Cape Eleuthera Institute.*
*Image credit: Kelly Martin, Cape Eleuthera Island Institute*

## *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.[2] 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.

*Visible "red tide" along the coast of La Jolla, San Diego County*
*Image credit: Kai Schumann*

# Stressor Impacts and Mitigation (SIM)

Stressors are factors that alter the biological performance or state of an ecosystem. Primary stressors include harmful algal blooms, chemical contaminants, nutrients, and pathogens that impact coastal habitats, resources, and communities. These stressors have been reported in every state and are increasingly affecting coastal, Great Lakes, and inland communities and economies. Chemical contaminants, hypoxic conditions, and the toxins produced by harmful algal blooms, for example, threaten human and animal health, and can cripple local and regional economies by contaminating drinking water for humans and livestock, closing fisheries, repelling tourists, and lowering property values.

Coastal, Great Lakes and inland communities rely on NCCOS for ecological forecasting, stressor detection, and an understanding of stressor impacts on coastal resources to assist in managing the security of their water supply, safety of local fishing and shellfishing industries, the health of their people, and the strength of their coastal and lakefront tourism. Federal agencies such as the Departments of the Interior, Agriculture, and Energy, and NOAA use NCCOS's scientific findings, models, tools, and technologies to inform response actions and injury assessments, and in coastal management applications. NCCOS conducts its SIM research in two sub-priority areas.

## *Harmful Algal Bloom (HAB) Detection and Forecasting*

Managers of fisheries, beaches, and water treatment facilities need information on HAB detection and forecasting to plan for and deal with the adverse environmental, economic, and health effects associated with HABs. These managers also need to know about a bloom's toxicity: is it a mere discoloration of the water, or is it dangerous to drink or touch? In 1998, Congress recognized the severity of these threats and authorized the Harmful Algal Bloom and Hypoxia Research and Control Act. Subsequent reauthorizations expanded the mandate for NCCOS to advance the scientific understanding and ability to detect, monitor, assess, and predict HAB and hypoxia events.

NCCOS empowers communities to take action on HAB issues by developing detection tools and forecasts. We are researching what makes blooms toxic (not all blooms are toxic), and developing hand-held and autonomous tools to detect toxins, as well as analytical methods and reference materials to assure measurements are accurate. Short-term forecasts pinpoint where blooms are, how big they are, and where they are headed. Longer-term, seasonal forecasts predict the severity of HABs for the bloom season in a particular region. Citizen monitoring networks inform managers of the onset of toxic bloom events. These new detection technologies and forecasts are not only making drinking water safer and helping us understand which blooms will become toxic, they are opening the door to new commercial fisheries by providing accurate onsite testing for toxins in commercial shellfish.

## *Biological Effects of Contaminants and Nutrients*

Contaminants and nutrients pollute the marine and coastal environment, causing acute or long-term impacts to ecosystems, humans and animals – from shellfish to pets. Federal agencies with regulatory, management, or response missions have science needs that frequently overlap with those of community, fisheries, and public works managers. NCCOS provides the science to help managers understand the biological effects of contaminants and nutrients and evolve actions over time, or respond quickly to avert a crisis.

NCCOS conducts national or long-term research to understand the effects of contaminants, nutrients, and hypoxia. Measuring contaminants in mussels and oysters, or the breadth of the Gulf of Mexico's dead zone, where agricultural runoff from the middle of the country leads to summertime conditions that cannot support bottom-dwelling marine life. These measurements and predictions allow better decisions affecting health and seafood safety by local, regional, and upstream managers.

NCCOS is also concerned with more specialized or localized research questions where there is a unique need by Federal, tribal, state, and local officials, often in partnership with an industry or non-profit organization. For example, scientific understanding of the impacts of oil dispersants in a laboratory setting can help coastal and fisheries managers, and the oil and chemical industries make long-term and rapid response decisions. NCCOS provides the science to help managers understand the biological effects of contaminants and nutrients and evolve their actions over time, or respond quickly to avert a crisis.

# Coastal Change: Vulnerability, Mitigation, and Restoration

Coastal storms, flooding, and rising seas pose a persistent threat to coastal communities; in 2016, the United States experienced 15 weather and climate disasters with losses exceeding $1 billion.[3] Businesses can suffer loss of production, or the inability to reopen. People can lose their lives, homes, businesses and/or property and the social fabric that knits the community can be torn asunder. Resilience is the ability of a community to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

Changes in climate and an increase in extreme events can alter coastal ecosystems and the services those ecosystems provide to support our coastal communities and economy. NCCOS's research efforts seek to understand the ecosystem services that improve a community's resistance to the impacts of weather and changing climate conditions. NCCOS provides timely and actionable scientific assessments, information, and tools which coastal communities use to make risk management decisions. The Coastal Change portfolio is comprised of four distinct sub-priorities.

## *Vulnerability and Risk Assessment*

Coastal decision makers need to understand the risks and vulnerabilities facing their communities and ecosystems in order to help them become resilient. Coastal decision makers can include city, county, and state elected officials, coastal and emergency managers and planners, leaders of industry or neighborhood associations. NCCOS develops models and tools that integrate biological, hydrologic, physical, socioeconomic, and other factors to evaluate coastal resilience. NCCOS provides assessments of a community or ecosystem's characteristics to provide a better understanding of how extreme events will impact its residents' or natural systems' ability to be resilient. These characteristics, which are subject to the impact and response of the community or ecosystem to events and disturbances, can help determine the vulnerability of the collective community, beyond its geographic, economic, or infrastructural vulnerabilities.

Together with other NOAA partners, NCCOS conveys useful risk and vulnerability assessment information to guide mitigative and adaptive planning under multiple management scenarios. Communities improve their capacity to plan, recover and adapt.

## *Natural and Nature-based Features*

How important is a natural coastline in protecting communities from the impact of storms and floods? A study conducted by The Nature Conservancy says coastal wetlands prevented more than $625 million in property damages during Hurricane Sandy and reduced property damages throughout the Northeast by 10% on average.[4]

Recently, the use of natural and nature-based features (NNBF) has gained traction as a means to mitigate the potential impacts of extreme events, sea level rise, and inundation of coastal communities. Natural and nature-based features refers to a spectrum of features that employ a combination of natural and human engineered structures to create a shoreline. The effective use of these natural and nature-based approaches requires data to provide guidance on how, where, and when to best employ NNBF solutions. NCCOS provides the research and science components and partners with NOAA's Office for Coastal Management to help coastal communities use NNBF as an effective and aesthetically-pleasing strategy to enhance their resilience.

## *Climate Impacts on Ecosystems*

Because the coastal zone is dominated by dynamic and complex interactions among biological and physical processes, we cannot yet accurately predict when or what threats will emerge, or how they will affect the 124 million people who live in U.S. coastal counties. Approximately 39% of Americans living in coastal counties fall into an elevated coastal hazard risk category. These include children, the elderly, households where English isn't the primary language, and those in poverty.[5]

*Image credit: CH Knox / Thinkstockphotos.com*

NCCOS is helping communities mitigate and adapt to climate change by conducting research on detecting and assessing change in coastal ecosystems. By observing the ecological responses of coastal habitats and species to climate change, NCCOS can help communities understand ecosystem relationships and develop indicators to evaluate progress towards long-term community resilience.

## *Restoration*

Coastal ecosystems are vulnerable to habitat loss from impacts such as boat groundings and declining water quality. Habitat restoration offers a way to regain ecosystem services lost as a result of acute or chronic injuries.

NCCOS is a leader in coastal restoration science, and will continue to develop scientific tools and evaluate methods to guide restoration of impacted habitats. This includes research to improve the scientific framework for natural resource damage assessment and restoration, and developing sound mitigation and remediation strategies. NCCOS will continue to establish national and international guidelines on conservation and restoration of corals, seagrasses, and other critical habitats.

*NCCOS social science research focuses on the study of connections between people and the environment. Image credit: NCCOS*


*Image credit: NOS*

# Social Science

Coastal communities depend on natural resources for food, health, economic security, cultural and spiritual benefits, and recreation, in addition to the less obvious benefits such as carbon sequestration, clean water, and storm protection. Society and coastal ecosystems are intertwined, so it is important that we identify and describe the connections using the social sciences so that consequences and benefits of our policies and actions are considered and understood.

Social science refers to a range of disciplines focused on the study of people and their associated social systems. NCCOS has a team of economists and sociologists who work across our MSE, SIM, and Coastal Change portfolios to ensure that the human element is considered in the science we conduct. NCCOS social science research focuses on the study of connections between people and the environment. We prioritize investigations into these connections within three interconnected sub-priorities of research.

## *Ecosystem Services Valuation*

Ecosystem services are the goods and services from ecological systems that are of benefit to people. These benefits include storm protection, nursery grounds for young or small fish and shellfish, and pure enjoyment through use or aesthetics. Valuation is defined by NCCOS as the act or process of assigning an economic (market or non-market), social or cultural worth, utility or importance to special places or particular ecosystem products, services, or functions. The value of these special places or ecosystem services, products, or functions may be deemed relative, absolute, inferred, or estimated depending upon the research questions or management needs.

Assigning a value to services provided by ecosystems provides a common language for decision making, allowing clear trade-off discussions between such ideas as development vs. conservation. NCCOS identifies, documents, measures and/or estimates the social, cultural, and/or economic value to stakeholders, coastal communities, or society of special places and important ecosystem services, products, or functions. Coastal communities, planners, managers, regulators, and industry can use this social, cultural, and economic value information to make holistic business and management decisions.

## *Assessing Human Use*

Community managers need to understand how people are using and impacting natural resources in a particular ecosystem. Managers who include data on the impacts of human use to complement the biological assessments of their coastal ecosystems are better equipped to address multiple-use issues or conflicts between competing stakeholders or user groups.

NCCOS focuses on the identification, documentation, and characterization of how people understand, interact with, and use coastal and marine environments, including special places. Community managers need NCCOS to identify and predict patterns of social, cultural, and economic behaviors and dependencies that influence how places and spaces are used, valued, managed, protected, and preserved.

## *Assessing Vulnerability and Resilience*

The history, culture, and economy of communities in the coastal zone are deeply intertwined with their natural resources. Climate and coastal hazard impacts can threaten property, and the fishing, tourism, and shipping industries, among others, which generate billions annually to the U.S. economy. Understanding the vulnerabilities of communities to climate and coastal hazard impacts – like sea level rise, coastal erosion, and increased frequency of severe storms – requires an integrated approach.

NCCOS generates tools and information to improve community resilience to a changing climate as well as other coastal hazards. NCCOS provides coastal communities, planners, managers, regulators, and marine industries with the social science research needed to plan, recover, and adapt to events, disturbances, and changes in ecological conditions.

# PEOPLE

NCCOS's strength lies in the people who do the research, management, and administrative work that results in the delivery of science that serves the Nation's environmental, social, and economic goals. We are committed to supporting our people by: 1) moving toward an inclusive workforce that is more reflective of the Nation we serve; 2) training; and 3) succession planning.

Every day, we will use words and actions to promote a culture of inclusivity at all levels of the organization. NCCOS will work together to make all employees feel respected, welcomed, and empowered in the workplace. Through training and succession planning we will support the retention and advancement of a diverse workforce.

## *Diversity and Inclusion*

NCCOS science incorporates a diversity of expertise and serves the needs of diverse communities around the Nation. We know the next generation of scientists will be more diverse than they have been in the past, and they will possess new skills and use emerging technologies that will be imperative to advance our ability to conduct future science.

NCCOS is committed to promoting diversity through actions such as the promulgation of recruitment opportunities to a broad swath of qualified individuals, in positions from entry level science staff to senior leadership. We will continue to build and maintain partnerships with academic institutions and science organizations to broaden access to diverse networks of science professionals and potential stakeholders. This outreach will include continued hosting of summer interns at our facilities, collaboration with faculty scientists and students, and engagement with diverse communities with needs that complement our science capabilities. NCCOS recognizes that diversity comes in many forms; we seek to make sure opportunities in our organization are open to all who have the interest and ability to contribute to the NCCOS mission.

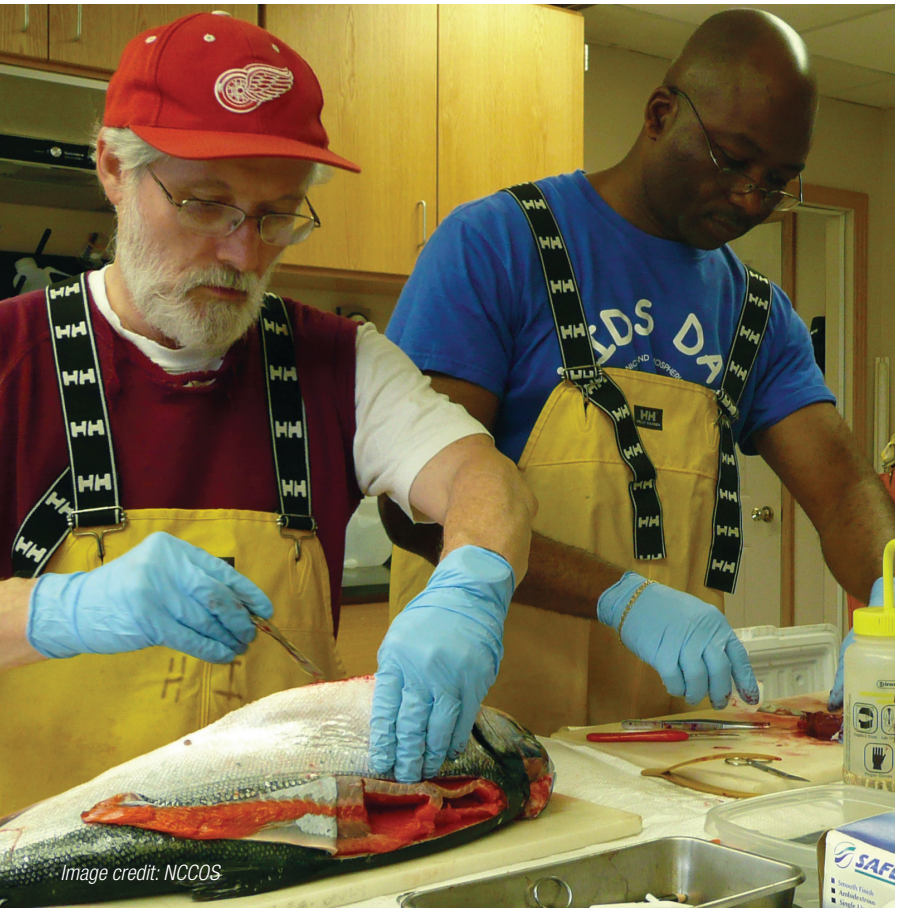

*Image credit: NCCOS*

## *Training*

NOAA relies on the technical, administrative, and policy skills of the NCCOS staff to ensure that taxpayer-funded science is conducted safely, efficiently and legally in support of the Nation's highest needs. We are committed to providing NCCOS employees appropriate training to ensure requirements are met, and to offer mentoring and other developmental opportunities to improve and enrich our employees' skills and competencies.

## *Succession Planning*

We employ world-class scientists, many of whom have retirement on their horizons. NCCOS is committed to supporting the professional development of current and future scientists who will serve as eventual leaders in the national and international science community.

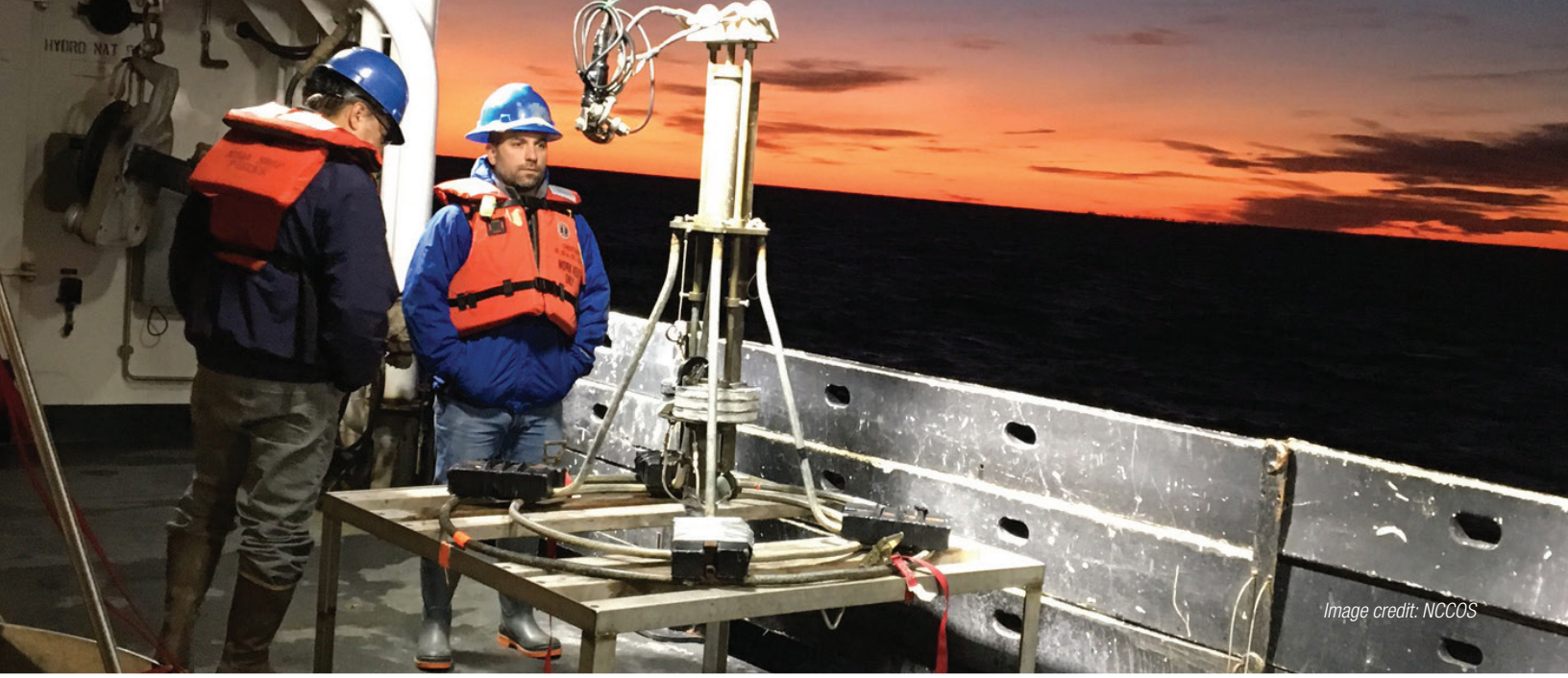

Image credit: NCCOS

Image credit: NCCOS

Image credit: NCCOS

*Aerial view of The NOAA Beaufort Lab*
*Image credit: NCCOS*

# OUR FACILITIES

## *NCCOS Program Office and Headquarters - Silver Spring, Maryland*

NCCOS leadership, scientists, and support staff are co-located with other NOAA offices in Silver Spring, MD. NCCOS employees plan, manage, and execute the budget, set information technology policy, and provide policy and communications support to NCCOS leadership in its internal and external partnerships, and in its interactions with Congress. The program office components manage the Competitive Research Program and the RESTORE Act Science Program, and supervise or conduct science, research, and associated model, tool, and product development.

## *The NOAA Beaufort Laboratory - Beaufort, North Carolina*

The NOAA Beaufort Lab, opened in 1899, is the second oldest federal marine laboratory and home to scientists from NOAA's National Marine Fisheries Service and National Ocean Service. Operated by NCCOS, the Beaufort Lab is recognized for an extensive array of research including seagrasses, coral reefs, harmful algal blooms, seafloor mapping, aquaculture, and salt marsh ecology. The combination of world-class scientists with an ideal location has expanded our research to include understanding the effects of a changing climate on coastal and offshore ecosystems. The NOAA Beaufort Lab also houses the North Carolina Coastal Reserve and National Estuarine Research Reserve, which serve as living laboratories for scientists and students to learn about coastal systems. About 100 staff work out of the 60,000 square-foot laboratory resting on 13 acres of Pivers Island, an island shared with Duke University Marine Laboratory. Because of the variety of research and activities conducted here, the lab has a full SCUBA diving roster, small boats, aquaculture systems, high-tech laboratories for cell analysis, necropsy facilities, electronics workshops, classrooms, and a large auditorium.

## *NOAA Charleston and Hollings Marine Laboratories - Charleston, South Carolina*

NCCOS's Charleston Laboratory is a 45,000 square-foot facility that includes chemistry, toxicology, molecular, microbiology, and ecology laboratories. The laboratory has separate facilities for culture of coral species, as well as challenge laboratories to simulate and assess impacts of climate and stress changes. There is a similar building for the challenge of fish and invertebrates to chemical contaminants, and a greenhouse-enclosed salt marsh mesocosm with tidal influence, to assess the effects of contaminants under conditions simulating a southeastern U.S. estuarine habitat.

The Hollings Marine Laboratory (HML) is a partnership between NCCOS, the National Institute of Standards and Technology, the Medical University of South Carolina, South Carolina Department of Natural Resources, and the College of Charleston. Researchers from all partner institutions work side-by-side, combining expertise to conduct research they could not accomplish otherwise. HML is built on an approximately 8-acre site within the Fort Johnson campus of the South Carolina Marine Resources Center in Charleston, South Carolina. Dedicated in December 2000, the laboratory is a NCCOS-run facility that promotes collaborative and interdisciplinary scientific research to sustain, protect, and restore coastal ecosystems. About 130 staff work out of the 103,000 square-foot laboratory.

Image credit: NCCOS

## The Cooperative Oxford Laboratory - Oxford, Maryland

The Cooperative Oxford Laboratory (COL) is located on the shores of Chesapeake Bay in Oxford, Maryland. The COL was established in 1960 by the U.S. Bureau of Commercial Fisheries for the primary purpose of investigating oyster diseases that struck the Chesapeake and Delaware Bays in the late 1950's. The facility became the Cooperative Oxford Laboratory in 1987, through an agreement between the Maryland Department of Natural Resources and the National Ocean Service to share the facility and cooperate in research. NCCOS operates the 16,000 square-foot main laboratory, with onsite partners including NOAA's Chesapeake Bay Office, the Maryland Department of Natural Resources, and the U.S. Coast Guard. The laboratory has a 55' research vessel used for regional research.


Image credit: NCCOS

## Kasitsna Bay Laboratory - Seldovia, Alaska

The Kasitsna Bay Laboratory (KBL) is the Alaska field station for both NCCOS and the National Marine Fisheries Service since the late 1950's. The University of Alaska Fairbanks helps NCCOS operate the Kasitsna Bay Laboratory. A wet/dry laboratory building which includes a 1,400 square-foot running seawater laboratory hosts research on the coastal impacts of climate change, ocean acidification, harmful algal blooms, and monitoring and change of nearshore biodiversity. The laboratory also serves as a testbed for underwater technology in high-latitude coastal ecosystems and under rugged conditions. Because of its remote location, the Kasitsna Bay Laboratory facilities include dormitory buildings with housing, kitchen, laundry and internet for up to 48 people.


Image credit: NCCOS

# APPENDIX I: DRIVERS

The directives and planning documents catalogued in this appendix are the major legislative, mission and policy drivers for the science and research conducted by NCCOS. These drivers, as well as needs expressed by key stakeholders, guide the efforts and activities for the accomplishment of various aspects of NCCOS's mission and goals.

## Legislative Drivers

- Clean Water Act, 1972
- Coastal Zone Management Act (CZMA), 1972
- Coral Reef Conservation Act (CRCA), 2000
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 1980
- Endangered Species Act, 1973
- Estuary (Estuarine) Protection Act, 1968
- Harmful Algal Bloom and Hypoxia Research and Control Amendments Act (HABHRCA), 2014
- Invasive Species Executive Order, 1999, 2016
- Magnuson-Stevens Fishery Conservation and Management Act, 1976
- Marine Mammal Protection Act, 1972
- National Coastal Monitoring Act, 1992
- National Contaminated Sediment Assessment and Management Act, 1992
- National Environmental Policy Act (NEPA), 1970
- National Marine Sanctuaries Act (NMSA), 1972
- Oceans and Human Health Act, 2004
- Oil Pollution Act (OPA), 1990
- Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE Act), 2012

## National and NOAA Drivers

- The National Science and Technology Council Subcommittee on Ocean Science and Technology's Comprehensive HAB and Hypoxia Research Plan and Action Strategy
- Coastal Green Infrastructure and Ecosystem Services White House Task Force Recommendations
- NOAA and National Ocean Service mission, vision, priorities
- NOAA's Natural Infrastructure Strategy
- NOAA-wide efforts in Integrated Ocean and Coastal Mapping (IOCM)
- NOAA Ecological Forecast Roadmap
- NOAA Habitat Conservation Team through the Habitat Science and Ecological Forecasting technical team
- NOAA's Ecosystem Based Fisheries Management Roadmap
- NOS Roadmap

# APPENDIX II: CITATIONS


[1, 5] *NOAA Office for Coastal Management*: Fast Facts, Economics and Demographics, https://coast.noaa.gov/states/fast-facts/economics-and-demographics.html

[2] *USDA National Institute of Food and Agriculture*: USDA Announces $1.2 Million in Available Funding for Aquaculture Research (April 6, 2016), https://nifa.usda.gov/announcement/usda-announces-12-million-available-funding-aquaculture-research

[3] *NOAA National Centers for Environmental Information*: Billion-Dollar Weather and Climate Disasters: Overview (July 2017), https://www.ncdc.noaa.gov/billions/

[4] *The Nature Conservancy, Coastal Wetlands and Flood Reduction*: Using Risk Industry-Based Models to Assess Natural Defenses in the Northwestern USA (October 2016), 9.

Image credit: NCCOS

# APPENDIX III: ACTIVITIES

Over the next 5 years, NCCOS will focus on the following activities related to its priorities:

## Marine Spatial Ecology (MSE)

### *Ecological and Biogeographic Assessments*

- Integrated bio-physical and socio-economic indicators to evaluate the status and trends of ecological conditions of coastal and marine ecosystems
- Robust statistical models – and measures of their uncertainty – to describe and predict conditions and/or changes in response to environmental and management actions
- New remote sensing and mapping technologies to support spatial model development to improve the understanding of ecological connectivity

### *Habitat Mapping*

- Characterization and assessment of benthic and pelagic, and coastal and marine habitats to provide baseline habitat conditions, enable monitoring activities, and evaluate management actions
- Spatial-temporal model development to improve understanding of connectivity of living marine resources between ecosystems
- Maps and inventories of critical habitats and associated species; spatial patterns of ecological "hotspots"; data analysis and visualization techniques that support spatial management

### *Regional Ecosystem Science*

- Indicators, characterizations and models that couple social, governance, and natural systems to support ecosystem-based management
- Investigate ecological connectivity to evaluate the efficacy of marine protected areas and associated management options

### *Coastal Aquaculture Siting and Sustainability*

- Research on the interactions between aquaculture and the environment
- Research on aquaculture's contribution to ecosystem services and social science issues
- Spatial products and services supporting aquaculture siting and management

# Stressor Impacts and Mitigation (SIM)

## *Harmful Algal Bloom (HAB) Detection and Forecasting*

- Forecasts and early warnings of HAB extent, trajectory, and toxicity, so managers can implement early action to more cost-effectively and efficiently mitigate the impacts of HABs
- Scenario-based predictive models of HAB abundance and toxicity to establish their relationship to causal factors, to improve management strategies for preventing and mitigating HABs, and to assess the effectiveness of prevention and control practices
- New detection technologies such as test kits, autonomous sensors, and portable instruments to enable local observations to support forecasts, and that provide states, municipalities and tribal Nations with the skills and tools to identify and quantify HAB species and toxicity
- Guide and support cost-effective volunteer observation opportunities through the "Phytoplankton Monitoring Network" to educate citizens, test new technologies, and inform managers of the onset of toxic bloom events
- Produce analytical methods and reference materials in concert with other federal agencies to support development of standardized methods and training for testing laboratories and validation of their use to assure accurate and reproducible measurements nationwide

## *Biological Effects of Contaminants and Nutrients*

- Field-based investigations that examine chemical, biological, and abiotic metrics that characterize stressor exposure and effects to key marine organisms, and application of biomarkers to assess physiological response to stressors
- Contaminant biological effects characterizations to support oil and chemical spill response and injury assessments, to include laboratory controlled studies to predict the environmental fate of and to determine effects thresholds for chemicals of concern
- Tools for the assessment and prediction of stressor impacts to include ecological forecasting, biomarker development, analytical methods development for chemical contaminant concentrations, and promulgating new/revised threshold guidance
- Consultative expertise in environmental toxicology and physiology, analytical chemistry, coastal ecology, statistical analysis, and modeling on issues related to stressor-related bioeffects in coastal ecosystems

# Coastal Change: Vulnerability, Mitigation, and Restoration

## *Vulnerability and Risk Assessment*

- Scenario-based modeling integrating biological, hydrologic, physical, socio-economic and other factors to improve predictions of coastal vulnerability and risk under varying climate, adaptation, and response scenarios
- Inclusion of "well-being" and other social indicators to provide communities with longitudinal information that can be used to improve community planning, response and adaptation
- Impacts of hazards on particular populations, infrastructure, and industries measured to determine potential for recovery
- New or enhanced climate risk assessment and vulnerability tools useful to coastal managers and private industry

## *Natural and Nature-based Features*

- Research ecosystem services of natural coastal ecosystems vs. nature-based infrastructure
- Couple hydrodynamic and biological/physical modeling platforms and the integration of field-based studies of relevant coastal processes to advance sea level rise and inundation predictive capabilities
- Science-based guidance to inform and empower effective decision-making related to the use of natural features
- Science support for policy development and permitting decisions related to nature-based infrastructure implementation


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### *Climate Impacts on Ecosystems*

- Field and laboratory-based studies on the ecological responses of coastal habitats and species to climate-scale changes in conditions to improve understanding of how changes in natural systems affect a coastal community's resilience, health and economy
- Change detection and early warning systems for community decision makers, coastal managers, and the public that identify changes in coastal conditions that may alter ecosystem services and undermine the resilience of coastal communities, ecosystems, and economies

### *Restoration*

- Establish thresholds for environmental injury and recovery to habitats and/or species and resource valuation approaches for primary or compensatory mitigation efforts
- Developing GIS decision support tools to prioritize restoration siting and provide analysis and visualization that support planning or siting of potential restoration options for natural resource recovery and management decisions

## Social Science

### *Ecosystem Services Valuation*

- Identify, document, and measure baseline economic, social, or cultural values of special places or of particular ecosystem services, products, or functions
- Characterize place-based social and cultural attachment to special places or particular ecosystem services, products, or functions
- Estimate and/or predict change to economic, social, or cultural values due to changes in ecosystems or to particular ecosystem services, products, or functions

### *Assessing Human Use*

- Identify, document, and characterize patterns pertaining to human use of coastal and marine places and spaces, as well as particular natural resources
- Assess reliance of stakeholders and coastal communities on special places, as well as the natural resources, features, and uses that make these places special or important
- Link patterns of human coastal and marine use to valuation of ecosystem services, products, and functions

### *Assessing Vulnerability and Resilience*

- Research and assess vulnerabilities to coastal hazards and impacts of climate variability in coastal regions
- Research impacts of severe storm events on particular populations, infrastructure and industries measured to determine potential for recovery

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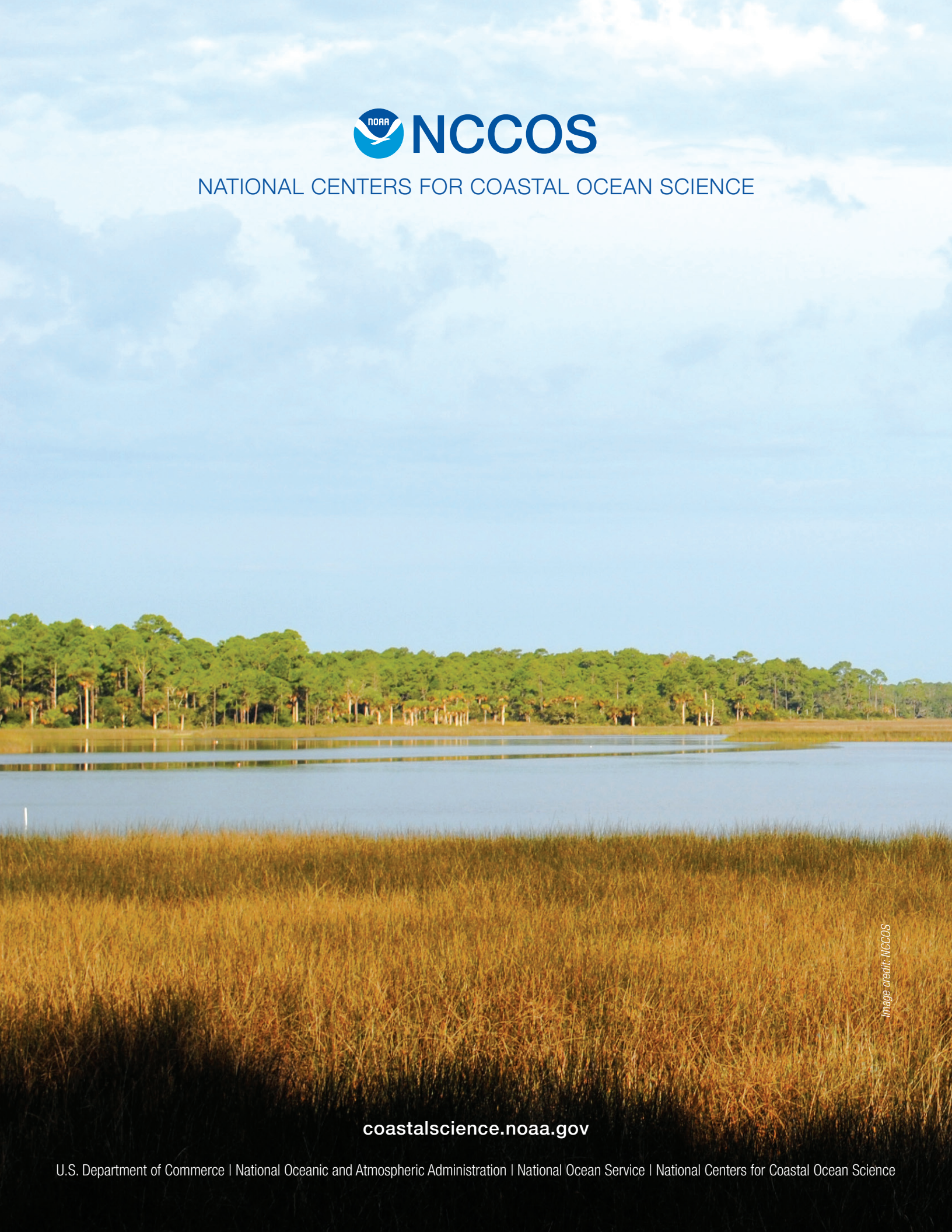

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