



NEWSWAVE

NEWS FROM THE U.S. DEPARTMENT OF THE INTERIOR: OCEAN, GREAT LAKES, AND COASTS

Special Feature—Deep Sea Research, see p. 18

Spring/Summer 2020

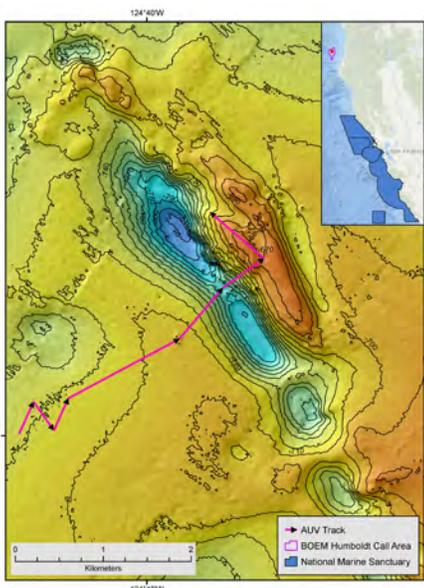
Exploring the Deep Sea Advancing Our Knowledge

By Ann Tihansky (USGS)

2019 was a big year for deep-sea expeditions, and the U.S. Department of the Interior (DOI) was pleased to be a partner supporting our Nation in advancing our knowledge about these remote and unexplored areas of the Earth.

The Outer Continental Shelf (OCS) of the United States is roughly 2.5 billion acres of seabed, whereas the total land area of the 50 States is 2.4 billion acres, essentially doubling our Nation's land area. Exploring our Nation's OCS is like discovering a new continent; describing what exists there and mapping it, in some places for the very first time. It is very exciting.

See Exploring the Deep page 18



\$57 Million Increase to Land and Water Conservation Fund

In March 2020, U.S. Secretary of the Interior David Bernhardt announced an increase of \$57 million over last year's Land and Water Conservation Fund (LWCF) allocation due to increased revenue from offshore

See LWCF page 3



Above, in June, the Secretary visited Bon Secour National Wildlife Refuge (NWR) and planted marsh grass with Refuge staff as part of coastal restoration activities to improve habitat and reduce erosion. Photo credit: Tami Heilmann, DOI

At left, an autonomous underwater vehicle (AUV) was used to characterize potential offshore wind energy lease sites. The red line shows the location of AUV Dive #7 at Bureau of Ocean Energy Management (BOEM) Humboldt Call Area off Eureka, CA. Image credit: NOAA-OER EXPRESS 2019 Surveying Deep-sea Corals, Sponges, and Fish Habitat

Sea Turtle Research Stewardship Mission Spans Gulf of Mexico

By Kristen M. Hart (USGS), Margaret Lamont (USGS), Donna J. Shaver (NPS), and Ann Tihansky (USGS)

A collection of articles in this issue demonstrates how DOI brings together diverse bureau expertise and partners to fulfill the broad mission. Read about science and tracking technology, species management and recovery, sea turtle protection, public education, and international partnership.

Part of the Federal Natural Resource Damage Assessment (NRDA) of environmental impacts resulting from the *Deepwater Horizon (DWH)* oil spill in April 2010 was focused on determining the impacts to threatened loggerhead (*Caretta caretta*) and endangered Kemp's ridley (*Lepidochelys kempii*) sea turtles.

Read the collection of articles starting on page 7.



Newly hatched Kemp's ridley sea turtles head out into the Gulf of Mexico (Gulf). Photo credit: NPS

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Contribute to NEWSWAVE!

If you have any questions, comments or want to receive NEWSWAVE by email, contact: Ann Tihansky: tihansky@usgs.gov

For more information, contact:

Liza Johnson, Ocean, Great Lakes, and Coasts Coordinator, Office of the Assistant Secretary for Insular and International Affairs
 1849 C Street, NW, Mail Stop 3117
 Washington, D.C. 20240
 Telephone: 202-208-1378
liza_m_johnson@ios.doi.gov



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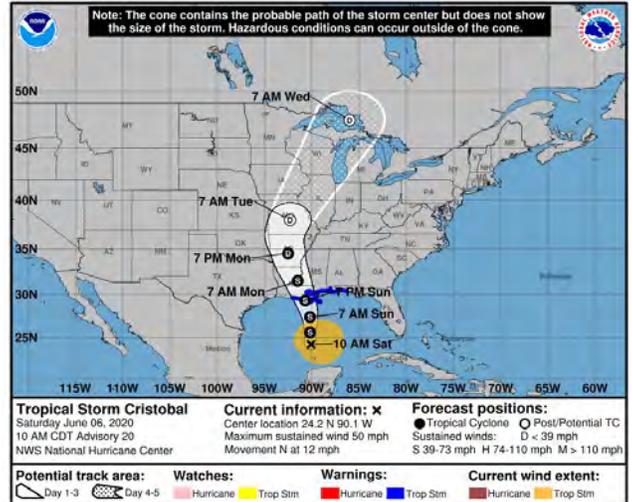


<https://www.facebook.com/USInterioroceancoastsgreatlakes/>

Safe Offshore Activities for the Bureau of Safety and Environmental Enforcement (BSEE)

Safety is literally BSEE's middle name. So, in early June, when Tropical Storm Cristobal threatened offshore oil facilities in the Gulf, BSEE activated its Hurricane Response Team. The Hurricane Response Team monitors offshore oil and gas operators in the Gulf as they evacuate platforms and rigs in response to the storm. The team works with offshore operators and other State and Federal agencies until operations return to normal and the storm is no longer a threat to Gulf oil and gas activities.

Follow and learn more about BSEE on Facebook: <https://www.facebook.com/BSEEGov/>



NEWSWAVE is a quarterly newsletter from the Department of the Interior featuring ocean, Great Lakes, and coastal activities across the Bureaus.

Visit us online: <https://www.doi.gov/ocean/newswave>

Editor: Ann Tihansky (USGS)

Technical Editor: Rebekah Davis (USGS); Layout: Bethany Fuss (USGS)

Contributors:

- | | | |
|-------------------------|---|--|
| BOEM | Nadine Leavitt Siak, USFWS | Lauren Wenzel, NOAA |
| Cathy Coon, BOEM | USGS | Raul de Jesus Gonzalez Diaz |
| Benjamin Pister, BOEM | Walter Barnhardt, USGS | Miron, Acuario de Veracruz A.C. |
| Michael Plummer, BOEM | Laura Brothers, USGS | Marth Lopez Hernandez, CONANP |
| Jeremy Potter, BOEM | Jason Burton, USGS | Adam Skarke, Dept. of Geosciences, Mississippi State Univ. |
| Michael Rasser, BOEM | Mike Cherkiss, USGS | IGFA |
| BSEE | Andrew Crowder, USGS | Lisa Morse, IGFA |
| DOI | Amanda Demopoulos, USGS | Nick Whitney, New England Aquarium |
| Tami Heilmann, DO | John Haines, USGS | Schmidt Ocean Institute |
| Liza Johnson, DOI | Kristen Hart, USGS | Stantec Inc. |
| Tanya Joshua, DOI | Ilsa Kuffner, USGS | Katrin Iken, Univ of Alaska-Fairbanks |
| NPS | Margaret Lamont, USGS | Brenda Konar, Univ of Alaska-Fairbanks |
| Krista Barentine, NPS | Nancy Prouty, USGS | Keenan Yakola, UMass Amherst |
| Heather Coletti, NPS | David Roche, USGS | Vida Milenaria |
| Tom Fish, NPS | Carolyn Ruppel, USGS | Fernando "Papa Tortuga" Manzana, Vida Milenaria |
| Christian Gredzens, NPS | Sara Schoen, USGS | Ivan Hurlzeler, photographer |
| Katlyn Haven, NPS | Michelle Staudinger, USGS | Miguel Ramirez Castillo, photographer |
| Tahzay Jones, NPS | Ann Tihansky, USGS | Edgar Woo, photographer |
| Sarah Laughlin, NPS | NOAA | |
| Jim Pfeiffenberger, NPS | Chris Caldwell, NOAA | |
| Joel Reynolds, NPS | Elizabeth Clarke, NOAA | |
| Cynthia Rubio, NPS | Jason Frohnmayer, NOAA, | |
| Sue Saupe, NPS | Shannon Hoy, Cherokee Nation Strategic Programs at NOAA-OER | |
| Donna Shaver, NPS | NOAA-OER | |
| Sarah Venator, NPS | NOAA-OER | |
| USFWS | Bob Stone, NOAA | |
| Mark Davis, USFWS | Mike Thompson, NOAA | |

NOPP Partnership Excellence Awarded to Arctic MARES Team

In February 2020, Marine Arctic Ecosystem Study (MARES) received the 2019 NOPP award for Excellence in Partnering Award. The annual award recognizes successful partnerships that advance ocean sciences.

BOEM coordinated and planned the MARES project, which is an international, interagency, and public-private partnership led by the design firm Stantec Inc.

“We are pleased that the important research we and our partners are conducting in the Arctic is being recognized. With increasing interest in the Arctic, it’s vital that we expand

our knowledge of the Beaufort Sea ecosystem to help inform our energy-related decision making. Forward-thinking partnerships like MARES rely on sustained collaborative efforts to succeed. We appreciate the commitment and dedication our partners have demonstrated throughout this study.” said BOEM Acting Director Dr. Walter Cruickshank

2014 MARES study announcement: <https://www.boem.gov/newsroom/press-releases/boem-nopp-partners-launch-arctic-ecosystem-study-us-and-canadian-waters>



MARES has implemented an integrated, multidisciplinary study. Here a team is retrieving data from one of the moored platforms from a research vessel. Photo credit: Stantec Inc.

Read more about the MARES project: <https://www.nopp.org/projects/mares/>

Celebrating and Conserving Wetlands!

May is American Wetlands Month, and hundreds of bird species will benefit from \$160 million in funding for various wetland conservation projects in North America. The funding was approved by the Migratory Bird Conservation Commission, which is chaired by U.S. Secretary of the Interior David L. Bernhardt.

“Wetlands are special places with an exceptional role to play in both the economy and conservation of our magnificent wildlife,” said U.S. Fish and Wildlife Service (USFWS) Director Aurelia Skipwith.

Wetlands provide many economic, ecological, and social benefits. North American Wetlands Conservation Act (NAWCA) grants conserve bird

populations and wetland habitat while supporting local economies and American traditions such as hunting, fishing, birdwatching, family farming, and cattle ranching. Of the approved funds, the Commission allocated \$22.1 million under the NAWCA to the USFWS and its partners to conserve or restore more than 160,000 acres of wetland and associated upland habitats for waterfowl, shorebirds, and other birds for 22 projects in 15 U.S. States. Partners will match these grants with an additional \$50 million.

Learn more: <https://www.doi.gov/pressreleases/secretary-bernhardt-announces-160-million-funding-wetland-conservation-projects-and>



Paddlers enjoy the Alligator River NWR in NC. Photo credit: USFWS

LWCF continued from page 1

oil and gas leases. A total of more than \$227 million will be distributed from the LWCF to all 50 States, five U.S. territories and the District of Columbia for specified park, outdoor recreation, and conservation projects. Each year the funds are awarded through Federal matching grants that leverage public and private investment in America’s State and local public parks.

“This is significant, as the LWCF leverages additional public and private dollars to expand outdoor recreation opportunities for the American people and invest in conservation projects across the country,” said Secretary Bernhardt.

“This is a State-Federal partnership that demonstrates how we can work together to improve and expand access to public outdoor recreation opportunities,” said Deputy NPS Director David Vela.

See related stories page 26 and 31

Read the press release: <https://www.doi.gov/pressreleases/secretary-bernhardt-announces-227-million-state-outdoor-recreation-and-conservation>

DOI is an Ocean Agency

By Liza Johnson (DOI) and Ann Tihansky (USGS)

The President proclaimed June 2020 as National Ocean Month. As one of our Nation's principal stewards of our ocean, Great Lakes, and coastal resources, the DOI recognizes the vital connection between the health of our Nation's natural resources, human health, and our economy. The ocean and the Great Lakes are used by millions of Americans for recreational boating and fishing, commercial fishing, transportation of goods, oil, gas, minerals, and renewable energy to support our economy.

DOI has a Blue Portfolio with broad and diverse responsibilities for offshore energy and the revenue it generates and for coastal ecosystems with the biological diversity and coastal protection they provide. We also have responsibilities for conservation, recreation, OCS lease management, and foundational science and technology to support the wise management and use of coastal and ocean resources. To fulfill our mission, we work across the federal family and rely on many partners.

DOI was one of several agencies that contributed to new planning documents that outline a first-ever national strategy for mapping, exploring, and characterizing the U.S. Exclusive Economic Zone, a 10-year plan to map the coast of Alaska, and a set of recommendations for efficient permitting and authorization of ocean exploration, mapping, and related research activities.

This is a monumental task. Members from the DOI Ocean Team at the U.S. Geological Survey (USGS) and BOEM, and others have worked alongside partners at the National Oceanic and Atmospheric Administration (NOAA), Department of Defense, National Science Foundation, and other agencies to produce these documents. We are already preparing to take next steps in implementing the strategies laid out in the documents.

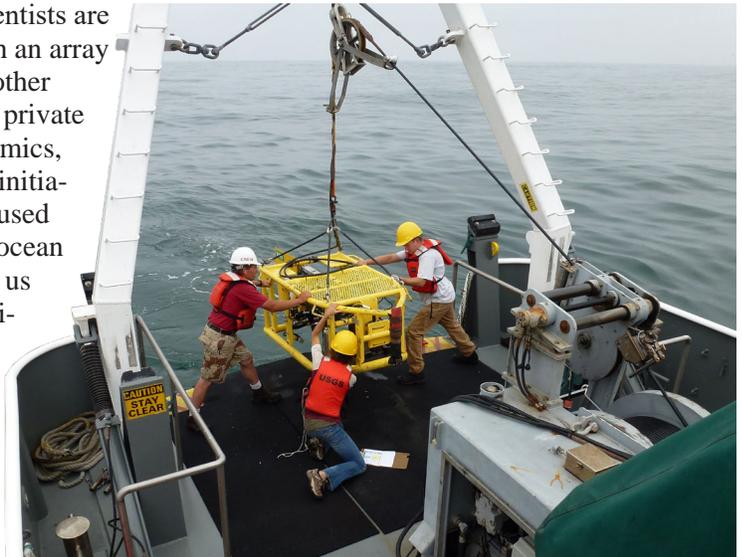
DOI staff and scientists are well engaged with an array of partners from other Federal agencies, private companies, academics, and international initiatives together focused on exploring our ocean areas and helping us identify and prioritize next steps.

"America is bigger than you might think," said Douglas W. Domenech, DOI's Assistant Secretary, Insular and International Affairs, who oversees the coordinated Ocean, Great Lakes, and Coastal Program. "When you consider the submerged area of the United States, it roughly doubles the size of our country. Exploring our Nation's OCS is like discovering a new continent; describing what exists there and mapping it, in many places for the very first time, will prove to be beneficial for many."

"The USGS is proud to be an inter-agency partner in the efforts to increase American exploration of our planet's oceans," said USGS Director Dr. Jim Reilly. "We have a long history of providing science expertise on marine geology; and geological processes to better understand the hazard and resource potential of the Nation's submerged lands. The strategic vision put forward by the Ocean Policy Committee is an important step forward in advancing ocean exploration, and the USGS stands ready to collaborate with our Federal and State partners to execute that vision."

As an ocean agency, DOI contributes to improving our understanding of the ocean and greater understanding of our planet overall.

In sharing the vast amounts of data we collect and the scientific research



USGS scientists and staff deploy a camera sled from the research vessel *Shearwater*. The sled is towed close to the seafloor and collects real-time photographs and videos. On board the vessel, scientists can watch the live video feed and make note of seafloor characteristics such as sediments, rocks, and biological cover to enhance the California Seafloor Mapping Program offshore of northern California. Photo credit: USGS

we produce, we advance offshore energy production, ensure safety and security for offshore infrastructure, prepare coastal communities for hazards such as tsunamis, sea level rise, land subsidence, and storm surge. We also help reduce conflict among the many users of our ocean resources, by protecting and managing offshore and coastal ecosystems and the multiple species that rely on them.

Using a coordinated approach, DOI is fulfilling its stewardship mission of ensuring current and future generations can benefit from and enjoy healthy, resilient, and prosperous ocean, Great Lakes and coastal resources.

See *Special Feature*, page 18

Read the Presidential Proclamation: <https://www.whitehouse.gov/presidential-actions/proclamation-national-ocean-month-2020/>

Read the press release: https://www.whitehouse.gov/wp-content/uploads/2020/01/20200611FINALOcean-Strategies-and-recommendations_press-release-1.pdf?fbclid=IwAR3exL7qsI1RMIFmbse6pULStvnXjFWToG8Bvqznr31GtrbZi_t5CR6fECM

Let's Go Fishing! Partners for Angling Education

By Lisa Morse (IGFA)

In 2019, the International Game Fish Association (IGFA) and the National Park Service (NPS) developed a new partnership focused on youth angler education. Together they launched a pilot program that has provided hands-on instruction on recreational fishing basics and ethical angling practices that, to date, has reached more than 1,100 children. This project is intended to grow recreational fishing opportunities in NPS locations throughout the southeastern United States and was funded in part by a grant from the National Park Foundation.

Before the launch of the pilot program, the IGFA and NPS had previously collaborated with the USFWS and TakeMeFishing.org, a national campaign of the Recreational Boating & Fishing Foundation, to create the *Junior Ranger: Let's Go Fishing!* activity book, which was distributed to NPS locations across the country, encouraging Junior Ranger Anglers to learn about recreational fishing opportunities in national parks.

To compliment the activity book, the IGFA and NPS worked together to host Learn-to-Fish clinics using the IGFA's Passports to Fishing

program—the pilot program. These events not only attract families to NPS locations, but the IGFA also trains and equips park staff with all the necessary items so they can host events in the future.

The first two “Learn-to-Fish” clinics occurred in Florida at Biscayne National Park on March 9, 2019, and Canaveral National Seashore on April 27, 2019. An event at Cape Hatteras National Seashore in North Carolina occurred on November 9, 2019, followed by Cane River Creole National Historical Park in Louisiana on February 8, 2020. The final “Learn-to-Fish” clinic in the southeast region was scheduled for Augusta Canal National Heritage Area on April 18, 2020, to celebrate Junior Ranger Day of National Park Week but has been temporarily postponed to September due to the current global pandemic.

“This clinic was perfect for me. The five stations were informative and fun without being overwhelming. It may be designed for ‘youngsters’ but it is ideal for beginners of any age. I now feel confident enough to select equipment and try surf fishing on my own,” said participant Linda Sue Boehmer after the event at Cape Hatteras National Seashore.

“I think the people who came had an absolute ball, and I



IGFA Instructor Jonathan Howard trains Avia Woulard, Park Ranger at Canaveral National Seashore, on how to tie proper fishing knots. Photo credit: IGFA

think we caught a load of fish! This was sensational. It's the experiences they had and the memories they made today that will help them keep on fishing and create more of their own memories in the future,” said Greg Parker, a volunteer with Cape Hatteras National Seashore.

Download the activity book: <https://www.nps.gov/subjects/fishing/junior-ranger-fishing.htm>.

For more information about the IGFA, visit: <https://igfa.org/>.



Jay Johnstone, Education and Outreach Coordinator, swears in new Junior Ranger Anglers at Biscayne National Park. Photo credit: Edgar Woo



Greg Parker, volunteer with Cape Hatteras National Seashore, helps Junior Ranger Angler Erica Dalkowski with a spotted seatrout (*Cynoscion nebulosus*) she caught and released while surf fishing for the first time. Photo credit: IGFA

Support for American Seafood

By Ann Tihansky (USGS)

New Executive Order (EO) marks years of progress, interagency discussions, and planning in support of competitiveness and economic growth.

The President signed the EO on May 7th. The EO will help solidify our Nation's food security, protect American jobs in the seafood industry, and create new jobs in the United States. Specific actions include furthering more efficient and predictable aquaculture permitting processes, accelerating regulatory reform to maximize commercial fishing, and upholding common-sense restrictions on seafood imports that do not meet American standards.

DOI was engaged in developing the EO through interagency discussions followed by three years of crafting the

draft document. Although DOI is not the lead agency involved in illegal, unreported, and unregulated fishing, aquaculture, or seafood trade, DOI has diverse roles in implementing the EO.

DOI's Blue Portfolio supports healthy American fisheries and includes diverse responsibilities for resources and management activities that influence healthy fisheries. DOI will continue to work with other Federal agencies and Tribal, State, and local partners to manage, restore, and protect critical and productive coastal wetland habitats that serve as nurseries and feeding areas for fish populations. This includes maintaining national parks and the NWR system that protect a diverse array of habitats and species; conducting the

science needed to inform management policies of watersheds and natural resources; and managing and permitting offshore energy activities so that they do not negatively impact offshore fisheries.

Read the EO here: https://www.whitehouse.gov/presidential-actions/executive-order-promoting-american-seafood-competitiveness-economic-growth/?fbclid=IwAR0pmKJ22nNg_QKt_F1Fh0GmzAsiyBvCat1figdvSrFpKEWka6gf1ljZOKc

Presidential briefing statements: <https://www.whitehouse.gov/briefings-statements/president-donald-j-trump-working-secure-americas-seafood-supply-chain-bring-jobs-home/?fbclid=IwAR0TckUtxUBldfJUBzu8RJ8BaTAKI8za-mh8GrzmcGb4g0T6o-12aL37m3DM>

Interior Supports Healthy Salmon Fisheries in the American West

The Pacific Region of the USFWS conducts a wide array of fish and wildlife resource management and restoration activities in the West that benefit salmon restoration and recovery. USFWS is one of the few Federal agencies funded to implement restoration activities across the landscape and funds or operates more than 45 fish hatcheries and associated production facilities that are:

- Coordinating with habitat restoration and harvest management efforts to assist in rebuilding naturally spawning populations of salmon and steelhead;
- Phasing locally adapted stocks into our hatchery broodstocks and changing management practices to ensure hatchery operations are compatible with wild stock protection;
- Developing captive broodstock and stocking programs to recover threatened and endangered species; and
- Continuing to release more than 200 million fish annually to meet Federal fishery mitigation responsibilities.

The USFWS implements more than 30 on-the-ground habitat restoration programs protecting and conserving aquatic, estuarine, wetland, and associated terrestrial habitats, such as:

- Instream flow conservation, fish passage improvement, and fish screening programs for important river systems such as the Columbia, Snake, Yakima, Sacramento, Trinity, and others;
- The Partners for Fish and Wildlife Program works with local landowners to protect and restore habitat on agricultural land;
- USFWS Coastal Program works to restore habitat in coastal and estuarine areas; and
- Manage an environmental contaminants program that works with other State and Federal agencies to mitigate for environmental impacts.

USFWS NWRs protect and restore important salmon habitats and provide scientific support, data analysis, and funding in many salmon harvest management forums to ensure harvest is managed appropriately to



Chinook salmon (*Oncorhynchus tshawytscha*) are also known as king salmon. An average-size adult is about 20 to 60 pounds, but they can grow to several feet long and weigh over 100 pounds. These large fish spawn in larger rivers and depend on healthy estuaries that provide habitat for invertebrates and smaller fish, which become food for the older Chinook salmon smolts. Photo credit: USFWS

conserve wild and hatchery stocks and meet federal obligations to conserve anadromous fish species and trust responsibilities to Native American tribes.

Read more: <https://www.fws.gov/salmonofthewest/fws.htm>

Sea Turtle Stewardship—A Collection of Articles



A nesting Kemp's ridley sea turtle at Padre Island National Seashore (PAIS), TX. Photo credit: NPS

Long-lived sea turtle species travel extensively as part of their complex life histories, which historically have presented many challenges to researchers and resource managers. New collaborations across DOI and with partners are helping to address them.

Bringing Research Pieces Together

In 2010, after the *DWH* oil spill, trustees began efforts to quantify impacts of the spill, including damage to resources. This effort highlighted how little was known about sea turtle distribution and abundance in the Gulf.

At the request of DOI, USGS scientists Kristen Hart and Margaret Lamont and NPS scientist Donna Shaver developed and executed annual NRDA plans in 2010–13, where they sampled and tracked nesting females in the northern Gulf and along the Texas coastline. The insights shed light on when and where turtles spend time foraging and migrating; key pieces to their life history puzzle.

The *DWH* damage assessment funding brought together and unified different DOI capabilities to address this unprecedented spill. Each scientist brought specific knowledge and technology from different areas of

the Gulf. They are now answering broad-scale questions Gulf-wide. It has also led to successful projects addressing critical knowledge gaps for sea turtles in the Gulf.

“We had each been leading various sea turtle projects in our respective regions, so working together in the

DWH assessment has helped us all fill in some major gaps in sea turtle ecology,” said USGS scientist Kristen Hart. It has also turned out to be very valuable for work being done with collaborative partners in academia, State, private, and Mexico.

“When we combine our findings and collaborate on research and publishing, we are converting those regional data into Gulf-wide data,” said USGS scientist Margaret Lamont.

“The long-term research through the binational partnership with colleagues from Tamaulipas, Mexico, has been significantly enhanced during the last decade due to the addition of Hart, Lamont, and new partners from Veracruz and Yucatan, Mexico, in the southern Gulf,” said NPS scientist Donna Shaver.

Collaborating with Mexican partners has provided the global turtle research community with more comprehensive ways to track and evaluate vital turtle population parameters as well as document their use of specific habitat areas.

New Directions

Since 2014, the researchers have continued to build on their collaborative and sophisticated work, engaging academic partners and using new

cutting-edge techniques to advance research. Technological advances involving combined satellite tracking and isotopic and genetic analyses, capture-mark-recapture studies, and capturing and sampling immature and male turtles at sea are allowing the scientists to make new discoveries that boost more-detailed understanding of behaviors of loggerhead and Kemp's ridley sea turtle species throughout the Gulf.

The researchers have been able to link biogeochemical tracers (e.g., stable isotopes) in tissues of NRDA satellite-tagged turtles to demonstrate success in predicting foraging locations as well as foraging area fidelity over time. Combined with satellite tracking data for loggerhead and Kemp's ridley sea turtle species, these findings showed that specific threats in near-shore Gulf waters were concentrated in areas where the turtles are most abundant. Understanding and quantifying this overlap of threats with habitat use is vital for managers to reduce injury and death of sea turtles, and aid in their recovery.

Starting in 2016, BOEM has funded Hart and Lamont in two projects: (1) sea turtle relocation trawling efforts (linked to the BOEM Marine Minerals program), and (2) the sea turtle component of a multiagency (USGS, USFWS, and NOAA) effort in the Gulf-wide assessment for sea turtles, sea birds, and marine mammals, known as the BOEM Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPPs).

Learn more: <https://www.boem.gov/environment/environmental-studies/gommapps>

This work provides data used directly by other Federal agencies such as BOEM and NOAA's National Marine Fisheries Service (NMFS) to evaluate current strategies associated with dredging operations and statistical

Sea Turtle Research continued from page 7
 methods for enumerating populations and is critical for restoring threatened and endangered sea turtle populations in the Gulf.

Together, the DOI turtle researchers have defined migratory corridors, interesting areas, and foraging grounds for Kemp's ridley and loggerhead sea turtle species. The team is also tracking individuals from other segments of the turtle populations in the Gulf, which is leading to new and very exciting discoveries.

- **Margaret Lamont's** work is primarily focused on how turtles use habitats in the northern Gulf. She uses a variety of technologies (e.g. satellite telemetry, acoustic arrays, animal borne cameras, etc.) and long-term (more than 25 years) mark-recapture programs at nesting beaches and in-water sites to better understand population structure and effects of environmental and anthropogenic stressors on adult and juvenile turtles. Learn more: https://www.usgs.gov/staff-profiles/margaret-lamont?qt-staff_profile_science_products=0#qt-staff_profile_science_products

- **Kristen Hart** leads in-water and land-based turtle capture, tagging, sampling, and tracking efforts at several sites in south Florida, the Gulf, and the Caribbean, many of which are within national parks and protected areas (including Everglades National Park, Dry Tortugas National Park, Biscayne Bay, Buck Island Reef National Monument in St. Croix). She leads long-term capture-mark-recapture projects on turtles captured in the water and on the nesting beach and uses various types of telemetry along with biological sampling to figure out unknown aspects of turtle ecology. Learn more: https://www.usgs.gov/staff-profiles/kristen-hart?qt-staff_profile_science_products=0#qt-staff_profile_science_products

- **Donna Shaver's** research in the western Gulf near Texas concentrates on data collection on nesting turtles, sea turtle nests, and stranded turtles, as well as satellite tracking of adult female and male Kemp's ridley turtles from United States and Mexico nesting beaches. She also studies in-water foraging and mating habitats and movement patterns for green (*Chelonia mydas*) and Kemp's ridley sea turtles. It dovetails nicely with her important responsibilities for conservation and public education with the NPS at PAIS. Her efforts raise public awareness and provide managers with critical information to understand how turtles use western Gulf waters. This includes understanding migratory movements between Texas and Mexico, where binational collaboration for recovery efforts is needed. For example, Shaver and Hart used these data to demonstrate that the migratory corridor used by adult female Kemp's ridley turtles encompasses nearshore Gulf waters in the United States and Mexico.

Survival of the species depends on adult females being able to successfully navigate their way through this corridor that links their most important foraging area in the northern Gulf to their primary nesting beach in Tamaulipas, Mexico.

See related stories, pages 9–17.

Learn more: <https://www.nps.gov/pais/learn/nature/stsr-index.htm>

The team is receiving DWH Early Restoration and NOAA Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States (RESTORE) Act funding, pushing for more advancements in research to improve management and conservation decisions.

This team is just one of many working across DOI to fulfill the important mission of balancing human activities with effective, science-informed natural-resources management.

Leading Sea Turtle Research in the Gulf

Marine turtle researchers at USGS and NPS are editing a special theme issue of *Frontiers in Marine Science* on sea turtles in the Gulf.

The DOI turtle research team of Shaver, Hart, and Lamont were invited to serve as guest editors for the peer-reviewed scientific journal. They will expand their collaborative exchange by compiling research focused on advancements in understanding how sea turtles use habitats and resources within the Gulf since the DWH oil spill.

Contributions will be classified into four themes: movements and habitat use; foraging ecology and food webs; growth, genetic stock, and population trends; and conservation and management.

The team is currently accepting contributions. The submission deadline is October 1, 2020

Call for contributions: <https://www.frontiersin.org/research-topics/9323/advances-in-understanding-sea-turtle-use-of-the-gulf-of-mexico>



A loggerhead sea turtle, outfitted with a popoff ADL package (orange item on the turtle's back), is released by New England Aquarium Biologist Nick Whitney. Photo credit: Andrew Crowder, USGS

Tracking Sea Turtles

New Data-Collection Techniques Provide Fine-Scale Data

By Kristen Hart, Mike Cherkiss, Andrew Crowder, Margaret Lamont (USGS), and Nick Whitney (New England Aquarium)

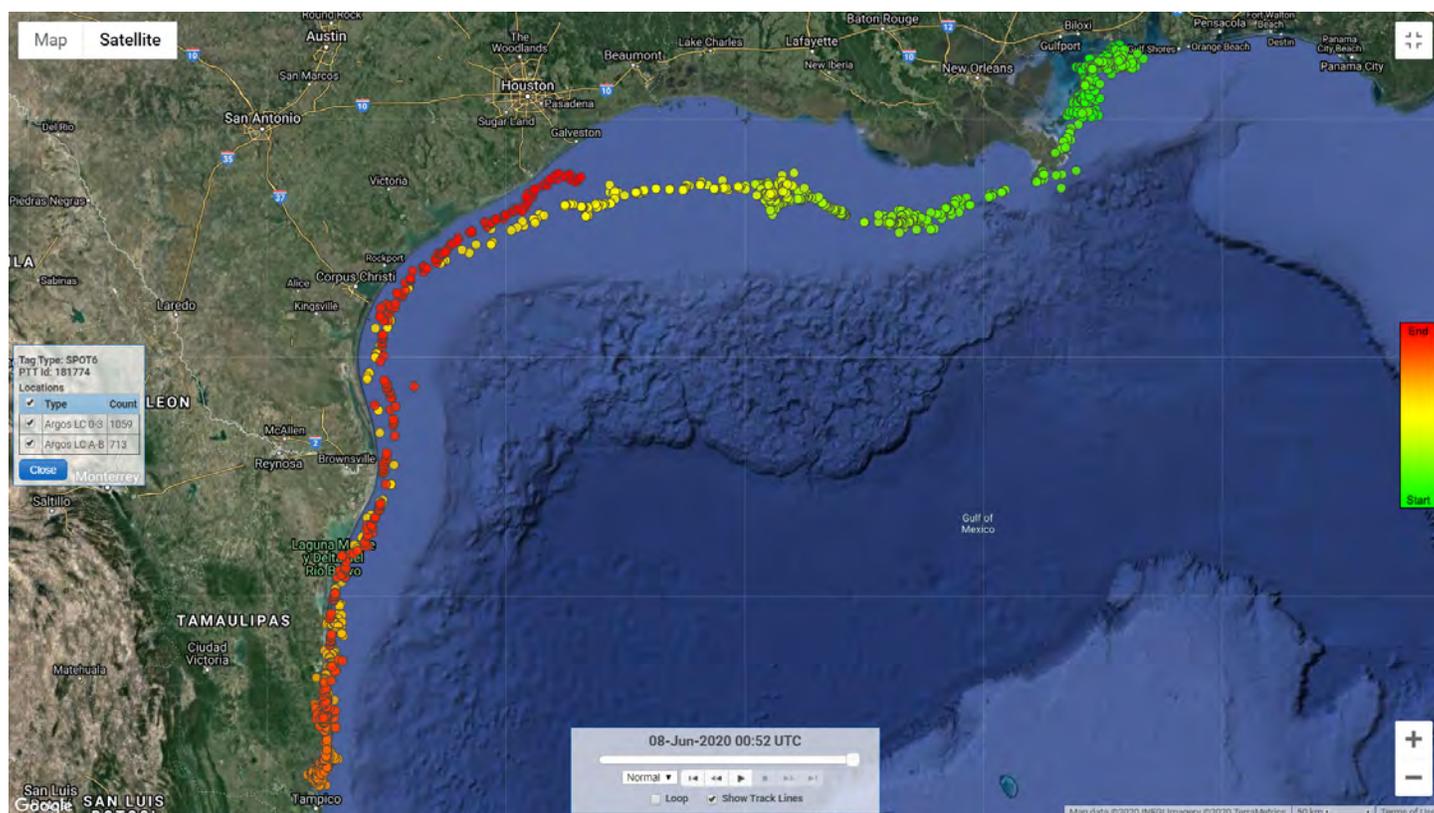
As global sea conditions change and the potential for human-caused environmental crises increases, there is a growing need by marine scientists and managers for acquiring direct evidence of how various environmental conditions affect the behavior of marine life. Although there are multiple approaches to collecting oceanographic data, animal-borne data loggers allow for monitoring immediate behavior and physiology of marine animals. Hard-shelled turtles are ideal subjects for carrying such devices due to their large size, extensive migratory movements, and need to regularly surface for air. Their carapace also provides an ideal substrate for affixing

long-term tags with epoxy, as opposed to suction cup or intramuscular attachment methods used on marine mammals and fishes, respectively. One complication is that these high-resolution data loggers must be recovered from the animals.

A “popoff” package that includes a float, a high-resolution Acceleration-Depth-Temperature data Loggers (ADL), and a radio tag was deployed and retrieved on threatened and endangered sea turtles as part of a cooperative study between the USGS and BOEM. Researchers are using advanced datalogging techniques to acquire novel data on dive profiles and

activity patterns of sea turtles to gain detailed insights into turtle physiology and behavior. Some of the turtles were also equipped with satellite tags for accurate tracking over time after release of the popoff package. This additional location information is useful for discerning whether a turtle is a “resident” at the site where behavior was logged at very fine scales or if, instead, it was migrating through the area. Together, this detailed information enhances our overall understanding of sea turtle behavior, migration, and habitat use. This kind of information about sea turtles has been elusive and difficult to obtain until now.

See related stories, pages 10-14



Map showing satellite tag locations of postrelocation movements of Finley, the adult female Kemp’s ridley sea turtle tagged in Pascagoula, MS, in the northern Gulf. Symbols are color coded by time showing the location in chronological order: cool colors, like green, are older (green is oldest), and hot colors, like red, are more recent). In early March, Finley was tracked to nesting areas on the Mexican coast. By June, she was well on her way back to home foraging grounds in the northern Gulf. Image credit: USGS

The Popoff ADL

The “popoff package” is a custom-designed tagging package that is affixed to the turtle for a specific period and then “pops” off and floats at the surface for retrieval by scientists.

It consists of a float with a satellite/VHF transmitter and datalogger. The team designed it for a range of sea turtle sizes with the goals of reducing size and drag while allowing its recovery. While affixed to the turtle, the tag collects second-by-second data, giving scientists detailed information on turtle activity.

“We can now know—second by second—what marine animals are doing in specific locations,” said USGS Research Ecologist Kristen Hart.

“It’s exciting to be able to glimpse into the daily life of these animals and see how they respond to human activities,” said USGS Research Biologist Margaret Lamont. The team has made extraordinary discoveries about turtle migratory patterns.

See related story, page 9.

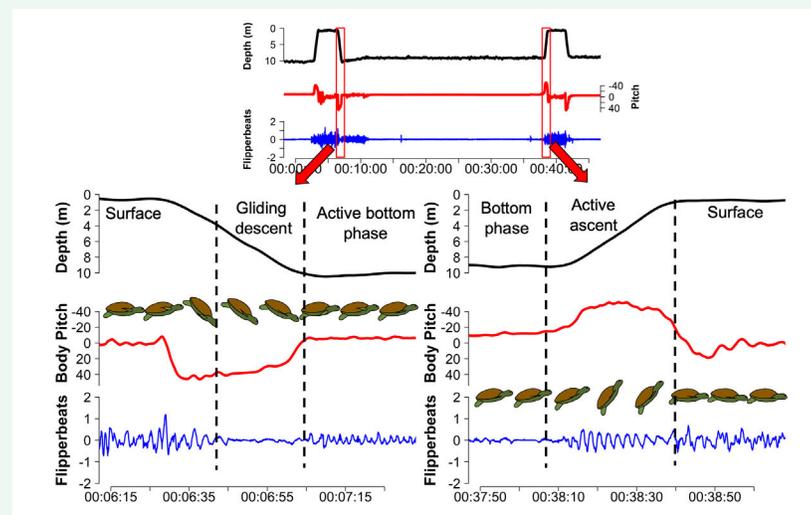
USGS scientists and partners at the Anderson Cabot Center for Ocean Life at the New England Aquarium conceived of, designed, tested, deployed, and successfully retrieved two popoff ADL packages on sea turtles in the Gulf. The second-by-second data stream logged in the accelerometers revealed patterns of diving, surfacing, and resting for 48 and 12 hours, respectively, for two imperiled turtles. The information can transform our understanding of sea turtle diving and activity patterns with implications for management of human activities affecting these imperiled species.

“Just a few years ago, the idea that we’d be able to tell how many seconds an animal spends on the bottom during a dive, how many flipperbeats it took while it was there, and what its body angle was, seemed impossible. We can now answer all of those questions and more with this technology,” said Biologist Nick Whitney of the New England Aquarium.

The first popoff ADL package was tested on a loggerhead sea turtle in South Florida in June 2018. The ADL was on the turtle for 32 hours in Dry Tortugas National Park, FL. Two days later, Whitney led the recovery of the ADL package.



Underwater view of a loggerhead turtle being released with newly installed popoff ADL package (orange item on turtle’s back). Photo credit: David Roche, USGS



The ADL allows scientists to collect detailed information about a sea turtle’s movement over time. In the graph, the turtle’s depth (black), rate of movement or flipperbeats (blue), and the body pitch or angle of the turtle (red) tell scientists a lot about what the turtle is doing and how much energy it is using. Image credit: USGS

the water column is particularly important for BOEM officials tasked with permitting offshore dredge operations. Additionally, the acquired data will be useful for informing BOEM management decisions associated with protected species monitoring, decommissioning activities, and mitigation best practices.

In September 2019, the second ADL package was applied on “Finley,” a female endangered Kemp’s ridley sea turtle. The ADL stayed on the turtle for 12 hours and 6 minutes. The detailed data from the ADL combined with satellite tagging, provides clues that will aid in managing for her species and others. See related story, page 14.

Scientists can use the acquired data to assess fine-scale behaviors of tagged turtles and their use of the water habitat around dredge sites that are active, inactive, or previously dredged. Sea turtles are at highest risk when they are close to active dredging operations. By knowing when and where turtles spend more time near the bottom, especially as related to the location of dredging operation intakes, the dredging operators can implement best practices to avoid the intake of turtles. All sea turtles are imperiled species, so reducing injuries and fatalities by dredging operations is a joint stewardship improvement goal for multiple agencies. The information on sea turtle behavior in

All work was conducted under NMFS permits 17381 and 17304-3, MTP-17-176, and DRTO-2018-SCI-0007.

United States and Mexico Work Together to Save a Species

By Donna J. Shaver (NPS), Sarah Laughlin (NPS), Cynthia Rubio (NPS), Raul de Jesus Gonzalez Diaz Miron (Acuario de Veracruz A.C.), and Martha Lopez Hernandez (CONANP)

The Kemp's ridley sea turtle, the most endangered sea turtle in the world, nests primarily on a small beach, Rancho Nuevo (RN), along the western shore of the Gulf of Mexico in Tamaulipas, Mexico.

In the United States, PAIS is the most important nesting beach for Kemp's ridley. PAIS plays a pivotal role in the long-term, binational recovery efforts for this species.

The Kemp's Ridley Sea Turtle Restoration and Enhancement Program (KRREP)

The Mexican government began protection efforts at RN in 1966, but the species continued to decline. In the mid-1970s, fearing extinction, the NPS proposed to re-establish Kemp's ridley nesting areas at PAIS and initiated U.S. aid to the ongoing recovery efforts in Mexico. By 1978, the NPS, USFWS, NMFS, Texas Parks and Wildlife Department, and Mexico's Instituto Nacional de Pesca came together in the binational, multiagency KRREP.

The re-introduction effort aimed to increase Kemp's ridley nesting at PAIS to form a viable, secondary nesting colony that could serve as

a safeguard for the species so that if a political or environmental catastrophe (e.g., hurricane, oil spill) occurred in RN, there would be another area to protect this species.

From 1978 through 1988, more than 22,000 Kemp's ridley eggs were translocated from Mexico to PAIS.

Transported eggs are imprinted with PAIS nesting locations. This imprinting effort, and the captive rearing of hatchlings for their first year of life in a process called "head-starting," were experimental at the time. It was unknown whether any would survive to maturity and return to nest at PAIS. In 1996, Shaver and colleagues documented the first confirmed "headstarting" turtles returning to PAIS and have confirmed several others nesting in south Texas.

Between 1989 and 2019, 52% of Kemp's ridley nests found in the United States were laid in Texas at PAIS. About 70% of the Kemp's ridley eggs laid in the United States each year are protected during incubation at PAIS to help form the secondary nesting colony and maximize the numbers of hatchlings produced and safely released.

The collaborative binational relationship between PAIS and colleagues in Tamaulipas, Mexico has grown with the addition of biologists from multiple organizations in the southern Gulf, from Veracruz and Yucatan, Mexico. Added partners expanded studies and collaborative information sharing about



NPS staff trains Mexican partners on applying satellite transmitters onto turtles, 2015. Photo credit: NPS

nesting, stranded turtles, and common threats—invaluable in expanding knowledge throughout the critical southern part of the geographic range of this species. In addition, through training to colleagues in Mexico, PAIS has been able to deploy transmitters on Kemp's ridleys throughout their nesting range, obtaining a more complete view of their internesting, migratory, and foraging habitats.

In 2010, DOI selected Dr. Shaver to serve as Principal Investigator for the NRDA study to quantify injury to nesting Kemp's ridley turtles and their eggs from the *DWH* oil spill and PAIS to serve as the main study area for this work. The NRDA study continued through 2013, with Shaver and NPS colleagues working in close partnership with colleagues from USGS, USFWS, and academia.

Although Kemp's ridley nesting beach conservation efforts have continued, nesting levels have fluctuated since 2010, and the prognosis for species recovery now remains unclear. Illustrating continued concern about this species and impact of the *DWH* oil spill to it, the National Wildlife Federation featured Kemp's ridley as the first of 10 species they included in their April 2020 report: <https://www.nwf.org/Educational-Resources/Reports/2020/04-07-20-10-Species-10-Years-Later>.



Arrival of Kemp's ridley eggs (in styrofoam cooler), which were flown from Mexico to Corpus Christi, June 1987. Photo credit: NPS

Important Conservation Partners: Kemp's Ridley Restoration and Enhancement Program

The Kemp's ridley sea turtle was almost extirpated due to egg collecting and incidental capture of juveniles and adults during fisheries activities. Its current prognosis for survival is unclear. However, continued binational, multiagency collaboration with partners from across the Gulf is required to adequately address complex, critical research questions pertaining to this species and to maintain on-the-ground conservation activities needed to ensure its long-term recovery. The KRREP is an important contributor to successful species recovery.

"KRREP is regarded as one of the best endangered species recovery efforts in the DOI. It exemplifies connected conservation with local, State, national, and binational partnerships to study and restore Kemp's ridley turtles. At the local level, this program involves widespread community support and highly successful civic engagement, including more than 100 volunteers per year at PAIS."

—Bryan Arroyo, Deputy Director of Operations, USFWS

GLADYS PORTER ZOO Since the 1980s, the Gladys Porter Zoo (GPZ) in Brownsville, TX, has been an invaluable partner in the multiagency, binational KRREP.

The GPZ has served as the U.S. contractor, facilitating transfer of USFWS, NOAA, and DWH NRDA Early Restoration funds to support efforts to locate, document, and protect nesting Kemp's ridley turtles and their eggs at RN, Tamaulipas, Mexico. This critically needed funding enabled hiring of personnel and purchase of supplies and equipment necessary to conduct this work.

From the mid-1960s through about 2005, virtually every Kemp's ridley nest found at RN was translocated to large screened enclosures called corrals. Nest numbers reached their low point in 1985, with only 702 nests recorded worldwide, but then increased substantially. Starting in about 2005, so many nests were found during some arribadas that it was not possible to translocate all the egg clutches in time to ensure egg survival, so some nests in concentrated areas of nesting where were left to incubate on the beach.

Beginning in 2010, the numbers of nests found annually declined drastically. Although the numbers of nests fluctuate annually, they have not returned to their previously projected exponential trajectory of increase. Kemp's ridley remains the most critically endangered sea turtle species in the world and continued monitoring of nest numbers and protection of nests through the decades-long, multiagency, binational Kemp's ridley program are critical for recovery of this species. Partners from Mexico and the United States can proudly say that great strides have been made with Kemp's ridley recovery efforts over the decades. The GPZ remains an invaluable and dedicated conservation partner.

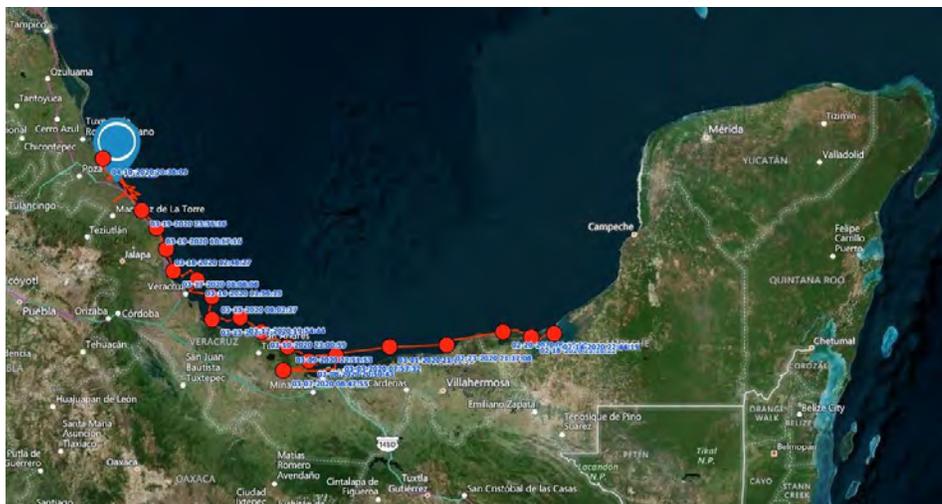
Learn more: <http://gpz.org/kemps-ridley-turtle-project/>



Kemp's ridley hatchling release at PAIS, TX, June 2006. Photo credit: NPS

Rafaela Makes Third Migration to Nest! Satellite Tagging and Binational Collaboration

By Sarah Laughlin (NPS), Cynthia Rubio (NPS), Fernando “Papa Tortuga” Manzano (Vida Milenaria), Raul de Jesus Gonzalez Diaz Miron (Acuario de Veracruz A.C.), Christian Gredzens (NPS), Kristen Hart (USGS), and Donna J. Shaver (NPS)



Tracking map of Rafaela’s movements leading up to nesting on April 13, 2020, shown with blue symbol. Image credit: Christian Gredzens, NPS

Recently, a satellite tagged Kemp’s ridley sea turtle named “Rafaela” was documented nesting in Veracruz, Mexico, and this was great news for biologists that were eagerly waiting for her.

On May 20, 2016, Rafaela was outfitted with her transmitter as part of a NPS project to deploy satellite transmitters on female Kemp’s ridley sea turtles after nesting in three critical locations: Veracruz, Mexico, RN, Mexico, and PAIS. These three beaches anchor the limits of the nesting range for the majority of the Kemp’s ridley sea turtle species. For three years the team deployed transmitters on adult female turtles to collect data about how they use various foraging grounds.

NPS-PAIS staff trained their Mexican colleagues on how to apply the transmitters to the turtles and then helped deploy the transmitters on adult male and female turtles in Mexico. This work was part of a decades-long, binational collaborative effort to monitor and track adult female and

male Kemp’s ridley turtles aimed at understanding how they use foraging grounds, internesting areas, and migratory corridors. .

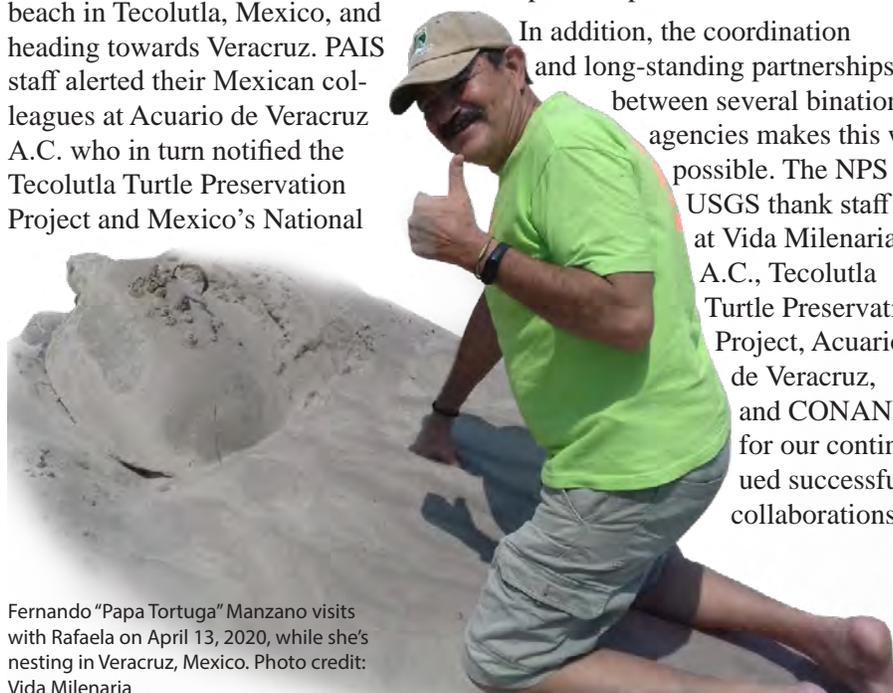
On March 29, 2020, NPS-PAIS staff who were following the turtle’s movements in near real-time, noticed Rafaela was located off the nesting beach in Tecolutla, Mexico, and heading towards Veracruz. PAIS staff alerted their Mexican colleagues at Acuario de Veracruz A.C. who in turn notified the Tecolutla Turtle Preservation Project and Mexico’s National

Commission for Protected Areas (CONANP), the equivalent of the NPS, to be on the lookout for Rafaela.

Fernando “Papa Tortuga” Manzano spotted Rafaela laying eggs in Tecolutla, Veracruz, on April 13, 2020, during an arribada (when many turtles nest at the same time) with approximately 60 other turtles, despite restrictions on beach monitoring due to the pandemic. He also documented her nesting on April 29, and after she was finishing nesting for the season, Rafaela migrated back to her foraging grounds in the Yucatan.

Rafaela’s story is extraordinary. This marks her third migration to the nesting beaches in Veracruz since she was originally tagged in 2016. In total, as of this writing (June 4, 2020) she has been tracked for 1,476 days and has returned to nest almost every year since 2016, except 2019, on the same beach where she was originally seen. To our knowledge, this is the highest number of times that a sea turtle has been tracked migrating back to the nesting beach during a single satellite transmitter deployment. It is rare that a tag continues to function for this long and it has been extremely helpful in advancing our understanding of this imperiled species.

In addition, the coordination and long-standing partnerships between several binational agencies makes this work possible. The NPS and USGS thank staff at Vida Milenaria, A.C., Tecolutla Turtle Preservation Project, Acuario de Veracruz, and CONANP for our continued successful collaborations.



Fernando “Papa Tortuga” Manzano visits with Rafaela on April 13, 2020, while she’s nesting in Veracruz, Mexico. Photo credit: Vida Milenaria

Turtle Ladies Tell Tales

By Margaret Lamont (USGS)

Three Turtles Provide Unique Insights to Sea Turtle Movements in the Gulf

Because female sea turtles come onshore to nest, they are more accessible to researchers and, as such, we know more about their movements and habitat needs than other life stages (like immature turtles and males).

But first, a little background. Most female turtles don't nest every year; they spend most of their time in the water foraging along the continental shelf. After nesting, females may spend 2–5 years at these foraging sites before returning to the beach to nest again. However, some aspects of their life history make studying adult females difficult. For example, critical foraging and nesting habitats for these individuals are not only hundreds of kilometers apart, but also can be in different countries. Researchers may tag a turtle on a nesting beach in the United States, but if she travels to foreign waters to forage, international travel and cooperation is necessary to continue the research.

In addition, the long period between nesting seasons means researchers don't have access to individual turtles every year. This presents challenges to learning about their ecology. For example, researchers can attach a satellite tag to a female while she is nesting and then track that individual to her foraging site to learn about the habitats she uses during migration. However, satellite tags typically only transmit for up to one year. Because turtles can remain at

the foraging site for multiple years, researchers have extremely limited information on the return trip to the nesting beach.

Researchers are left with many unanswered questions. How long did the turtle forage? When did the turtle depart the foraging area and migrate to the nesting area?

One way to solve this problem is by capturing and tagging turtles at their foraging sites. However, these locations are in the open ocean. Capturing a turtle in 20–30 feet of water is challenging, especially in areas where the water is murky. Many capture methods, such as hand capture, require that researchers see the turtle underwater so they can jump off the boat and grab her. Net captures are possible in murky waters but setting a net risks capture of non-target species and in relatively deep water, the large net size required would greatly increase the potential of capturing other imperiled species such as dolphins. Without a safe way to capture turtles at in-water foraging sites, important data gaps will remain.

Researchers at the USGS have recently begun using trawling as a method of capturing turtles at in-water foraging sites in the Gulf. This method has been used extensively to safely cap-

ture and relocate turtles away from dredging operations but not commonly used as a primary research capture method due to the complexity and costs.

USGS scientists Margaret Lamont and Kristen Hart began working with BOEM to capture turtles using trawlers at various in-water sites in the northern Gulf to evaluate how sea turtles use dredge borrow sites. These opportunistic turtle captures are helping to fill gaps in sea turtle forage information.

In addition to Rafaela, two other female turtles have told us about their incredible journeys.

See related story, page 13

Meet the Turtle Ladies

In November 2017, USGS biologists joined East Coast Observers aboard the shrimp trawler *Wild Dream II* (owned and operated by Anthony Nelson) off the coast of Mississippi. As part of a project to dredge sediment traps, the group was trawling with gear modified to safely capture sea turtles and remove them from the path of the dredge. During the first week of November, six female turtles were captured offshore of Petit Bois and Horn Islands, MS. Each turtle received a satellite tag to track their movements.

See Turtle Ladies page 15

BIG NEL!



Kemp's ridley female turtle, named Big Nel, during nesting as part of the 2018 arribada in RN, Mexico. Photo credit: Miguel Ramirez Castillo

RAFAELA!

Turtle Ladies continued from page 14

Big Nel

The largest Kemp's ridley was an adult female that the crew named "Big Nel". After she was tagged and released, researchers tracked her south towards the coast of northern Mexico.

On May 27, 2018, an arribada occurred on RN, Mexico, with more than 7,000 turtles emerging from the water on that one day to nest. Big Nel was observed on the beach during this arribada and the binational Kemp's ridley team documented the event by sharing photographs taken both in the United States (by Dr. Donna Shaver, NPS PAIS) and in Mexico (coordinated by the Comisión Nacional de Áreas Naturales Protegidas-CONANP and the Gladys Porter Zoo).

See related story, page 11.

Finley

In September 2019, another adult female Kemp's ridley was captured by a trawler during

A female Kemp's ridley sea turtle, named Finley, shows off the popoff ADL (orange) and satellite tag (blue). Photo credit: Andrew Crowder, USGS



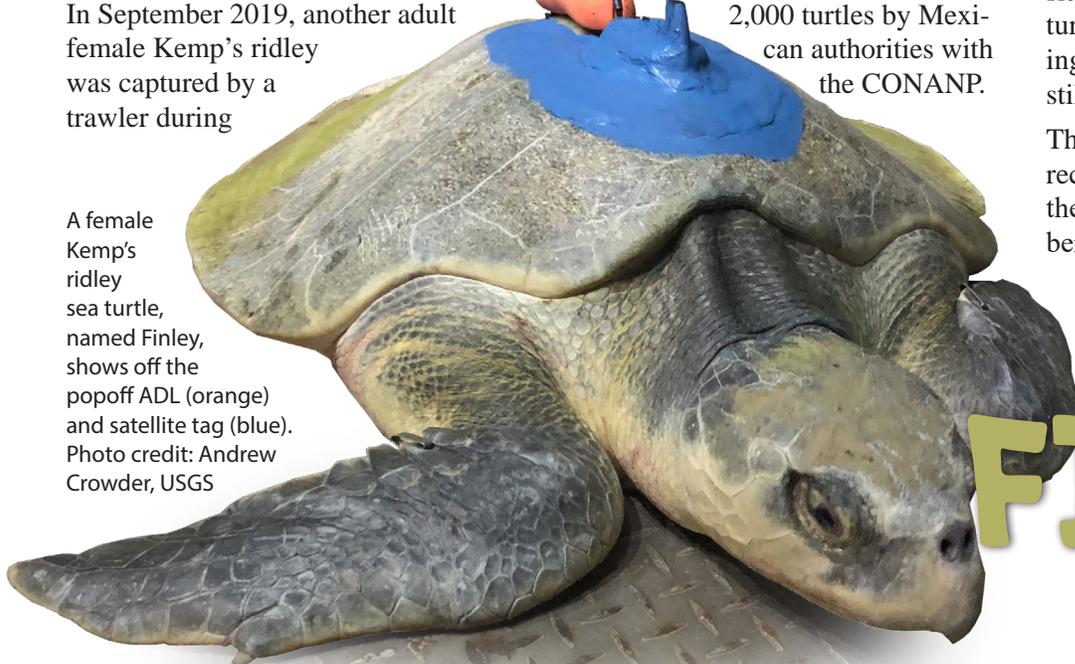
Rafaela returning to the ocean on April 13, 2020, after nesting in Veracruz, Mexico. Photo credit: Vida Milenaria

a USGS-led field trip to tag sea turtles and deploy and recover pop-off ADL packages at Ship Shoal, LA. This BOEM-funded project is aimed at defining fine-scale behavior of sea turtles at dredging sites. During this trip, USGS Andrew Crowder deployed a satellite tag on an adult female named Finley. Similar to Big Nel, Finley was subsequently tracked to her nesting beach and observed nesting on April 12, 2020, during an arribada of about 2,000 turtles by Mexican authorities with the CONANP.

These three tagged turtle ladies, Big Nel, Finley, and Rafaela, illustrate the incredible value of DOI turtle collaborations in the Gulf. Documenting Big Nel and Finley nesting on the beach during those two massive arribadas are not small feats!

These turtle ladies play a critical role in the survival of their species. Identifying the timing of departure by females from foraging sites to their nesting beaches is critical for wildlife managers; if environmental disasters, such as oil spills, occur at foraging sites, it is important to know whether turtles have left the area for the nesting beach already or whether they are still at the impacted site.

The funds provided through DWH recovery programs have accelerated the pace of Gulf turtle research to the benefit of all sea turtle species.



FINLEY!

40 Years Dedicated to Turtle Conservation!

By Mark Davis, USFWS

Donna Shaver casts a great shadow in the conservation community. Shaver, Chief of the Division of Sea Turtle Science and Recovery at NPS PAIS in Texas, has spent four decades working to save the endangered Kemp's ridley sea turtle from extinction. In July 2005, "ABC World News Tonight" declared her its "Person of the Week."

"The first time I saw [Padre Island National Seashore], I just fell in love with this place," said Shaver. It's a love that's only deepened in her years of helping conserve one of the planet's most-imperiled turtles, the Kemp's ridley. Once the most abundant turtle species in the Gulf, they are now the most critically endangered. The smallest of the sea turtles, the Kemp's ridley nests in the United States and in Mexico. While other turtles are almost global in their wanderings, the Kemp's ridley range remains within the confines of the Gulf and along the U.S. Atlantic coast.

The *DWH* oil spill occurred 10 years ago on April 20, 2010. It was a frightening time as oil spread across the Gulf, fouling shores in Florida, Alabama, Louisiana, and Mississippi. Conservationists in Texas feared the oil would come to the 100-plus-mile Padre Island. The turtle to which Shaver has devoted her career could be devastated.

The dreaded landfall of oil didn't happen at the seashore—but that

is no guarantee that the incident in the Gulf didn't have an impact on the turtle and other species. Ten years later, Shaver and other conservationists are keeping a close watch on the turtle population.

Like other sea turtles, Kemp's ridleys mature slowly; hatchlings that scrambled from the sand to the surf aren't likely to return to nest and lay eggs for a dozen years or more. What happened in the Gulf a decade ago may not be fully understood yet.

Shaver knows this much. "That first year" after the oil spill? Everyone scrambled to learn if the turtle species would be wiped out.

The real work, post-spill has focused on collecting small samples of scute from carapaces, or upper shells, of turtles after they nested and outfitting them with satellite transmitters so they can



Donna Shaver during a Kemp's ridley sea turtle hatchling release event. Shaver has worked with an array of agencies, including the USGS, the USFWS, and the NPS, ensuring that the turtle remains a paddling, nesting presence along the Texas coast. Photo credit: NPS

Service to America

Congratulations to NPS Scientist Dr. Donna J. Shaver!

Donna is one of 27 national finalists for the prestigious Samuel J. Heyman Service to America Medal for 2020 or "Sammies," known as the "Oscars" of government service. She was recognized in the category of Science and the Environment. She is also one of five finalists for the People's Choice Award.

"Sammie" finalists are a highly respected honor as they have made it through a rigorous selection process and are contenders for six Service to America Medals.

Learn more: <https://servicetoamericamedals.org/>

be tracked. The samples were analyzed for stable isotopic signature to indicate foraging habitat. Shaver and her USGS colleague Dr. Kristen Hart have tracked these females as they forage, feed, and nest within the Gulf. The research team estimated that 51% of the turtles analyzed were exposed to oil. "When you extrapolate the number of female turtles in the population, that's a lot—a lot." That statistic troubles Shaver.

Shaver said, "In the early 2000s, things were looking really rosy," for the turtles—their nesting had increased along the Texas coast; reports from Mexico were equally encouraging. But in 2010, surveys showed a decline in Kemp's ridley nesting.

Questions surround the long-term impact of *DWH*, said Mary Kay Skoruppa, a USFWS biologist who oversees sea-turtle conservation in Texas. She and Shaver communicate almost daily.

Although other turtles also nest on Texas shores, said Skoruppa,

40 Years Dedicated continued from page 16

Kemp's ridley turtles are different. They don't have the extended, "almost global" range of other, larger sea turtles. They roam primarily in the Gulf and were potentially exposed to oil there during the spill.

As the 2020 nesting season continues, Shaver, along with other biologists is monitoring closely.

And, as she has done countless times in decades of conservation work, Donna Shaver stands at the water's edge. She's still searching.

Shaver examines a nesting Kemp's ridley sea turtle for tags on North Padre Island, TX. Shaver established and runs the only long-term, continuous, mark-recapture program for nesting Kemp's ridley sea turtles in the world. Shaver began this mark-recapture tagging study and satellite tracking adult female and male Kemp's ridley turtles in 1997. Photo credit: NPS



Turtle Talk—Fun Facts About Turtle Biology

Arribada: The synchronized, large-scale nesting event of some species of sea turtle. Commonly seen with the Kemp's ridley and olive ridley (*Lepidochelys olivacea*) sea turtle species

Clutch: Turtles lay their eggs during nesting season in clutches. The clutch is the eggs that are laid in the same nest. The number of clutches and number of eggs per clutch varies by species. For Kemp's ridley sea turtles, the clutch size varies from 50 to 140 eggs. Loggerheads lay from 2 to 10 clutches per year.

Internesting area: The offshore habitat area used between laying clutches of eggs within a nesting season. Kemp's ridley sea turtles stay offshore but in close proximity to the nesting beach where they move rather extensively as their bodies prepare the next clutch of eggs for deposition.

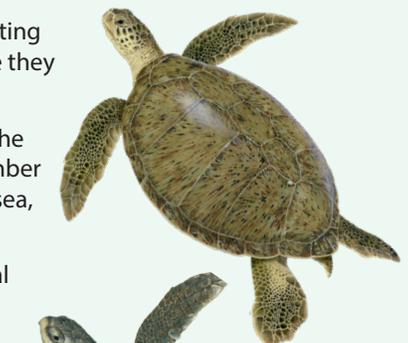
Nest: The only time sea turtles come ashore is to lay eggs, so only females come ashore. When the females come ashore, they find an appropriate area (above the high tide line) to dig a nest chamber in the sand into which they deposit their eggs. They cover the nest with sand and return to the sea, never returning to provide maternal care to that nest.

Nesting season: The time of year that sea turtles come ashore to lay eggs. Turtles can lay several clutches in separate nests several times during a single nesting season. Nesting seasons differ among turtle species and locations. Most nesting on Gulf beaches occurs between March and September.

In the northern Gulf, loggerhead turtles are the primary nesting sea turtle, but green turtles, leatherbacks and rarely Kemp's ridley can nest there. Nesting occurs primarily May through August. Incubation of the eggs is temperature dependent (faster in warmer years and slower in colder years). The northern Gulf average for incubation is about 60 days.

Hatching occurs about 60 days after the first nest is laid (first nests usually hatch in mid-July), and hatching season extends until late October or early November.

Turtle crawl: When a female comes ashore to lay eggs, it is referred to as a crawl. Sea turtles sometimes make a false crawl; that is, they come ashore without laying any eggs.



(*Eretmochelys imbricata*), and loggerhead (*Caretta caretta*). All five species are listed as threatened or endangered under the U.S. Endangered Species of 1973 and became depleted due to human activities.

Learn more: <https://www.fisheries.noaa.gov/sea-turtles> Image credits: NOAA

DOI Explores and Maps the Deep Sea

Exploring the Deep continued from page 1

The USGS and BOEM have been busy working with many partners including Federal agencies, private companies, academics, and international initiatives focused on exploring ocean areas. The missions have ranged from pure exploration and mapping to distinct followup efforts that have developed innovative technologies to sample, measure, and map the deep sea. They have collected enormous quantities of data and samples, there have been exciting new discoveries as we steadily fill the “gaps in the maps.” Together these expeditions not only improve our understanding of the ocean but also provide greater understanding of our planet overall.

The 2019 cruises are listed here in chronological order with the name and a brief overview of the mission. Several following articles expand on these entries. Please see related stories to read more.

- April 9–30, 2019, “**DEEP SEARCH 2019: Deep Sea Exploration to Advance Research on Cold/Canyon/Cold seep Habitats (DEEP SEARCH)**” DEEP SEARCH’s primary goal is to predict the location of seafloor communities off the coast of the southeast United States that are potentially sensitive to disturbance.

The area includes submarine canyons, cold-water coral mounds and gardens, methane seeps, and soft sediments.

See related story, page 19.

- May 30–July 12, 2019, “**Exploring Deep Sea Habitats of the Southeastern US,**” is part of the multiyear, multiagency ocean exploration effort known as “**Windows to the Deep.**” USGS, NOAA and partners collected baseline information about unknown and poorly understood deep-water areas of the southeastern United States on board NOAA Ship *Okeanos Explorer*.

See related story, page 20

- June 12–July 3, 2019, “**Observing Seafloor Methane Seeps at the Edge of Hydrate Stability,**” concentrated on a deep-sea expedition aboard the Research Vessel (R/V) *Falkor* off the coast of Oregon and Washington, in the U.S. Pacific Northwest. Scientists combined many disciplines to study methane seeps along the seafloor. In addition to investigating what makes these seeps tick, in terms of understanding their origin and associated biogeochemistry, scientists on this cruise examined the kinds of creatures and organisms that live in the benthic zone along the cruise route.

See related story, page 20.

- August 6–September 15, 2019, “**Deep Connections 2019: Exploring Atlantic Canyons and Seamounts of the US**

and Canada.” DOI’s USFWS and NOAA jointly manage the Northeastern Canyons and Seamounts Marine National Monument. It includes two units: (1) The Seamounts Unit—four undersea mountains: Bear, Mytilus, Physalia, and Retriever seamounts and (2) The Canyons Unit—three undersea canyons: Oceanographer, Lydonia, and Gilbert. The monument is renowned for its rich and unique biodiversity of deep-sea coral communities and concentrations of marine wildlife. Geographic features create oceanographic conditions that attract pelagic species including whales, dolphins, turtles, migratory fishes such as tunas, billfish, swordfish, and sharks. Many seabirds also rely on this area for foraging, including Atlantic puffins (*Fratercula arctica*).

Scientists on board the NOAA Ship *Okeanos Explorer*, as well as scientists on shore, worked together to critical baseline information. This expedition conducted 12 remotely operated vehicle (ROV) dives; six were in deep extensions of marine managed areas, including the Gully Marine Protected Area, the Northeastern Canyons and Seamounts Marine National Monument, and the Frank R. Lautenberg Deep Sea Coral Protection Area. Deep-sea corals and sponges were recorded on all of the 11 benthic-focused dives.

The team mapped deep-sea areas around the Northeast Channel, the Fundian Valley, north of Alvin Canyon, and along the United States-Canadian boundary, which had not yet been mapped using high-resolution Change to “sound navigation and ranging (sonar).

Learn more: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1905/dailyupdates/dailyupdates.html>



At Pamlico Canyon, walls were covered in brisingid starfish and a diversity of other corals. Image credit: Ivan Hurzeler and NOAA-OER DEEP SEARCH 2019

See Exploring the Deep page 19

Exploring the Deep continued from page 18

• October 5–November 20, 2019, **“2019 Southeastern US Deep-Sea Exploration.”** This two-part expedition (EX-1906 and EX-1907) on board NOAA Ship *Okeanos Explorer* focused on top-priority areas where baseline information about deep-water areas of the southeastern U.S. continental margin was needed. Marine scientists and managers at USGS, BOEM, and the South Atlantic Fisheries Management Council selected these areas to gain information that contributes directly to the ecosystem assessment work being coordinated as part of the five-year interdisciplinary DEEP SEARCH study and the Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE). Read the overview: <https://oceanexplorer.noaa.gov/okeanos/explorations/2020-overview/welcome.html>

• October 5–26, 2019, **2019 Southeastern U.S. Deep-Sea Exploration–Mapping**

DEEP SEARCH's Ongoing Mission

By Michael Rasser (BOEM)

Since 2017, the DEEP SEARCH study has explored the deep-sea ecosystems of the U.S. Mid- and South Atlantic, characterizing regional biological communities, examining their sensitivity to natural and human disturbance, and identifying the oceanographic, geological, geochemical, and acoustic conditions associated with each observed habitat.

Researchers hope that DEEP SEARCH will improve their ability to predict the location of seafloor communities off the U.S. southeast coast that are potentially sensitive to disturbance. This area encompasses a variety of habitat types, including submarine canyons, coldwater coral mounds and gardens, methane seeps, and soft sediments.

To date, DEEP SEARCH researchers have spent 65 days at sea on five

• October 31–November 20, 2019, **2019 Southeastern U.S. Deep-sea Exploration–Remotely Operated Vehicle and Mapping Operations**

• October 7–November 7, 2019, **“Surveying Deep-sea Corals, Sponges, and Fish Habitat.”** Scientists and engineers from USGS, BOEM, NOAA, and the Global Foundation for Ocean Exploration (GFOE) conducted a 29-day expedition aboard NOAA Ship *Reuben Lasker* exploring the deep sea along the California, Oregon, and Washington coasts. This expedition contributed to the greater “EXPRESS” (Expanding

different research vessels, completing 25 vehicle dives and exploring the ocean bottom for nearly 260 total hours. DEEP SEARCH has discovered 85 linear miles of *Lophelia pertusa* coral reef about 160 miles southeast of Charleston, SC. Researchers also observed tubeworms growing on carbonate rock at the Kitty Hawk seep offshore North Carolina—the first known instance of tubeworms being observed in this area of the Atlantic.

The team completed three dives with autonomous underwater vehicle (AUV) *Sentry*, 11 dives with human occupied vehicle (HOV) *Alvin*, and 11 dives with the ROV *Jason*.

DEEP SEARCH is funded through an interagency partnership between BOEM, NOAA, and the USGS with sponsorship from the National

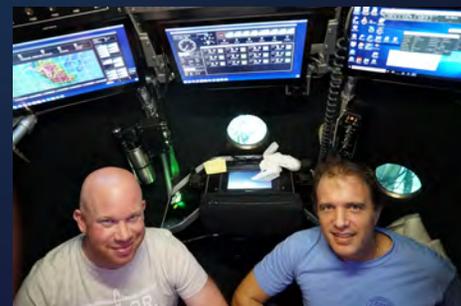
A geologic fault observed during the Deep Connections 2019 expedition. Image credit: NOAA-OER



Pacific Research and Exploration of Submerged Systems) research effort in fusing multiple data sets across research cruises to support U.S. government missions of growing commerce, increasing resource independence, maintaining national security, and evaluating environmental impacts.

<https://oceanexplorer.noaa.gov/explorations/19express/welcome.html>

https://www.usgs.gov/centers/pcmsc/science/express-expanding-pacific-research-and-exploration-submerged-systems?qt-science_center_objects=0#qt-science_center_objects



BOEM's Michael Rasser (right) and Jay Lunden of Temple University aboard the HOV *Alvin* at 381 meters deep off the North Carolina coast. Photo credit: BOEM

Oceanographic Partnerships Program (NOPP).

BOEM scientists Michael Rasser, Kate Segarra, and Mark Mueller have participated in one or more DEEP SEARCH cruises, assisting in the collection and processing of some of the more than 2,800 biological, chemical, and geological samples gathered from the seafloor and water column.

The study will conclude in 2022.

Windows to the Deep 2019

Exploring Deep Sea Habitats of the Southeastern U.S.

By Carolyn Ruppel and Ann Tihansky (USGS)

Although the east coast is home to millions of Americans and some of the highest population growth rates in the United States, the southeast U.S. continental margin has some of the largest gaps in high-resolution ocean mapping data and limited previous observations via submersibles. In fact, the deep-water areas offshore Florida, Georgia, South Carolina, and North Carolina are some of the least explored areas along the U.S. east coast.

From May 30 through July 12, 2019, USGS joined NOAA and partners on NOAA Ship *Okeanos Explorer* to collect critical baseline information about unknown and poorly understood deep-water areas of this area. The research expedition is part of the multiyear, multiagency ocean exploration effort known as “Windows to the Deep.”

The 38-day, two-leg expedition focused on priority exploration areas identified by the ocean management and scientific communities. And on the 100th mission for the *Okeanos Explorer*, it visited new methane plumes where the U.S. Atlantic seeps story began. In November 2012, through a collaboration between NOAA’s Office of Ocean Exploration and Research (OER) and the USGS, the *Okeanos Explorer* mapping team discovered the first evidence of widespread seafloor methane seepage on the northern U.S. Atlantic margin. This initial discovery led to the subsequent identification of over 570 seafloor methane seep sites using 94,000 square kilometers of sonar data collected between Cape Hatteras and Cape Cod.

Learn more: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1903/background/overview/overview.html>

Excerpt from the Ship’s Mission Log, July 12, 2019

By Adam Skarke (Department of Geosciences, Mississippi State University), Carolyn Ruppel (USGS), and Shannon Hoy (Cherokee Nation Strategic Programs at NOAA OER)

*Final mission Dive 19 proceeded from a depth of about 1,625 meters upslope to about 1,530 meters through a cluster of methane plumes mapped on the south side of a pronounced ridge. The area has effusive gas discharge, robust chemosynthetic ecosystems, extensive beds of *Bathymodiolus childressi* mussels, abundant carbonate rock, and ubiquitous bacterial mats. In addition, a second, much larger type of mussel (*Bathymodiolus heckeriae*) has been collected at the seeps, the first such occurrence of this species so far north on the U.S. Atlantic margin.*

*As the dive continued, the team observed an increasing density of empty *Bathymodiolus* mussel shells, and the scene then transitioned to beds of live *Bathymodiolus childressi* mussels adjacent to outcrops of authigenic carbonate rocks. Dense bacterial mats and distributed echinoderms and anemones were also seen, as well as rays, fish, and crabs.*

Read the full mission log here: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1903/logs/july12/july12.html>

Seafloor Methane Seeps at the Edge of Hydrate Stability

By Amanda Demopoulos, Nancy Prouty, and Carolyn Ruppel (USGS)

In June 2019, USGS scientists led a 22-day deep-sea research expedition aboard the R/V *Falkor* to examine methane seep dynamics and processes along the Cascadia Margin offshore of Washington and Oregon. This expedition, the Cascadia Margin Methane Research Action (CAMERA), was led by the USGS and conducted in partnership with Schmidt Ocean Institute, British Geological Survey, GEOMAR, the University of North Carolina-Chapel Hill (UNC), and NOAA’s Pacific Marine Environmental Laboratory (PMEL).

Using the ROV *SuBastian*, the scientists directed 24 submersible dives at sites including Astoria Canyon, Grays Canyon, Heceta, and Coquille. The dives studied the physics, chemistry,

See *Windows to the Deep* page 21



Location of Norfolk seeps offshore Virginia and south of Norfolk Canyon. Image credit: NOAA-OER, Windows to the Deep 2019



A high diversity and density of corals and sponges were characteristic of the entire dive 9 of Deep Connections 2019 on Retriever Seamount. Image credit: NOAA-OER

Windows to the Deep continued from page 20 ecology, and geology of seafloor methane seeps landward of the deformation front where the Juan de Fuca tectonic plate subducts beneath the North American plate. In addition, the ROV acquired images of the seafloor and water column at the seep sites and collected samples of water, the benthos (sediments and megafaunal invertebrates), and carbonate rocks that were formed in place as a result of microbial activity.

The expedition conducted seafloor mapping, video surveys, and quantitative sampling to characterize seafloor habitats and the associated benthic communities near seeps. Taken together, these samples and analyses are providing valuable information about seep dynamics and processes at different locations and on several timescales.

This expedition made some notable advances for deep-sea research. See the YouTube summary here: https://www.youtube.com/watch?v=P_GH74FhUrY&feature=emb_rel_end

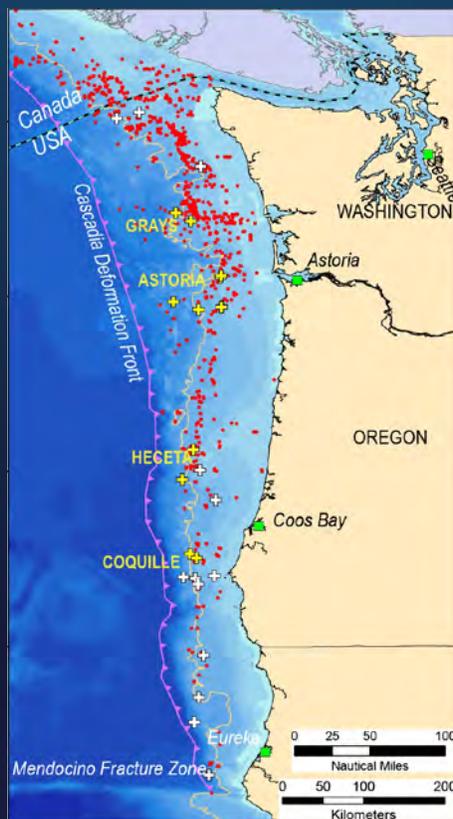
Funding for this research was derived from several sources, exemplifying the power of partnering to conduct offshore research.

Multidisciplinary expeditions like CAMERA link observations of seafloor habitats and benthic communities with studies of gas fluxes, the timing of seep emissions, the composition of emitted gas streams, and the rates at which microbes consume methane in the water column. Ultimately, this

information can be used to predict where these systems occur elsewhere in the Pacific, which will in turn inform management and conservation of these sensitive environments and links between fluid expulsion and geohazards. Watch the video: <https://schmidtocean.org/cruise-log-post/hunting-bubbles-week-02-video-update/>

Learn more: <https://schmidtocean.org/cruise/methane-seeps-at-edge-of-hydrate-stability/>

Read more in the USGS *Sound Waves* special issue on deep-sea research: <https://www.usgs.gov/newsletter/sound-waves-newsletter-special-issue-deep-sea-research>



Map of the Cascadia subduction zone. Cascadia Deformation Front: pink line with triangles, red circles: methane seep locations, white and yellow crosses: ROV dive locations, tan line: 1,000 meter depth contour. Image credit: Carolyn Ruppel, USGS

EXPRESS: Expanding Pacific Research and Exploration of Submerged Systems

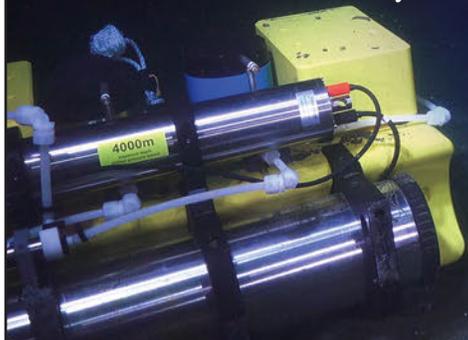
Interagency Collaborative Efforts Explore Deep Ocean Areas

By Nancy Prouty (USGS), Jeremy Potter (BOEM), Amanda Demopoulos (USGS), Elizabeth Clarke (NOAA), and Chris Caldwell (NOAA)

As State and national interest in offshore renewable energy development and substantial commercial and recreational fishing activities grows, managing offshore habitats becomes increasingly challenging. In response, USGS and BOEM have joined NOAA and several non-Federal partners to initiate EXPRESS, a multiyear collaborative campaign to inform offshore activities and natural resource management decisions and improve knowledge of submarine geohazards to human health, safety, and infrastructure off the west coast of the United States.

The EXPRESS campaign, which began in 2018, targets deep-water areas off of California, Oregon, and Washington, and collects information that will help (1) guide wise use of living marine resources and habitats;

See EXPRESS Research page 22



Two UNC mini landers, surrounded by Sablefish (*Anoplocoma fimbria*) and pink sea urchins, incubate seawater in situ to enable calculations of methane oxidation rates. Image credit: ROV SuBastian/Schmidt Ocean Institute

EXPRESS Partnerships Expand Capabilities

Demonstrating an unprecedented level of government cooperation, USGS, BOEM, eight different NOAA offices, the Monterey Bay Aquarium Research Institute, and the GFOE contributed financial or scientific expertise to an EXPRESS expedition in fall 2019.

From October 7 to November 7, 2019, a team of scientists from USGS, BOEM, and NOAA embarked on a 29-day expedition aboard the NOAA Ship *Reuben Lasker* to explore deep-water sites along the California, Oregon, and Washington coasts, including sites within three National Marine Sanctuaries. Researchers relied on underwater robots like ROVs and AUVs, environmental DNA (eDNA) analysis, and other advanced technologies to explore and characterize deep-sea habitats. In addition, with the support of NOAA's OER and the nonprofit GFOE, a fly-away telepresence system was used to engage scientists and the public remotely. The expedition returned to sites identified by previous EXPRESS missions and significantly expanded our knowledge of deep-water areas off the U.S. west coast.

For more information on this expedition, please visit: <https://oceanexplorer.noaa.gov/explorations/19express/welcome.html>

EXPRESS Research continued from page 21

(2) inform potential offshore energy and mineral resource decisions; and (3) improve offshore earthquake, landslide, tsunami, and nautical hazard assessments.

In just two years, EXPRESS has helped coordinate 24 cruises, including a 29-day expedition aboard the NOAA Ship

Reuben Lasker in fall 2019, to support multiple Federal, private, and other stakeholder information needs. From those cruises, over 25,000 additional square kilometers of seafloor have been mapped with modern multi-beam sonar; 110 ROV and 70 AUV dives have been conducted; dozens of conductivity, temperature, and depth casts have been used to collect water samples and environmental data; and hundreds of specimens have been collected, resulting in numerous data products and countless

additional research questions. The campaign's demonstrable achievements are due in part to a self-organized team composed of scientists and marine resource managers spanning numerous disciplines, as well as a willingness of multiple agencies to cost share otherwise expensive deep-water expeditions.

Learn more about EXPRESS: <https://www.usgs.gov/centers/pcmsc/science/express-expanding-pacific-research-and-exploration-submerged-systems>.

Read more in the USGS *Sound Waves* special issue on deep-sea research: <https://www.usgs.gov/newsletter/sound-waves-newsletter-special-issue-deep-sea-research>

Read the summary: <https://oceanexplorer.noaa.gov/oceanos/explorations/ex1907/logs/summary/media/summary-infographic-800.jpg>



Our team of engineers recovers ROV *Deep Discoverer* at night after Dive 02, an extended dive, of the 2019 Southeastern U.S. Deep-sea Exploration. Image credit: NOAA-OER, 2019 Southeastern U.S. Deep-sea Exploration

ASPIRE—Exploring the Atlantic Deep Sea

By Ann Tihansky (USGS)

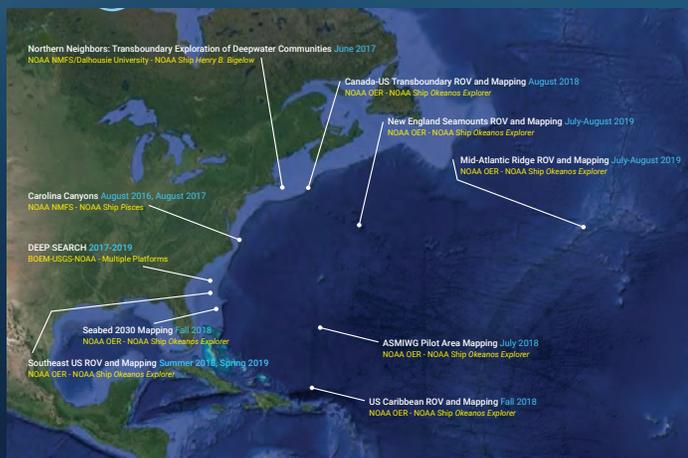
DOI's BOEM and the USGS are key Federal partners with the NOAA-led ASPIRE effort in exploring the Atlantic Ocean along with international partners from the European Union and Canada. The NOAA Ship *Okeanos Explorer* is supporting operations with

partners in the region from 2018 to 2020 to build on initial ASPIRE fieldwork conducted in 2016 and 2017..

In 2019, the ASPIRE Southeastern U.S. Deep-sea Exploration included expeditions 1906 and 1907 and was, in total, a 43-day, two-leg, telepresence-enabled expedition where DOI joined NOAA and other partners in mapping and conducting ROV operations. Each ASPIRE expedition has its own objectives that support the goals of the larger campaign. The 2019 exploration collected baseline information

about unknown and poorly understood deep-water areas of the southeastern U.S. continental margin (see map). It addressed scientific themes and priority areas identified by NOAA, other Federal agencies, regional management agencies, and the ocean science community. The expedition entailed mapping and ROV operations, filling data gaps in the region toward Seabed 2030 goals for mapping unexplored regions of Earth's ocean and exploring a variety of deep-sea features.

In addition, the expeditions engaged the public through live interactions, live streamed video, expedition web content, and media/web stories. In case you missed it, you can watch recorded videos from the ROV dives and read about major accomplishments in the exploration summary here: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/summary/media/1906-07-summary.pdf>



Map of currently identified ASPIRE expeditions (2016–19) in the Atlantic Ocean. Image credit: NOAA-OER

The Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE)

ASPIRE is a NOAA-led major multiyear, multinational collaborative ocean exploration field program focused on raising collective knowledge and understanding of the North Atlantic Ocean (meaning north of the equator and including the Atlantic U.S.). Building on the successes of the 2012–13 Atlantic Canyons Undersea Mapping Expeditions, the ASPIRE campaign will broaden the geographic focus to include more of the U.S. Atlantic and the high seas. The campaign will provide data to inform and support research planning and management decisions in the region.

SEABED 2030

Seabed 2030 is a collaborative project between the Nippon Foundation of Japan and the General Bathymetric Chart of the Oceans. It aims to bring together all available bathymetric data to produce the definitive map of the world ocean floor by 2030 and make it available to all.

The project was launched at the United Nations (UN) Ocean Conference in June 2017 and is aligned with the UN's

Sustainable Development Goal #14 to conserve and sustainably use the oceans, seas, and marine resources.

Knowing the depth and shape of the seafloor (bathymetry) is fundamental for understanding ocean circulation, tides, tsunami forecasting, fishing resources, sediment transport, environmental change, underwater geohazards, cable and pipeline routing, mineral extraction, oil and gas exploration

and development, infrastructure construction and maintenance, and much more.

Despite many years of effort, less than 20% of the ocean's seafloor has been mapped. This coordinated international effort is needed to bring together all existing data sets and to identify areas for future surveys to help "map the gaps." Learn more: <https://seabed2030.gebco.net/>

ASPIRE

NOAA-OER 2019 Southeastern U.S. Deep-sea Exploration

Explore Shipwrecks Online: BOEM's Virtual Archaeology Museum

By Michael Plummer (BOEM)

In the course of oil and gas exploration, BOEM has discovered many amazing shipwrecks. These shipwrecks are important submerged cultural resources and each one tells a story of our shared history. BOEM has created a “virtual” marine archaeology museum using video publicly available from NOAA’s OER. With technological advances in ROVs) and underwater videography, highly detailed surveys of these shipwrecks are now possible, and computer technology has reached the point where photo-real and hyper-accurate three-dimensional (3D) models can be created from two-dimensional imagery.

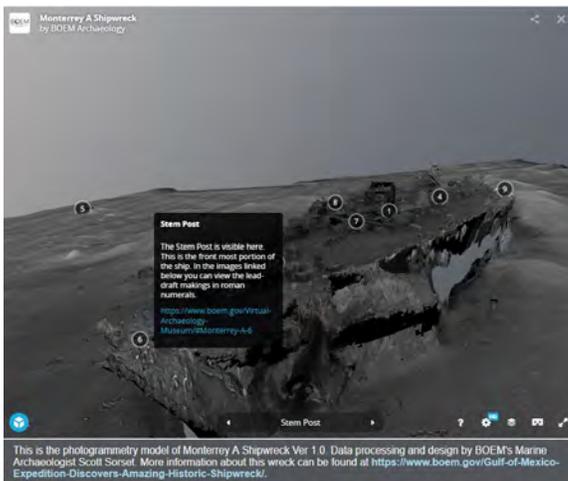
“With the ROVs we can clearly examine the artifacts in these shipwrecks up close, in thousands of feet of water. Through the use of the 3D models, we can see each shipwreck site as a whole

and monitor changes to it over time,” said BOEM Gulf of Mexico Regional Director Mike Celata.

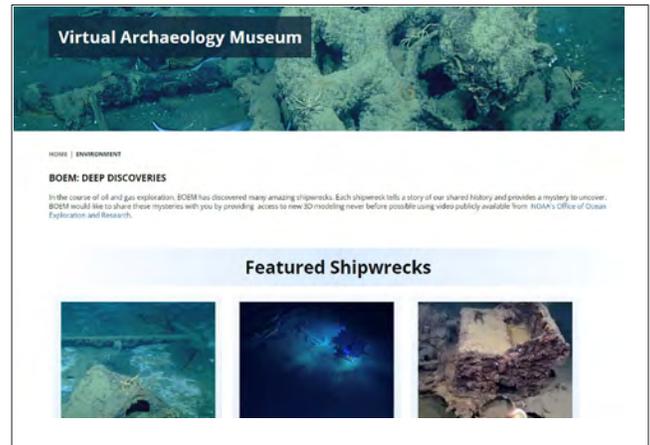
BOEM “opened” the Virtual Archaeology Museum in May 2019, with displays of video, detailed 3D models, and mosaic maps of shipwrecks from the 19th and 20th centuries. Visitors can easily access these models online and see shipwrecks that have been lying on the bottom of the ocean, some for hundreds of years. Professional and amateur scientists will have the ability to monitor these shipwrecks over time, gauging changes to the

shipwrecks and their artifacts, as well observing the various aquatic species that inhabit their hulls, making the bottom of the sea accessible like never before.

“The Virtual Archaeology Museum will serve as a valuable teaching asset in both school and university classrooms, and the data collected will be a focal point for marine archaeological researchers, its online presence allowing collaboration worldwide,” said Celata.



Shipwreck imagery and annotation can be explored through detailed photogrammetry models created with multiple imagery and data processing. Image credit: BOEM



The virtual Archaeology Museum home page. NOAA's OER has collaborated with BOEM to gather data at shipwreck sites in the Gulf and Atlantic. You can visit them at BOEM's Virtual Archaeology Museum: <https://www.boem.gov/Virtual-Archaeology-Museum/> Image credit: BOEM



A photomosaic of the Monterey shipwreck. Image credit: BOEM

2020 Hurricane Season—Science Supports Hazard Preparedness

By Jason Burton (USGS)

The 2020 Atlantic hurricane season started June 1. As we have seen in the past, hurricanes and extreme storms can have devastating impacts on our Nation. The USGS works with partners and emergency managers to provide science and build capabilities to reduce risk, improve situational awareness, in order to protect lives and property if a major storm makes landfall this season.

Tropical storms, hurricanes, and other large coastal storms can impact coastal and inland communities and ecosystems with high winds, storm surge, erosion, and flooding. Already there have been two tropical storms before the official start of the 2020 Atlantic hurricane season, which goes from June 1 to November 30.

When a major storm threatens to make landfall in the United States or its territories, the USGS provides comprehensive scientific capabilities and information that decision makers, emergency responders, and communities can use to help them prepare for, cope with, and recover from a storm. This includes the USGS's ability to forecast coastal change; track storm surge, river and stream levels, and flow; capture high-resolution ground elevation and topographic data; create detailed maps that can be used by disaster teams responding in the aftermath of storms; and measure coastal and inland flooding across entire regions

Before a storm's expected landfall, USGS coastal change experts forecast how a storm may reshape the coastline using a sophisticated system they developed called the coastal change hazard forecast model.

The model provides detailed forecasts of a strong storm's likely effects on sandy shorelines along the Atlantic and Gulf coasts. It

predicts where protective sand dunes are likely to be eroded at their bases or overtopped by storm waves and where coastal areas behind the dunes could be inundated by seawater.

These forecasts can help emergency managers make critical decisions before a major storm strikes, including which areas to evacuate, which roads to use and where to position storm cleanup equipment. The forecasts typically begin 72 hours before a storm is expected to make landfall, are updated based on the latest forecasts from the National Hurricane Center, and are available at the USGS Coastal Change Hazards Portal. The site has recently been updated with new coastal elevation data that reflect sandy shoreline changes brought by recent hurricanes and new scenarios of storm-induced erosion. This allows forecasts for the 2020 hurricane season to be based on the latest information available.

Working with NOAA's National Weather Service, the coastal hazards storm team also updates forecasts for some areas several times a day using real-time water levels from the weather service's Nearshore Wave Prediction System. The team's Total Water Level and Coastal Change

Forecast Viewer displays results from a new model that currently covers about 1,865 miles of coastline in select areas from Florida through Maine. The model predicts the timing and height of water levels at the shoreline as well as potential impacts to coastal dunes. NOAA will use the predictions to help inform forecasters at the National Hurricane Center. As the program's coverage area expands, the predictions will also be made available to National Weather Service forecasting offices and to the public.

"We are working to expand the Total Water Level Viewer to include the Gulf coasts of Texas, Alabama, and the Florida panhandle, as well as additional areas along the Atlantic coast, which will give us about 2,900 miles of total coastline coverage," said Oceanographer Kara Doran, USGS Coastal Change Hazards Storm Team leader. "We hope the new information will be publicly available sometime later this season." So stay tuned and stay safe.

Read more: <https://www.usgs.gov/news/usgs-ready-respond-during-2020-atlantic-hurricane-season>

Visit the Portal: <https://marine.usgs.gov/coastalchangehazardsportal/>



Screenshot from the USGS Coastal Change Hazards Portal showing Hurricane Dorian's position and coastal impact forecast on 9/2/2019. Image credit: USGS

\$353 Million for Gulf State Coastal Conservation and Hurricane Protection Projects

In March 2020, DOI Secretary David Bernhardt announced that the DOI disbursed almost \$353 million in fiscal year (FY) 2019 energy revenues to the four Gulf oil and gas producing states—Alabama, Louisiana, Mississippi and Texas—and their coastal political subdivisions as part of the Gulf of Mexico Energy Security Act of 2006 (GOMESA).

The funds will be used to support coastal conservation and restoration projects; hurricane protection programs; and activities to implement marine, coastal, or conservation management plans in Alabama, Louisiana, Mississippi, and Texas.

GOMESA funds are derived from qualified oil and gas leasing revenues on the OCS and disbursed in accordance with the revenue-sharing provisions of the GOMESA legislation. During FY 2019, DOI’s Office of Natural Resources Revenue (ONRR) disbursed about \$125 million to the Land and Water Conservation Fund (LWCF; *see related story, page 3*) and \$549 million to the U.S. Treasury from bonuses, rentals, and royalties paid for GOMESA leases. As required by the legislation, disbursements to the LWCF and Treasury are made in the same year of receipt, whereas disbursements to the States and CPS are made the year following receipt.



Learn how GOMESA works: <https://revenue.data.doi.gov/how-it-works/gomesa/>

DOI’s ONRR manages and ensures full payment of revenues owed for the development of the Nation’s energy and natural resources on the OCS and onshore Federal and Indian lands. In performing this important fiduciary role, ONRR collects an average of over \$10 billion dollars in annual revenue, one of the Federal government’s largest sources of non-tax revenue.

Learn more: <https://www.doi.gov/pressreleases/interior-disburses-353-million-gomesa-revenues-gulf-state-coastal-conservation-and>

New Ferries for Pensacola Bay

By Nadine Leavitt Siak (USFWS)

Spanish explorer Tristán de Luna’s Royal Geographer Carlos de Sigüenza y Góngora described Pensacola’s natural harbor as “the finest jewel possessed by His Majesty.” More than 450 years later, two new vessels help others explore the coastal area.

Two 150-passenger catamaran-style ferryboats are connecting walkable and bikeable areas around the historic harbor, thanks to settlement funds resulting from the 2010 DWH oil spill’s NRDA process. The ferries began running from downtown Pensacola at a new \$3.5 million brand-new home port that opened for business in April 2019. *See related story, page 6.*

The DWH oil spill damaged public access to beaches and the waters in many places along the Gulf. Among



The *Turtle Runner* Ferry sails to Fort Pickens, which is within Gulf Islands National Seashore. Photo credit: NPS

them was the Gulf Islands National Seashore, typically one of the top-10 most visited national park areas in the United States. The DWH NRDA process led to a settlement with BP in which funds were earmarked specifically to help restore lost visitor use. The two ferries were purchased with \$4 million of the settlement funds for this purpose.

The ferries were named *Turtle Runner* and *Pelican Perch* by local fourth grade students. They carry passengers between their new home port in downtown Pensacola, Pensacola Beach, and historic Fort Pickens on Santa Rosa Island. *Turtle Runner* and *Pelican Perch* feature a climate-controlled enclosed main deck and a shaded upper deck for observation, and include a snack bar, restrooms, and passenger storage. The ferries were constructed to Americans with Disabilities Act standards and have bike racks for those wishing to explore Fort Pickens or Santa Rosa Island by bicycle.

“We work for walkability and bikeability and to make our waterfront more accessible. Now we are adding boat-ability!” said Pensacola City Council Member Ann Hill at an April 13th ribbon-cutting ceremony. She emphasized how the ferries and infrastructure will advance efforts to promote outdoor recreation. Local officials also value the ferries for their service in ensuring continued public access to the park should it eventually become impractical to continually repair and rebuild a road that connects Santa Rosa to the mainland. Fort Pickens Road has washed out frequently during hurricanes and even heavy rain events.

NPS Park Superintendent Dan Brown noted that the new service is more than simple point-to-point transportation; the ferries are an outreach and educational opportunity. Park rangers are onboard to provide interpretive information about the park, historic Fort Pickens, and to point out dolphins, pelicans, and other wildlife. The ferries provide the community and visitors a unique way to experience the many jewels of Pensacola Bay.

Learn more: <https://www.nps.gov/guis/index.htm>

\$5 Million to Protect Coral Reefs, Combat Invasive Species

By Tanya Joshua (DOI)

In September 2019, U.S. Interior Assistant Secretary of Insular and International Affairs Doug Domenech announced \$5,192,241 to protect coral reefs and natural resources and to combat invasive species, including the Brown Tree snake (*Boiga irregularis*) in FY 2019. The funding was provided for a variety of projects intended to benefit American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, the U.S. Virgin Islands (USVI), the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau.

“The funding provided will help to protect important coral and natural

resources and combat invasive species that are threatening the stunning, but fragile ecosystems found across the U.S. territories and in the freely associated states,” said Domenech.

He made the announcement while co-chairing the U.S. Coral Reef Task Force meeting with co-chair Rear Admiral Tim Gallaudet, Deputy Director of NOAA.

“This funding is a great example of the Department of the Interior’s continuing efforts to protect our treasured natural resources.” said U.S. Secretary of the Interior David Bernhardt.

The Coral Reef Initiative and Natural Resources program supports efforts



Lush thicket of staghorn coral (*Acropora cervicornis*) in Dry Tortugas National Park. Photo credit: Ilsa Kuffner, USGS

to protect the health of all natural resources in the U.S. insular areas for the long-term economic and social benefit to their island populations. For more information, visit: <https://www.doi.gov/oia/financial-assistance>

A “Quintessential” Forage Fish

Understanding the Crucial Role of the Sand Lance

By Michelle Staudinger (USGS)

A new paper published in March 2020 in *Fish and Fisheries* reviews the state of knowledge and the research needed to update our understanding and population status of the sand lance, a zooplanktivorous fish that spans coastal temperate to polar waters in the Northern Hemisphere.

Scientists have insufficient or outdated information about the sand lance’s basic life history, population dynamics, and its ecological role as prey of many fish, birds, and marine mammals, limiting our ability to understand the risks and vulnerabilities to this fish related to specific threats from changing climate and oceanographic patterns, as well as human activities such as commercial fisheries and offshore energy development.

More than 20 scientists, managers, and conservation practitioners came together to explore gaps and future research needs.

The northwestern Atlantic Ocean environment (NWA) region is experiencing

rapid warming of coastal and ocean water temperatures due to climate change. Regional warming has been observed during all seasons but most substantially during summer. These changes could have major effects on sand lance occurrence and subsequent impacts on commercial fisheries, seabirds, and other natural resources that depend on them.

“We brought together experts from across the various communities to summarize the current state of knowledge and also identify important information gaps,” said Michelle Staudinger, USGS scientist and lead author of the study. “The limited information we do have is from the 1970s and 1980s, and one of our concerns is that shifts in seasonal oceanographic conditions, circulation, and the phenology of lower trophic level species are affecting what were once considered to be established patterns in regional timing and availability of resources.”



An Arctic tern (*Sterna paradisaea*) feeding its chick a large sand lance. Photo credit: Keenan Yakola, UMass Amherst

The NWA is a highly dynamic ecosystem currently facing many varied impacts from climate change, fishing, aquaculture, offshore energy development, and altering nearshore and shoreline areas through activities such as sand mining and shoreline armoring. These anthropogenic activities have the potential to impact sand lance

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What is a Sand Lance?

The sand lance, often referred to as a sand eel, is actually a zooplanktivorous fish (meaning that it eats tiny marine animals at the base of the food chain). In the NWA region, the two primary species are the Northern sand lance (*Ammodytes dubius*) and American sand lance (*Ammodytes americanus*). Sand lance are small in size and have an elongate body form that allows them to “dive” into sandy seabed sediments. The sand lance depends on the presence of clean, sandy substrates on the seafloor in relatively shallow water depths (less than 300 feet). The small (three to six inches long), wiggly fish spend their days feeding on zooplankton in the water column and bury themselves in the sand to hide from predators at night. Sand lance form dense schools that appear to fluctuate widely in abundance and distribution over seasonal, annual, and decadal scales.



A sand lance pokes its head out of the sand, Photo credit: NOAA

The slender fish with a skinny snout is a favorite food of humpback whales (*Megaptera novaeangliae*), sharks, seals, seabirds, commercial fishes, and many other ocean predators. Overall, 72 regional predators including 45 species of fishes, 2 squids, 16 seabirds, and 9 marine mammals were reported to consume sand lance in the NWA region.



A humpback whale actively feeding on sand lance. Photo credit: Mike Thompson, NOAA

“Their shape makes them very attractive to many predators because they’re easy to swallow. Most marine predators don’t chew their food, rather they swallow their food whole. It’s like eating spaghetti instead of a meatball; there are no legs or spines to get caught in your mouth or throat. Even small seabird chicks can swallow large sand lance because they slide right down into the gullet,” said the study’s lead author, USGS scientist Michelle Staudinger.

Their abundance and distribution are linked to commercially valued fisheries such as Atlantic Cod (*Gadus morhua*) and Bluefin Tuna (*Thunnus thynnus*), as well as species of high conservation concern such as humpback whales and seabirds like Great Shearwaters (*Puffinus gravis*) and endangered Roseate Terns (*Sterna dougallii*).

Read more: https://necsc.umass.edu/sites/default/files/SandLance_2pager_2017_0.pdf

Sand Lance continued from page 27

by one or a combination of threats—either directly through harvest or by degrading habitat, or indirectly through altered food web relationships. Depending on the vulnerability of these species to these stressors, there could be cascading indirect impacts on predators that could cause disturbances in the greater ecosystem with effects on dependent human-ecological systems. At the base of it all is the sand lance, which needs to be better understood and considered,

especially when it comes to making policy decisions for management and conservation.

“To the best of our knowledge this is the first comprehensive assessment of this fish species in the NWA region. Results are intended to inform new research, and to help guide conservation and management efforts by regional Fishery Management Councils, regulatory agencies, fishing communities, conservation organizations, and coastal development groups, all of whom share responsibilities and

interests in these fish and their predators throughout their range in continental shelf waters from North Carolina to Greenland,” said Staudinger.

Read more: <https://www.umass.edu/newsoffice/article/base-food-chain-small-fish-should-command>

Read the paper: <https://onlinelibrary.wiley.com/doi/full/10.1111/faf.12445>

Seafloor Maps Support Integrated, Multi-Use Management of Massachusetts Waters

By Walter Barnhardt and Laura Brothers (USGS)

The USGS, in cooperation with the Massachusetts Office of Coastal Zone Management is mapping the geology of the seafloor within the Massachusetts coastal zone.

The maps of seafloor geology show how different bottom types are distributed across the inner continental shelf. The maps and related data, such as depth to bedrock, bottom classification, side-scan sonar imagery, and bottom photos, are important first steps toward protecting fish habitat, delineating marine resources, and assessing environmental changes caused by natural or human impacts.

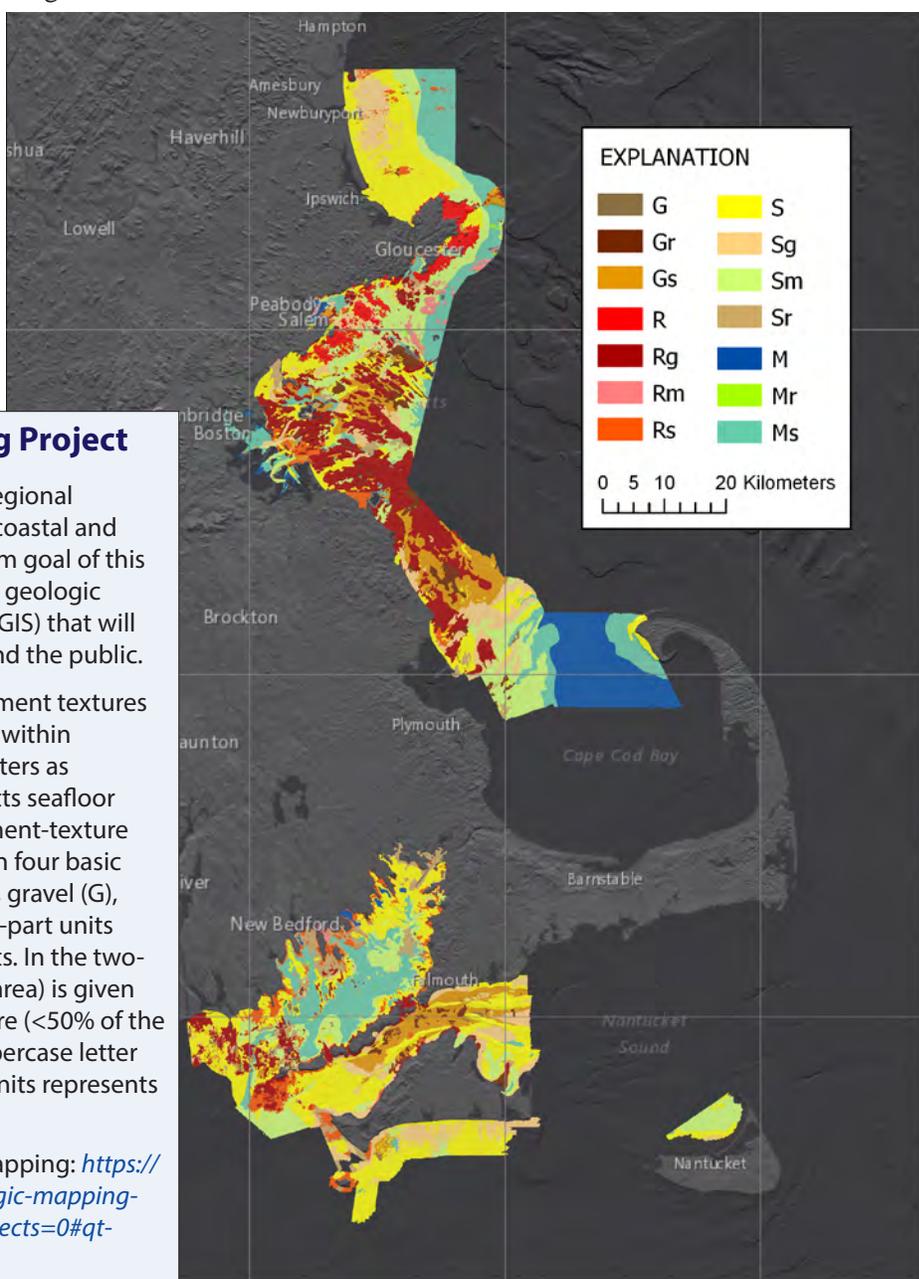
See related story, page 27.

This seafloor information provides critical scientific guidance for appropriately siting offshore development such as sand mining, pipelines, and renewable-energy projects. The products and knowledge developed

by this project have broad application to regional science and resource-management issues. For example, the Massachusetts Division of Marine Fisheries uses the maps to monitor habitat recovery after pipeline construction in Massachusetts Bay and to conduct fisheries research. Ultimately, these maps will support the Massachusetts Ocean Management Plan—an integrated, multi-use proposal for the management of Massachusetts waters.

In addition, these maps provide critical information to understand how processes shape the coast, how the coast has evolved over time, and describe trends that help understand and evaluate the vulnerability of coastal environments to storms, sea-level rise, and long-term climate change.

Learn more about USGS seafloor mapping capabilities: https://www.usgs.gov/centers/whcmssc/science/sea-floor-mapping-group?qt-science_center_objects=0#qt-science_center_objects



Massachusetts Seafloor Mapping Project

Started in 2003, the program is developing regional geologic framework information to support coastal and marine resources management. The long-term goal of this mapping effort is to produce high-resolution geologic maps and a geographic information system (GIS) that will serve the needs of research, management, and the public.

ROCK	R	Rg	Gr	G
	Rs	Rm	Gs	Gm
	Sr	Sg	Mr	Mg
	S	Sm	Ms	M
SAND				MUD

The distribution of sediment textures is mapped by the USGS within Massachusetts State waters as part of the Massachusetts seafloor mapping project. Sediment-texture classification is based on four basic sediment units: rock (R), gravel (G), sand (S), and mud (M). Twelve additional two-part units represent combinations of the four basic units. In the two-part units, the primary texture (>50% of the area) is given an uppercase letter, and the secondary texture (<50% of the area) is given a lowercase letter. Only the uppercase letter is used for areas where one basic sediment units represents >90% of the texture. Image credit: USGS

Learn more about Massachusetts seafloor mapping: https://www.usgs.gov/centers/whcmssc/science/geologic-mapping-massachusetts-seafloor?qt-science_center_objects=0#qt-science_center_objects

Celebrating BOEM Scientists

Science is foundational to fulfilling DOI’s mission of effectively maintaining healthy and sustainable ocean, Great Lakes, and coastal resources. BOEM’s “One Scientist’s Story” series introduces you to a range of marine scientists that currently work for the Bureau. These interviews capture personal interests, experiences, and perspectives that show how their careers unfolded and how they got to where they are now. These are just excerpts from the full interviews available through links provided.



Donna Schroeder. Photo credit: BOEM

Donna Schroeder

Marine Ecologist Donna Schroeder’s passion for science started in kindergarten. “My father is a sailor and a recreational fisherman, and I never remember a time in my childhood when I wasn’t around boats,” Schroeder said. “I remember declaring in kindergarten that I wanted to be a scientist when I grew up, specifically a marine biologist. My passion is for the science that our Bureau funds and manages—and how that feeds directly into decision making. I love that because I feel that it gives my work a great deal of meaning when it fits into a larger program.” She is particularly proud of the large body of research surrounding artificial reef science.

Read more: <https://www.boem.gov/newsroom/one-scientists-story-donna-schroeder>



Mary Boatman. Photo credit: BOEM

Mary Boatman

For BOEM Oceanographer Mary Boatman, science is an adventure that never stops. “Growing up in Minnesota, no one expected me to venture out the door and become an oceanographer,” she said. “I watched Jacques Cousteau documentaries and became attracted to the mysteries of the ocean. Crossing the equator was a big adventure that included surviving rituals with my fellow Pollywogs like dancing on the deck wearing mask and fins to appease Neptune.” Boatman currently coordinates science activities along the Atlantic in support of offshore wind in the Office of Renewable Energy Programs.

Read more: <https://www.boem.gov/newsroom/one-scientists-story-mary-boatman-views-science-one-adventure-after-another>



Ann Bull. Photo credit: BOEM

Ann Bull

A love of the sea started early for Ann Scarborough Bull, the Chief of Environmental Sciences for BOEM’s Pacific Regional Office. Since the tender age of four, when her father took her out on a trip aboard a commercial fishing vessel, she has been captivated by the ocean. “We saw two *Mola mola*, as big and round as the dining room table back at my house,” she recalls. “They were sunning themselves at the surface as they floated the giant Pacific gyre. So I wondered, ‘What other wonders were out there in that cold, blue, wet world?’” She participates in field studies and leads the general direction for the Bureau’s research program in the region. Her passion for the ocean and hard work brought her to the DOI 29 years ago.

Read more: <https://www.boem.gov/newsroom/one-scientists-story-ann-bull>



Guillermo Auad. Photo credit: BOEM

Guillermo Auad

Growing up, Guillermo Auad never missed a single documentary about the ocean. A native of Buenos Aires, Argentina, Auad grew up as a “natural and dedicated science nerd.” At 14, he decided to become an oceanographer after reading the book “Oceanography” by Richard Vetter. “The ocean is the cradle of life. It also plays a fundamental role in our lives, from climate to health and food security, and ultimately because the ocean symbolically and practically unites all humans sharing the Common Home,” said Auad. Advancing an integrated knowledge of the oceans is directly linked to our well-being and sustainability.”

Read more: <https://www.boem.gov/newsroom/one-scientists-story-guillermo-auad>



Caryn Smith. Photo credit: BOEM

Caryn Smith

For Oceanographer Caryn Smith, it’s all about pollution prevention. “My biggest passion about ocean science is sharing with others that every drop that reaches the ocean matters,” said Smith. “Pollution prevention is key. We want to keep pollutants and trash out of the ocean if we can. Oil spills are a primary concern to BOEM scientists and stakeholders. Working as a team is essential to the development of a National Environmental Policy Act analysis. If you can’t convey the science you are doing, especially to BOEM’s stakeholders, then it is difficult—if not impossible—to make any forward progress.”

Read more: <https://www.boem.gov/newsroom/one-scientists-story-caryn-smith>

Ten Years After the *Deepwater Horizon* Oil Spill

By DOI

The *DWH* oil spill occurred 10 years ago on April 20, 2010.

Since the spill, the DOI has maintained a team of experts that is laser focused on restoration. We know this commitment is important for many reasons, but one of the most important is that the health of the Gulf is inextricably linked to the quality of life of Gulf Coast residents and the economy of the Gulf Region.

DOI is a member of two key groups established shortly after the spill: (1) The *DWH* NRDA Trustees, came together immediately after the spill, as mandated by the Oil Pollution Act, and (2) The RESTORE Council came into being in 2012 when Congress passed the RESTORE Act. Both groups are made up of representatives of the five Gulf States and key Federal agencies. DOI also serves as formal advisors to the National Fish and Wildlife Federation's Gulf Environmental Benefit Fund, which received \$2.5 billion from an earlier settlement with BP.

DOI is the steward of our Nation's national parks and NWRs, and that is where we are focusing a great deal of our restoration efforts. These parks and refuges provide habitat that is essential to the survival of many species of wildlife injured by the spill and

recreation for hundreds of thousands of visitors. The restoration projects we have already implemented or will implement in the near future are, in and of themselves, truly awe-inspiring.

But, another truly special aspect of our work centers on our efforts to create synergy by leveraging multiple funding sources and partners, by implementing projects in multiple locations across the Gulf, and by seeking to benefit multiple natural resources with a single project. By doing these things, we define better projects along with our partners, the five Gulf States, and the U.S. Environmental Protection Agency, U.S. Department of Agriculture, and NOAA. All of our alliances are founded on an overarching goal of obtaining the greatest environmental benefit from the funding we use.

In Florida, the oil spill caused a temporary loss of coastal recreational opportunities. In response, we had two 150-passenger ferries built using NRDA funds. The ferries are now sailing between the City of Pensacola, Pensacola Beach, and Gulf Islands National Seashore. This project represents a "win-win" for the NPS and local governments because both have wanted the service for decades but have always lacked sufficient funding. *See related story, page 26.*

In Alabama, we worked with the State, the National Fish and Wildlife Foundation, and the



A healthy coastal marsh found along the Gulf. Marshes injured by the *DWH* oil spill are being restored with NRDA settlement funds. Photo credit: USFWS

Conservation Fund to protect pristine scenic property adjacent to Bon Secour NWR from development. Within the refuge, we rehabilitated an aging trail that is along the flight path of a vast array of migratory bird species. This enhanced amenity for birdwatchers is helping to boost ecotourism, an important component of the local economy.

Off the coast of Louisiana, we have the largest restoration project ever undertaken by the USFWS—restoration of North Breton Island, a barrier island within Breton Island NWR. The island is an important nesting spot for the brown pelican (*Pelecanus occidentalis*), but it has eroded to only a fraction of the size needed to support these birds. This restoration project will not only help a species that was once almost extinct, but it will also act as a buffer to the Louisiana mainland.

These are just a few of the 40 or so restoration projects the DOI is implementing. With 12 more years of funding yet to be received, DOI will remain committed to restoring the Gulf.

Learn more: <https://www.doi.gov/deepwaterhorizon>
<https://www.doi.gov/deepwaterhorizon/ten-years-after-deepwater-horizon-oil-spill-0>



The Jeff Friend Trail in Bon Secour NWR. Replacement of the old and dilapidated trail was paid for with NRDA settlement funds. Photo credit: USFWS

CESUs—Benefit Coastal and Ocean Ecosystems

By Krista Barentine and Tom Fish (NPS)

For more than 20 years, the Cooperative Ecosystem Studies (CESU) Network has been supporting ocean and coastal projects and the stewardship mission for the DOI.

The CESU Network is a national consortium of Federal agencies, Tribes, academic institutions, State and local governments, nongovernmental conservation organizations, and other partners working together to support informed public trust resource stewardship. Authorized by Congress in 1998, the CESU Network facilitates research, technical assistance, education, and capacity building to advance the study of natural and cultural resources and their management. The network consists of 17 individual units that coordinate collaborative projects on any topic from anthropology to zoology within their regions.

In 2019, the CESU Network celebrated 20 years of collaborative science, stewardship, and education. The program began with only four CESUs and 30 partners. It has continued to expand in its number of partners (more than 480), coverage, and involvement, keeping environmental, educational, and cultural stewardship at the core.

A few examples demonstrate how the CESU Network has supported the ocean and coastal realm:

- **Tools to Assess Landscape Conservation—Assist with prioritizing, coordinating northern Gulf conservation activities.**

The USFWS along with Mississippi State University began a project with the Gulf Coast CESU on May 1, 2017, to inform the activities of the Gulf Coast RESTORE Council. By combining land conservation plans already in existence, the Council is prioritizing criteria to evaluate existing land conservation projects, map land conservation possibilities, and develop a user interface so users can examine the multiple



Deployment of observation equipment in the Beaufort Sea. Photo credit: BOEM

tradeoffs with various land conservation options. A Strategic Conservation Assessment (SCA) will help guide Gulf conservation using a \$1.9 million fund over three years.

The project goal is to create planning tools that the Council can use to identify and prioritize “voluntary land conservation opportunities” aligned with the “environmental and socioeconomic priorities of the Gulf Coast community.”

The RESTORE Council was created under the RESTORE Act. Read more: <https://www.federalregister.gov/agencies/gulf-coast-ecosystem-restoration-council>

- **Ocean Acidification—Establishing Coral reef sentinel sites to monitor water chemistry at the Flower Garden Banks National Marine Sanctuary (FGBNMS).**

Since the 1970s, BOEM (formerly the Minerals Management Service) has worked with Texas A&M University, NOAA’s Office of National Marine Sanctuaries, and, more recently, the Gulf Coast CESU to study the Flower Garden Banks. FGBNMS contains some of the last remaining high-quality coral reef ecosystems in the wider

Caribbean region. Ocean acidification has the potential to reduce the ability of coral species to precipitate calcium carbonate, impacting the rate they can grow. The overarching goal of the Coral Reef Ocean Acidification Sentinel Site in the FGBNMS study is to assess the variability in ocean acidification through the collection of multiyear baseline data.

As part of BOEM’s commitment to protect this unique area, historic and ongoing physical, chemical, and biological measurements are maintained at this location. A new ocean acidification monitoring station installed at the FGBNMS will provide valuable information on the impact of changing pH on the site’s coral reefs and contribute useful information for characterizing changes in this ecosystem over time.

- **Estuarine Dependent Species—Understanding impacts of climatic and environmental changes on fisheries.**

Environmental changes such as salinity and temperature in estuaries have the potential to threaten important estuarine-based fisheries. Recent observed declines in relative abundance

See CESUs page 33

Marine Protected Areas and NAMPAN

By Jason Frohnmayer (NOAA)

On February 25, 2020, 137 Marine Protected Area (MPA) managers and practitioners across the country discussed challenges and how partnerships like the North American Marine Protected Area Network (NAMPAN) might collaborate and share information.

Participants from NOAA's National Marine Sanctuaries, the National Estuarine Research Reserve System, the DOI's NPS, and the USFWS joined State and Indigenous community representatives connected virtually in 13 local hubs across the continental United States, Hawaii, and the Caribbean. They discussed the challenges and opportunities within their individual MPAs and how a network like NAMPAN might assist them.

The meeting was organized by NOAA's MPA's Center and supported by the UN Environment Programme and MIT SOLVE. Common challenges experienced across the MPAs include addressing climate change, connectivity among sites, jurisdictional challenges, the need to educate the public and other stakeholders through a unified message, and monitoring and evaluating visitor impacts.

The meeting yielded several ideas for future collaboration on MPAs. The resulting reports of this and other related events will help inform the U.S. preparation for the UN Decade of Ocean Research beginning in 2021.

For more information on NAMPAN, contact: Lauren.Wenzel@noaa.gov



MPA practitioners and managers gather in Annapolis, one of 13 meeting hubs. Photo credit: Lauren Wenzel, NOAA



Map of the Beaufort Sea and study area. Image credit: BOEM

CESUs continued from page 32

of important fishery species along with large-scale environmental changes, emphasize the need for expanded assessment of the cumulative effects on fisheries. Potential climatic variability and harvest impacts can possibly affect the sustainability of estuarine-based fisheries and associated populations.

The Pontchartrain Institute of Environmental Sciences at the University of New Orleans, working with BOEM and the Gulf Coast CESU, identified the need to accurately monitor the response of these coastal communities to environmental changes. The “Abundance and Distribution of Commercially Important Estuarine Dependent Species Populations within the Gulf of Mexico” project is measuring how estuarine organisms react to disturbances, ensuring that data collection is able to overcome significant sources of ecological data “noise” and that these analyses encompass large temporal and spatial scales to improve our understanding of potential impacts.

- **Arctic Marine Conditions—Modeling water masses Arctic-wide**

In the central Beaufort Sea, north of Alaska in the Arctic Ocean, scientists at BOEM worked with colleagues at the University of Alaska Fairbanks (UAF) and University of Alaska Anchorage,

through the Alaska CESU, and the USGS to measure and model marine conditions. The group collected water column hydrographic information (conductivity, temperature, and pressure) during their cruises to provide sound speed corrections for multibeam sonar data and information on the origin and characteristics of the water masses in the study area. Multibeam sonar data (seafloor depth and backscatter strength) gathered within and outside of Foggy Island Bay will be used to create a digital elevation model for the ocean and wave hydrodynamics modeling part of the study. It will also track changes in seafloor topography between survey years to estimate sediment fluxes. Data from a meteorological station, acoustic Doppler current profiler, and seafloor grab samples will be used to determine sediment-size distributions and transport. The comprehensive model will help characterize water masses and coastal and marine characteristics.

Thank you to Pasquale Roscigno, Arie Kaller, and Heather Crowley at BOEM and John Tirpak at USFWS for sharing information about the work that they and their partners do through the CESUs.

Learn more: <http://www.cesu.psu.edu/>

Baselines for Biodiversity

A Biological Frontier along Remote Alaskan Shores

By Benjamin Pister (BOEM), Cathy Coon (BOEM), Heather Coletti (NPS), Katlyn Haven (NPS), Katrin Iken (UAF), Tahzay Jones (NPS), Brenda Konar (UAF), Mandy Lindeberg (NOAA), Joel Reynolds (NPS), Sue Saupe, and Sarah Venator (NPS)

Cook Inlet, a 180-mile stretch of coastal landscape in south-central Alaska extending from the Gulf of Alaska to Anchorage, is a microcosm of everything that makes Alaska, Alaska. A handful of small coastal towns, relatively few and far apart on the eastern shore, make their living from the ocean. Huge tides and substantial glacial runoff make dangerous currents and murky waters. Oil and gas platforms, in state waters, in the upper Inlet extract energy from the Earth. Mountains, glaciers, volcanoes, and a plethora of wildlife get in the face of anyone with enough moxie to access them with a boat or a plane as there are not many roads here. Large swaths of the area are still quite unknown and mysterious, at least by western science standards.

The Cook Inlet region lies within the national energy and mineral resources program through which BOEM manages environmentally and economically responsible development of U.S. OCS under DOI's authority. Under the National Environmental Policy Act (NEPA), environmental analyses of physical and biological

characteristics of the ecosystem affected by these activities are a requirement. To support them, BOEM teamed up with researchers from the NPS, NOAA, UAF, and the Cook Inlet Regional Citizen's Advisory Committee (CIRCAC) to gather baseline information on the intertidal and shallow subtidal rocky marine habitats in some of the most remote corners of Cook Inlet.

Starting in early summer from 2015 to 2018, the multiagency team gathered ecological data along rocky coastlines on the west coast of lower Cook Inlet, an underdescribed region stretching roughly 85 miles between Lake Clark National Park and Preserve in the north to Katmai National Park and Preserve in the south. The combinations of physical conditions such as extremely broad flat rock benches, large tides with strong currents, heavy sediment loads, and scouring sea ice in the winter support a marine ecological community quite different from coastlines elsewhere, even within the Gulf of Alaska. Although the specific species observed could all be found in other places, the morphologies

displayed by the algae, and the overall assemblages of species, were unique and not well described. Mandy Lindeberg, a NOAA intertidal ecologist on the team, described a particularly unusual section of coast as "like going to Mars. The rules and patterns we're used to observing in the rocky intertidal in most places don't seem to apply here."

The results of the effort will fill a substantial information need in our collective ecological knowledge of Cook Inlet, which supports tourism, fishing, and subsistence, as well as oil and gas activities. In addition to regulatory requirements under NEPA for best-available information, the data gathered will form the basis for future monitoring efforts, research projects, restoration planning, and greater understanding of the ecological processes and biological diversity in the Cook Inlet.

Read the final report: <https://irma.nps.gov/DataStore/Reference/Profile/2272505>

Watch the biologists in action in a video of the project made by the team: <https://www.youtube.com/watch?v=cl-W5mDviM4&feature=youtu.be>



Sue Saupe (CIRCAC) and Danielle Siegert, a graduate researcher from UAF, work together counting organisms in a tidepool on an unnamed island in western Cook Inlet. The mountains in the background are part of Katmai National Park and Preserve. Photo credit left: Jim Pfeifferberger, NPS. Photo credit right: Mandy Lindeberg, NOAA

Cold Water Corals? Yes!

By USFWS

For most, the word “coral” conjures up sunshine, sandy beaches, and warm, shallow waters in tropical places.

But the natural world is always full of surprises, and corals are alive and thriving in the stark, cold waters of Alaska’s Aleutian Islands, where the North Pacific Ocean meets the Bering Sea.

The Aleutian Islands are protruding peaks of a submerged volcanic mountain range that runs east-west across the northern latitudes, stretching more than 1,000 miles from the tip of the Alaska Peninsula nearly to Siberia. Many of the island-volcanoes are active today. Dense fog, intense winds, and heavy precipitation dominate the weather.

The Alaska Maritime NWR, which includes most of the Aleutian Islands and the exceptionally productive waters that surround them, are overseen by the USFWS. The treeless islands are probably best known for the tens of millions of nesting seabirds, some found nowhere else in the world, and marine mammals such as whales, sea otters, seals, and endangered Steller’s sea lions (*Eumetopias jubatus*). However, below the water’s surface, is a colorful, textural, lush ecosystem teeming with some of the most diverse, abundant, and pristine communities of deep-sea corals in the world.

These corals thrive in extremely cold waters, with little to no light, in a highly unpredictable, volcanically active ecosystem prone to frequent and intense storms. Like their warm-water counterparts, deep-sea corals are colonies of small animals that build, and live in, a common skeleton. And, like warm-water corals, they can live for hundreds, even thousands of years, growing and reproducing extremely slowly.

Unlike warm-water corals, deep-sea corals don’t require sunlight, they pull their food directly from the nutrient-rich water column.

Since the early 1900s, we have known about the Aleutian Island corals, but in 2002 scientists started to investigate these remote coral communities through submersible explorations and examining fisheries bycatch. Scientists have confirmed the presence of at least 100 different kinds of corals in the Aleutian Islands. Some of them are living at depths of nearly 3,000 meters, and many are endemic to the region.

Research indicates that the corals are also integral to the health and functioning of the entire Aleutian marine environment—an ecosystem renowned for its rich biodiversity and home to one of North America’s most productive fisheries. While they are a beautiful example of ecological adaptation they are also susceptible to human impact.

Deep-sea corals can easily be damaged by fishing gear, and living within a major maritime shipping route leaves them vulnerable to oil spills and other activities. Additionally, as global climate change alters ocean ecosystems worldwide, deep-sea corals are likely to be impacted. Because these deep-sea corals are slow-growing, long-lived, and particularly sensitive to disturbance, these impacts could be especially detrimental to Aleutian Island coral habitats and the overall ecosystem.

There’s still a lot to learn about deep-sea corals and their role in ocean ecosystems. In the face of rapid ocean changes, (increasing ocean temperature and acidification, and shifting food web dynamics), through monitoring these corals, scientists can document how these changes affect deep-sea coral communities. This may prove particularly important for understanding and

predicting future large-scale changes in the ecology of the area.

Learn more: <https://spo.nmfs.noaa.gov/sites/default/files/pp16.pdf>

Alaska Maritime NWR: https://www.fws.gov/refuge/alaska_maritime/

NOAA Deep-Sea Coral Data Portal: <https://deepseacoraldata.noaa.gov/>

Read more: <https://www.scientificamerican.com/article/seabird-poop-speeds-up-coral-growth/>

The Alaska Maritime NWR provides a unique opportunity for scientists to observe and study relatively healthy and intact deep-sea coral communities.



Bubblegum corals at a depth of 179 meters near Tanaga Island in the central Aleutian Islands. Photo credit: Bob Stone, NOAA



Coral and sponge habitat at 150-meter depth near Adak Island in the central Aleutian Islands. Photo credit: Bob Stone, NOAA



Explore USGS Coastal and Marine Science Online

- **The Decadal Strategic Plan (DSP):** <https://wim.usgs.gov/geonarrative/cmhrp/>
- **DSP Overview:** https://www.usgs.gov/natural-hazards/coastal-marine-hazards-and-resources/science/cmhrp-decadal-strategic-plan-2020-2030?qt-science_center_objects=0#qt-science_center_objects
- **USGS Coastal and Marine Hazards and Resources Program:** <https://www.usgs.gov/natural-hazards/coastal-marine-hazards-and-resources>

The DSP supports the vision for “a Nation prepared for coastal and ocean changes.”

The Surfing Bison

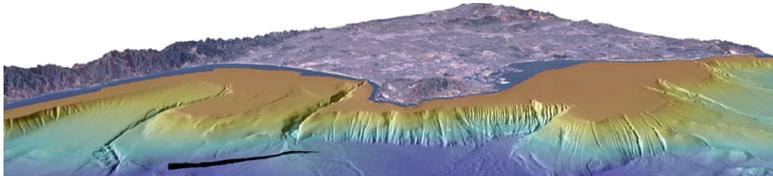


By John Haines, Carolyn Ruppel, and Ann Tihansky (USGS)

The USGS Coastal and Marine Hazards and Resources Program conducts a wide variety of research in coastal and marine environments with the goal of conducting research and developing science-based tools that lead to safer, more productive coastal communities and improved stewardship of natural resources.

The new interactive strategic plan is available online—and is an opportunity to explore the breadth of the USGS science related to coastal and ocean resources, geology, and related hazards.

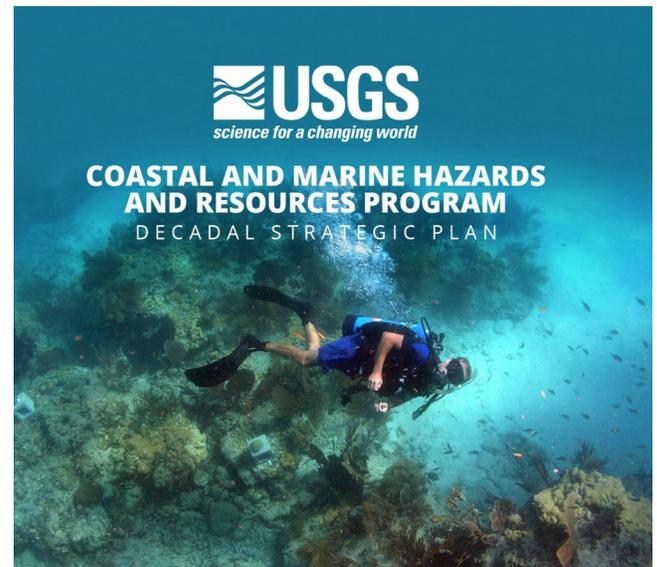
Explore a range of research projects and capabilities covering topics as diverse as coastal zone hazards, earthquakes, and tsunamis, U.S. Extended Continental Shelf mapping, estuarine ecosystems recovery, seafloor minerals, coral reefs, Arctic environmental change, coastal groundwater systems, gas hydrates, seafloor mapping, marine seismic imaging, and light detection and ranging. You can explore the science by location or topic. Dive in!



USGS bathymetric map showing continental shelf offshore from southern California. Image credit: USGS



R/V *Alaskan Gyre* conducting scientific surveys in Harriman Fjord, AK, in 2012. Photo credit: Sarah Schoen, USGS



The DSP describes the vision, goals, and framework for USGS activities and scientific research providing high-quality, timely, and impartial scientific information needed to inform stakeholders about public safety, resource management, and advancing technology and data management. Explore examples of work designed to address hazard preparedness, response, and natural-resource management. Photo credit: Ilsa Kuffner, USGS



Mineral-laden water emerging from a hydrothermal vent on the Niuia underwater volcano in the Lau Basin, southwestern Pacific Ocean. As the water cools, minerals precipitate to form tower-like “chimneys.” The photograph was captured during the 2016 “Virtual Vents” cruise. The USGS was a collaborator on this expedition. Image credit: Schmidt Ocean Institute