BOEM OCEAN SCIENCE

THE SCIENCE & TECHNOLOGY JOURNAL OF THE BUREAU OF OCEAN ENERGY MANAGEMENT

VOLUME 12 ISSUE 2 • JULY/AUGUST/SEPTEMBER 2015

BOEM Scientists in the Field

Science Collaboration and Study Involvement on the Outer Continental Shelf

Putting Scientists in the Water: Scientific Diving and BOEM's Environmental Studies Program

Partnerships at Work in the Pacific Region

Atlantic Region: Embracing Technology, Preserving History

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BOEM's Gulf of Mexico Region Evaluates Effects of the *Deepwater Horizon* Oil Spill

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BOEM OCEAN SCIENCE is published quarterly by the Bureau of Ocean Energy Management to communicate recent ocean science, technological information, and issues of interest related to offshore energy recovery, marine minerals, and ocean stewardship.

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ON THE COVER
BOEM Biological Oceanographer Susan Zaleski, who leads BOEM's study of *Watersipora*, dives among the kelp forest at Anacapa Island to document the invertebrate communities. *Photo by Brandon Doheny, University of California, Santa Barbara.*

All photos courtesy of the Bureau of Ocean Energy Management unless otherwise noted.

Publication services provided by Schatz Publishing Group.

Frequently Used Abbreviations

DOI	Department of the Interior
DWH	*Deepwater Horizon* (2010 oil spill)
EMF	electromagnetic field
ESP	Environmental Studies Program
GOM	Gulf of Mexico
MMS	Minerals Management Service
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
ROV	Remotely Operated Vehicle
UAF	University of Alaska Fairbanks
UCSB	University of California, Santa Barbara

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Check out the Bureau of Ocean Energy Management website at **www.boem.gov**.

The Director's Message

I often say that among BOEM's greatest assets is the quality of our research that comes from the many scientific disciplines represented in the bureau. Working with outside partners, our scientists complete an average of 45 to 50 studies per year. These studies are an important part of BOEM's business—we invest about $35 million annually in this valuable applied research. In this issue of *BOEM Ocean Science* you will see the results of our scientific field work—where the action is.

It is important to know that BOEM is so much more than a funding agency for ocean science. Our scientists take tremendous pride in what they do, pursuing their chosen fields with a passion. Whether it is physical oceanography, atmospheric studies, biology, protected species, social sciences, cultural resources, or environmental fates and effects, BOEM scientists take a hands-on approach. They conduct essential research that informs decisions about our nation's OCS energy and marine resources, and expand the body of scientific knowledge about our nation's human, marine, and coastal environments.

Collaboration is the key. Rather than simply monitor contractor performance on individual studies, our scientists take every opportunity to get out of the office and live and breathe ocean science. Participating in these studies, actually "doing science," they stay current on new and evolving methods for data collection, as well as contribute to innovative research in new and exciting subjects. Under the knowing eyes of our seasoned experts, these studies offer our newer BOEM scientists the experience they need to truly gain a thorough understanding of their chosen field. As active participants in ongoing research, all of our BOEM scientists have endless opportunities to increase their knowledge of their disciplines.

In this issue we see our scientists at work, with several articles that highlight our regions, including examples of significant BOEM participation in fieldwork and data analysis. One article focuses on BOEM's Scientific Diving Team, whose underwater missions contribute to various field studies all around the OCS. There are two articles that discuss interagency agreements and cooperative agreements in both the Alaska and Pacific Regions, detailing BOEM's partnerships in ocean studies. Another article examines the effects of the *Deepwater Horizon* oil spill on the Gulf of Mexico Region's manatees, as well as historical and archaeological sites.

BOEM is proud to offer you this sampling of some of our bureau's best work in scientific research. Please enjoy this issue of *Ocean Science*.

– Abigail Ross Hopper, Director

For More Information

BOEM's Environmental Studies Program
http://www.boem.gov/Studies/

A colony of the encrusting bryozoan *Watersipora subtorquata*, growing on an oil platform in the Santa Barbara Channel. The non-native species typically has red to maroon frilly lobes and can form cauliflower-shaped masses more than 1 foot (30 centimeters) in diameter. *Photo by Brandon Doheny, University of California, Santa Barbara.*

Science Collaboration and Study Involvement on the Outer Continental Shelf

Researchers measuring the intertidal in Lower Cook Inlet, Kamishak Bay, Alaska. *Photo by Mandy Lindeberg, NOAA.*

For more than 40 years, BOEM's Environmental Studies Program (ESP) has funded and conducted research on the environmental impacts of energy development and mineral resource extraction on the U.S. Outer Continental Shelf (OCS). However, BOEM, unlike other Federal agencies such as the National Science Foundation, does not have the authority to issue grants for this research. Instead, BOEM primarily utilizes cooperative agreements and interagency agreements, which rely on partnerships and collaboration among multiple scientists and organizations. Science conducted in the ocean is not easy, and from its very beginning the ESP has recognized the importance of partnerships and opportunities to cost-share. These relationships have proven to be invaluable for accomplishing productive science to acquire the environmental information needed for decision making. This is especially true when the information acquired by a study fulfills the information needs of other parties besides BOEM.

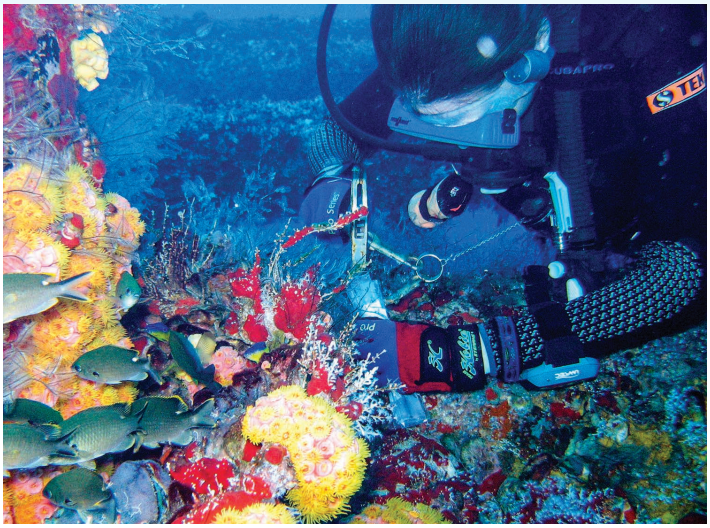
By its very nature, scientific investigations in the marine environment are inherently difficult. It is a hostile place to work, with high seas/winds, strong currents, great depths, and sea ice as just a few of the challenges that scientists might face. These challenges are compounded by the sheer size and location of the OCS; 1.7 billion acres located mostly between 3 and 200 miles (5 and 322 kilometers) offshore. Data collection and research on the OCS can often only be conducted directly—by using large research vessels, or remotely—by using technology such as satellites or airplanes in the air, or remotely operated vehicles (ROVs) in the water. The instruments and vehicles capable of conducting oceanographic research at significant water depths are also comparatively limited, and they require a significant expense and specialized personnel to operate.

The capacity to do science on the OCS is not only limited by physical resources but by scientific expertise. The scientific questions that the BOEM ESP addresses are often multidisciplinary in nature, which provides opportunities for sharing equipment and financial resources. BOEM maintains core expertise in numerous scientific disciplines including chemical and physical oceanography, biology, socio-economics, and archaeology. BOEM scientists actively engage in science by developing study ideas, overseeing applied research projects, and even conducting fieldwork and analyzing data as partners in our studies. There is a definitive correlation between collaboration and both research productivity and financial support (Subramanyam 1983), and the ESP relies on collaboration to ensure productive science that leverages financial resources whenever possible.

The primary mechanisms by which the ESP partners with other research institutions or Federal agencies are through cooperative agreements and inter/intra-agency agreements. These procurement instruments account for approximately two-thirds of the current ESP study budget. There are significant differences between these instruments, but each of them allows, and in some cases requires, the involvement of BOEM scientists.

Cooperative agreements are formed between a Federal and non-Federal party. Through the Outer Continental Shelf Lands Act, BOEM has the Congressional authority to establish cooperative agreements with State-owned institutions located in those coastal States that may be affected by BOEM's mission and decision making. When conducting a scientific study through a cooperative agreement, the primary objective is to "transfer money, property, services, or other things of value" to accomplish a public purpose (OIG 2007:1). Therefore, in order to enter into a cooperative agreement with BOEM, the research must be of benefit to the non-Federal party as well

BOEM Marine Biologist Desray Reeb (left) and NOAA researchers inspect the hydrophone array on board NOAA's R/V *Henry B. Bigelow* during an AMAPPS survey. *Photo by Suzanne Yin, NOAA NMFS.*



Sampling corals from a Gulf of Mexico oil and gas platform. *Photo by Greg Boland, BOEM.*

BOEM scientists actively engage in science by developing study ideas, overseeing applied research projects, and even conducting fieldwork and analyzing data as partners in our studies.

as to the bureau. Not all BOEM studies meet these criteria, so a cooperative agreement is not the appropriate procurement mechanism in these cases. If the information provided by a study is strictly to fulfill BOEM's need, then a contract is awarded to a vendor and BOEM is often the sole funding source. Another benefit of cooperative agreements is that they require substantial involvement from the cooperating Federal agency (OIG 2007). As you will see in this issue of *BOEM Ocean Science*, this involvement may take the form of BOEM scientists guiding project direction, participating in field work, and assisting with the interpretation and publication of data.

Inter-agency agreements are formed between one or more Federal agencies. If an agreement is written solely between or among Department of the Interior (DOI) agencies, it is referred to as an intra-agency agreement (DOI 2008). There are numerous statutory authorities that allow these types of agreements, and they recognize the advantages of government agencies working together. Examples of statutory authorities that BOEM uses to enter into agreements with other Federal partners include the Fish and Wildlife Coordination Act, which allows government agencies to form agreements with each other to assist in the protection of ecological habitats, and the Clean Air Act of 1972 and 1990, to assure protection of public health and welfare.

To be certain, though, not only are collaborative studies beneficial to the Bureau due to cost-sharing and pooling available resources; these studies allow BOEM's scientists to actively participate and stay current with the latest methodological and technological developments in their respective fields.

– By Michael Rasser, BOEM

BOEM Sociocultural Specialist Chris Campbell (front row, second from left) at the Traditional and Local Knowledge Workshop in Ottawa. *Photo by the Sustainable Development Working Group, Arctic Council.*

For More Information

Subramanyam, K. 1983. Bibliometric studies of research collaboration: A review. *Journal of Information Science* vol. 6:33-38.
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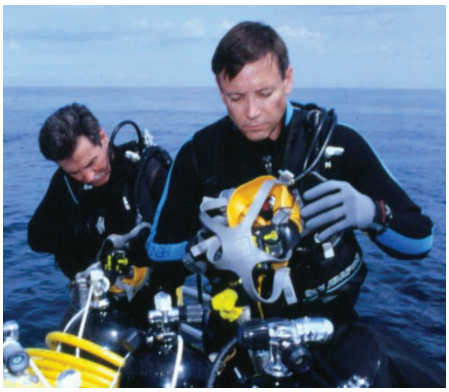
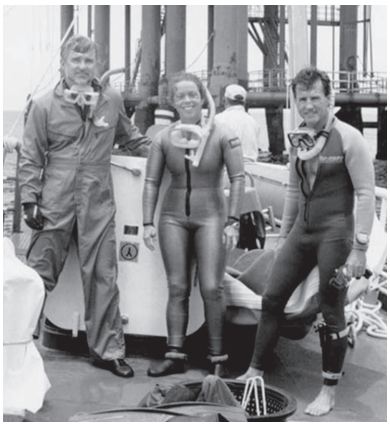
https://www.doioig.gov/reports/proper-use-cooperative-agreements-could-improve-interiors-initiatives-collaborative

DOI. 2008. Inter/Intra-Agency Aquisition (IAA) Handbook.
https://www.doi.gov/pfm/handbooks/upload/iaa.pdf

Putting Scientists in the Water: Scientific Diving and BOEM's Environmental Studies Program





For a Federal regulatory agency that funds and conducts world-class science primarily within the marine environment, it only makes sense that BOEM retains a team of highly trained scientists that serve as the eyes and ears of the bureau on the seafloor. BOEM's Scientific Diving Team traces its origin to the 1970s in the Bureau of Land Management's New Orleans Outer Continental Shelf (OCS) Office in the years after passage of the National Environmental Policy Act (NEPA) in 1969. Understanding and protecting sensitive natural and cultural resources from OCS oil and gas activities became focal points of the OCS Program during this period as they continue to be today. The New Orleans OCS Office and its dive team later became part of the Minerals Management Service (MMS).

Formerly known as the "MMS Seafloor Monitoring Team," the current team officially began with a pilot project in 1997 to assess industry compliance with the mitigative measures that MMS assigned as conditions of approval for permitted activities. Mitigative measures typically consist of avoidance of confirmed or potential biological or archaeological features on the seafloor to ensure they are not negatively impacted by oil and gas-related activities on the OCS. Nearly 15 years later, the Seafloor Monitoring Team—then under the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE)—was split in 2011 with the reorganization of BOEMRE into BOEM and the Bureau of Safety and Environmental Enforcement (BSEE). BOEM's dive team is now referred to as the Scientific Diving Team to more broadly describe its role in support of applied science conducted for BOEM's Environmental Studies Program while BSEE's dive team focuses on environmental compliance monitoring. BOEM and BSEE science divers often work together on dive-related projects that collect scientific information or support resource management and long-term monitoring efforts.

Currently consisting of 11 divers from the Pacific and Gulf of Mexico OCS Regions, Headquarters, and Office of Renewable Energy Programs, BOEM's Scientific Diving Team is typically composed of marine archaeologists, biologists, geologists, and environmental scientists. While participation on the Diving Team is strictly voluntary, divers must acquire and maintain a wide variety of diving certifications and demonstrate experience diving in a variety of conditions.

Science divers are highly trained and complete the following certifications from professional diving organizations before they join the BOEM Scientific Diving Team: Basic/Advanced Open Water, Rescue Diving, and Enriched Air Nitrox. Additional dive certifications are encouraged and may include: Diving Risk Management, Drysuit, Cavern or Overhead Environment, Tri-mix/Mixed-Gas Diving, or Surface-Supplied Diving, among other specialties. In addition, BOEM divers

typically acquire advanced leadership training and certification as Dive Masters or even Dive Instructors.

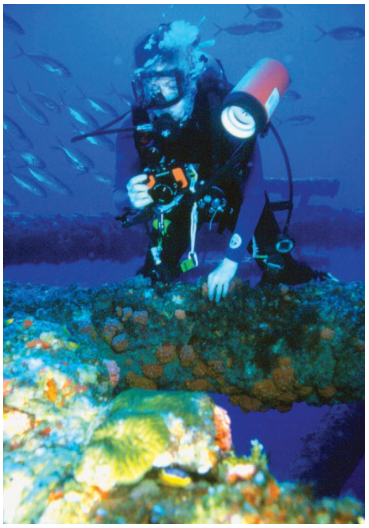
So what do BOEM Science Divers actually do? Since the Scientific Diving Team's inception, our divers have participated in a variety of projects ranging from archaeological investigations to biological surveys. BOEM divers often participate in data collection for our environmental studies, primarily those that partner with other Federal agencies such as the National Oceanic and Atmospheric Administration (NOAA), or universities such as the University of California, Santa Barbara.

For example, our science divers have participated in long-term monitoring efforts in the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico for decades. They have worked alongside NOAA divers to collect coral samples, photograph corals, and conduct surveys of resident biota. BOEM divers have also investigated and mapped historic shipwrecks in the Gulf and Atlantic regions, and mapped exposed paleo-landforms that might contain preserved prehistoric archaeological remains. Other studies have conducted diver visual surveys and sampling of corals and other biota residing on oil and gas platforms in the Gulf and Pacific OCS Regions. One study in the Pacific Region uses divers to assess non-native species on oil and gas platforms. Several of these studies are described in later articles in this issue.

In addition to diving operations, our Scientific Diving Team has a suite of remote sensing instruments at its disposal for conducting various types of surveys offshore. For example, BOEM archaeologists might employ a marine magnetometer, side scan sonar, and/or sub-bottom profiler to conduct a cultural resources survey for potential or reported archaeological sites. BOEM biologists might use the sector-scanning sonar or a small Remotely Operated Vehicle (ROV) to conduct a biological survey at a coral reef, hard-bottom habitat, or oil and gas platform. Underwater photo and video cameras allow BOEM divers to not only record important scientific information, but to collect high-quality imagery that can be used for public outreach and education through BOEM's website and publications.

Our Scientific Diving Team is one small part of a cadre of BOEM scientists committed to conducting topnotch science for the bureau!

– By Melanie Damour, Dave Ball, Joseph Christopher, and Donna Schroeder, BOEM



Photos, page 6, top left to right: BOEM dive team, 2015; Les Dauterive and Terry Dempre, GOM, 2005; Les Dauterive; Joe Christopher, Ann Bull, and Les Dauterive, GOM, 1990s; Suzanne Moore, 2000; Terry Dempre, Dave Ball, and Chris Horrell, GOM, 2005. Page 7, top left to right: Donna Schroeder and Susan Zaleski, California, 2015; Susan Childs, photographing platform community, GOM, 2001; Jesse Hunt, 1980s; Jim Kendall, Rik Anuskiewicz, Ann Bull, Les Dauterive, Gail Rainey, and Joe Christopher, California, 1991; Dave Ball maps U-*701. Photo by Steve Sellers, Battle of the Atlantic Project, 2008;* Mike Burdette and Rick Defenbaugh, 1980s. *All photos by MMS/BOEM unless otherwise indicated.*

Partnerships at Work in the Pacific Region

Scientific partnerships with other organizations provide BOEM with high-quality and timely scientific information to help BOEM meet its mission goals. A number of such partnerships are underway in the Pacific Region.

Electromagnetic Field Effects

It is important for BOEM to understand the potential effects of underwater power transmission cables on marine species, as this affects National Environmental Policy Act (NEPA) consideration of future offshore renewable energy projects. Offshore renewable energy installations convert wave or wind energy to electricity and transfer the generated power to shore through transmission cables laid on the seafloor. The movement of electrons through a cable produces a surrounding electromagnetic field (EMF).

West Coast fishermen who harvest the highly prized dungeness crab (*Metacarcinus magister*) and the rock crab (*Cancer spp.*) have expressed concern about the potential effect of EMF on crab behavior. To find out, BOEM established a cooperative agreement with the University of California, Santa Barbara (UCSB) to study the impacts—if any—of seafloor power cables on the fisheries of these valuable crab species. Relying on fishermen and using existing transmission cables that electrify oil platforms, BOEM and UCSB researchers want to see, in real ocean circumstances, if crabs will cross cables to reach baited traps. The experimental method uses scuba divers to deploy a confined cage system and two baited commercial traps. Crabs can enter either of the baited traps. For one, they simply walk across the sand; for the other, they have to walk over a cable that is emitting EMF. So far, researchers have examined the behavior of more than 400 rock crabs during the 2014–2015 harvest season in the Santa Barbara Channel.

Through another cooperative agreement with UCSB, researchers examined whether power cable EMFs in crucial habitat areas affect the most common species of Pacific rockfish, electrosensitive species such as the thresher shark (*Alopias macrourus*), angel shark (*Squatina squatina*), longnose skate (*Raja rhina*), and large invertebrates such as sea stars and anemones. The study used two existing power cables in a seafloor corridor within the Santa Ynez Unit in the Santa Barbara Channel; one cable was energized while the other was not (disconnected from the grid). Researchers conducted multiple cable surveys and EMF measurements, and compared species at both cables. They surveyed fish and large invertebrates by scuba diving in shallow water and used the *Dual DeepWorker* submersible, with a BOEM scientist onboard, to survey in deeper water along the cables. This allowed researchers to see whether EMFs would attract (or repulse) any of these species and to determine the effectiveness of burying the cable, a commonly proposed mitigation. Interestingly, there was no difference in the number or type of fish or invertebrate species at either cable, indicating a lack of response to EMF.

Watersipora subtorquata growing in an assemblage of anemones and barnacles on an oil platform in the Santa Barbara Channel. *Photo by Brandon Doheny, University of California, Santa Barbara.*

Connectivity of California Reefs and Manmade Structures

Also off the coast of California, BOEM is researching the biological connectivity of natural reefs and manmade structures to understand how offshore oil and gas platforms contribute to mainland and island marine invertebrate communities. This overall research includes examining a non-native invertebrate that is now found on some oil and gas platforms.

Watersipora subtorquata, a non-native bryozoan from Asia, was first documented in southern California in 1963 on a manmade island in state waters. Now the bryozoan is present in bays and harbors along the West Coast from southern California to Oregon. Typically, species present in coastal embayments are rarely found on the open coast; however, in 2001, researchers found *Watersipora* on one of the offshore oil and gas platforms in the Santa Barbara Channel. Based on this finding, BOEM set out to determine the geographic distribution, abundance, and life history of this non-native species with the goal of developing simple mitigation measures to prevent establishment of *Watersipora* in uncolonized habitats.

BOEM and UCSB scientists are working together using scuba divers to photograph invertebrate communities at depths of 20–60 feet (6–18 meters) and retrieve settlement plates from platforms, natural reefs, and harbors to determine reproductive seasonality of native and non-native species. Results from field research are then input into a 3D Regional Ocean Modeling System (ROMS) and particle tracking model to determine biological oceanographic connectivity of the offshore oil and gas platforms with harbors and mainland

BOEM Biological Oceanographer Susan Zaleski completes a transect survey for *Watersipora* and other invertebrates in the kelp forest at Anacapa Island. *Photo by Brandon Doheny, University of California, Santa Barbara.*

BOEM Marine Biologist Ann Bull prepares for a deepwater dive in the *Dual DeepWorker* submersible to study fish and their behavior around a seafloor power transmission cable in the Santa Barbara Channel. *Photo by Donna Schroeder, BOEM.*

Experimental equipment used to test whether crabs will cross a seafloor power transmission cable to reach a baited trap. The apparatus, which includes a crab introduction chamber (lower left) and a baited trap (upper right), sits directly on top of the cable. Yellow rope guides divers to/from each apparatus in poor-visibility conditions. *Photo by Brandon Doheny, University of California, Santa Barbara.*

and island reefs. The modeling effort enables BOEM to determine pathways for larval dispersal and settlement in different seasons, in turn, shedding light on the role that offshore artificial structures may have in linking and affecting biological communities.

Oregon Seafloor Mapping

With the proposal of a wind energy demonstration project in federal waters off Coos Bay, Oregon, BOEM will conduct environmental evaluations of the potential lease area, including how the installation and operation of a renewable energy device might impact the seafloor and associated resources (e.g., archaeological sites). Because knowledge of the depth (bathymetry), shape (topography), and physical conditions of the seafloor is critical to understanding potential impacts, BOEM has partnered with the U.S. Geological Survey (USGS) to conduct detailed bathymetric mapping.

In 2014, USGS collected high-resolution, multibeam bathymetric data across a 250-square-mile (647-square-kilometer) area offshore Coos Bay, in water depths of 1,000–1,800 feet (305–549 meters). Swath sonar and backscatter intensity data were also collected, along with high-definition video and still photography. The data are being processed and converted into detailed bathymetric maps and other images that will provide insight about the physical conditions of the seafloor.

Six BOEM scientists participated in the field work by helping to characterize seafloor conditions, inventory mammals, and observe invertebrates during sled dives. Among the interesting activities that took place above water, BOEM's avian biologist sighted and photographed a Blackburnian Warbler (*Setophaga fusca*), a rare species on the West Coast. BOEM scientists also recorded birds' behavior, flight direction and height, and distance from the boat, and sighted several other uncommon or rare species.

– By Ann Bull, Susan Zaleski, and Cathie Dunkel, BOEM; and Rita Hess, Schatz Publishing

For More Information

Potential Impacts of Submarine Power Cables on Crab Harvest
www.boem.gov/pc-14-02

Renewable Energy *in situ* Power Cable Observation
www.boem.gov/pc-11-03

Understanding Biological Oceanographic Connectivity of Southern California Reefs and Manmade Structures: Applications to Managing Potential *Watersipora subtorquata* Invasions
www.boem.gov/pc-13-04

Oregon OCS Seafloor Mapping: Selected Lease Blocks Relevant to Renewable Energy
www.boem.gov/pr-13-osm

Atlantic Region: Embracing Technology, Preserving History

Partnerships in the Atlantic Region have given BOEM access to new technology that, in some cases, is changing the way we collect and assess data. In other cases, partners are helping us document America's maritime history and incorporate valuable Native American knowledge of populations potentially affected by wind energy development.

Winds of Change in Massachusetts

BOEM manages exploration and production in approximately 1.7 billion acres of OCS, part of which includes the Massachusetts Wind Energy Area. Before issuing wind energy leases in the 877-square-nautical-mile (3,012-square-kilometer) area, BOEM needed baseline geophysical and archaeological data to inform decision makers and to monitor potential environmental changes. The bureau also wanted to determine if newer technology was effective for identifying submerged prehistoric archaeological sites, and whether such surveys would affect acoustically sensitive marine mammals.

Through cooperative and interagency agreements, the *Collaborative Archaeological Investigations and Sound Source Verifications within the Massachusetts Wind Energy Area* study leveraged the resources of partners like the National Park Service Submerged Resources Center (NPS SRC), U.S. Geological Survey, and the University of Rhode Island as well as cultural resources monitors of the Mashpee Wampanoag Tribe.

The 2012 study resulted in recommended revisions to BOEM's *Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information*. To locate and identify archaeological resources, BOEM relies on surveys that use remote sensing equipment, including a magnetometer. Guidelines provide survey parameters to developers, but BOEM lacked the ability to verify the submitted data. To automate the assessment of magnetometer coverage, the NPS SRC and BOEM personnel developed an ArcGIS script (geographic information system software) as part of the *Marine Magnetic Survey Modeling* study, which archaeologists tested at Biscayne National Park in southern Florida, the site of numerous historic shipwrecks.

The Value of Traditional Knowledge in Environmental Studies

Tribal input greatly benefits other studies, too. Thousands of years ago, Narragansett Indian tribes occupied villages on land that is now off Rhode Island's shore. While few studies in recent decades evaluated the potential presence of submerged ancient Native American archaeological resources on the Atlantic OCS, none of the studies integrated tribal historic preservation concerns or tribal research partners. With increased interest in offshore wind energy developments in the region, BOEM needs appropriate information-gathering protocols to help identify—but not disturb—these sites.

Photo left: BOEM Federal Preservation Officer Brian Jordan (left) points out exposed paleosols to Doug Jones, BOEM Marine Archaeologist (right), on Block Island, RI. *Photo by Melanie Damour, BOEM.*

Photo below: BOEM Marine Biologist, Desray Reeb, was one of the AMAPPS visual observers on board the NOAA ship, *Henry B. Bigelow. Photo by Suzanne Yin, NOAA NMFS.*

Thus, in partnership with the University of Rhode Island and the Narragansett Indian Tribe, BOEM personnel went to work collecting data, mapping submerged paleolandforms, and screening for artifacts in a study called *Developing Protocols for Reconstructing Submerged Paleocultural Landscapes and Identifying Ancient Native American Archaeological Sites in Submerged Environments*.

The project involves working directly with tribes while developing needed best-practice protocols to incorporate tribal knowledge into the current archaeological and geological research, and training tribal representatives in surveying, sampling, analyzing, and interpreting collected data. In the first phases of the study, participants collected samples of submerged sediments, which were analyzed for signs of human activity (e.g., plant seeds, flakes from stone tool manufacturing). When combined with tribal knowledge, the data provides an interesting, more complete understanding of the paleocultural landscape of the region. The final phase of the project will include a report, best-practices protocols, a geo-spatial predictive model framework, and a documentary film about the traditional knowledge used in the study and

the team's attempts to identify ancient submerged Native American sites in the area.

Preserving Our Nation's History

Interagency and cooperative agreements are also ensuring our nation's rich maritime history is preserved. In a five-year agreement with the NOAA's Office of National Marine Sanctuaries (*Battle of the Atlantic Expedition 2010-2015*), BOEM personnel helped document Axis and Allied losses during World War II offshore North Carolina. Hundreds of vessels were lost from 1939 until the war with Germany ended in 1945, and many of them rest on the seafloor as archaeological sites. Well-preserved U.S. and British naval vessels, German U-boats, and U.S. Merchant Marine ships truly reflect the battle that raged above.

Similar to other archaeology studies funded by BOEM, team members investigated known locations and conducted wide-area remote sensing surveys to identify additional targets for investigation; they also mapped and recorded their findings using photo-mosaics, videos, and photos. Results will include a report on fieldwork and historical significance, National Register of Historic Places nominations, and multiple public outreach products.

AMAPPS = Improved Assessments

BOEM is also working with partners such as the U.S. Navy, NOAA Fisheries, and the U.S. Fish and Wildlife Service to enhance our ability to assess seasonal population abundance and spatial distribution of marine mammals, marine turtles, and avian species through the AMAPPS (*Atlantic Marine Assessment Program for Protected Species*) I and AMAPPS II studies. This information impacts siting and environmental permitting of offshore energy projects; in addition, collecting oceanographic and acoustic data assists BOEM's environmental assessments.

The previous Atlantic coastwise abundance surveys in the spring, winter, and fall time periods were funded by MMS in the early 1980s using methods that resulted in negatively biased abundance estimates for many, but not all, species. This lack of recent seasonal assessments limited the ability to predict seasonal distribution for these species. The AMAPPS study addresses these biases and includes species that were previously not assessed.

BOEM and its partners are using direct aerial and shipboard surveys, visual and acoustic survey techniques, tag telemetry studies, and other methods to expand survey timetables and improve survey methods. Thus far, BOEM personnel have assisted with daily watches, digital and manual data collection, photographing and cataloging species, and processing plankton samples, among other tasks. AMAPPS II (2015–2019) will continue multi-season surveys, as well as support a deepwater acoustic array, loggerhead turtle monitoring, and drone use to assist in sea turtle detection and select whale studies. The resulting data will provide detailed information on resources potentially affected across BOEM's programs, including marine minerals operations.

– By Rita Hess, Schatz Publishing

Photo above: NPS and BOEM marine archaeologists examine a shipwreck in Biscayne National Park. *Photo by NPS SRC.*

Photo right: BOEM Marine Archaeologist Willie Hoffman preparing to dive. *Photo by John McCord, University of North Carolina, Coastal Studies Institute.*

For More Information

Collaborative Archaeological Investigations and Sound Source Verifications Within the Massachusetts Wind Energy Area

http://www.boem.gov/Collaborative-Archaeological-Investigations-Sound-Source-Verifications-Final

Marine Magnetic Survey Modeling: Custom Geospatial Processing Tools for Visualizing and Assessing Marine Magnetic Surveys for Archaeological Resources

www.boem.gov/Marine-Magnetic-Survey-Modeling

Final AMAPPS Reports (2010–2014)

www.nefsc.noaa.gov/psb/AMAPPS

AMAPPS II

www.boem.gov/Atlantic-Marine-Assessment-Program-for-Protected-Species-II

Developing Protocols for Reconstructing Submerged Paleocultural Landscapes and Identifying Ancient Native American Archaeological Sites in Submerged Environments

www.boem.gov/Developing-Protocols-for-Reconstructing-Submerged-Paleocultural-Landscapes

Battle of the Atlantic Expedition 2010-2015

www.boem.gov/AT-10-04

Alaska Region Partnerships: Old and New

The vast majority of BOEM research in Alaska is conducted on a collaborative basis with an extensive range of partnerships. Cooperative and interagency agreements allow multiple Federal and State partners to pursue mutual data collection efforts to inform resource management decisions.

Partnerships and Technology

Some of BOEM's cooperative and interagency agreements date back many years. Since 1979, for example, BOEM and its predecessor agencies conducted aerial surveys of the bowhead whales' fall migration to observe changes in distribution and habitat use. They are an important subsistence species potentially affected by offshore energy exploration in the Chukchi and Beaufort seas. Agreements with the NOAA National Marine Mammal Laboratory help this important monitoring effort continue.

Other agreements with NOAA also provide year-round monitoring with acoustic and sensory technologies that help explain the distribution and habitat requirements of endangered or threatened marine mammals, such as the humpback, fin, and bowhead whale. One study, *Use of the Chukchi Sea by Endangered Baleen and Other Whales*, examines currents and resources in the Barrow Arch, which may be changing because of warming surface waters and increasing retreat of summer sea ice. Indeed, recent humpback and fin whale sightings in the Chukchi and Beaufort Seas indicate one or both species' ranges are expanding. In October 2014, BOEM personnel helped recover, service, and redeploy mooring systems that contained acoustic and physical oceanographic equipment for this effort.

Under agreements with the University of Alaska Fairbanks (UAF) School of Fisheries and Ocean Science, and with the Canadian Department of Fisheries and Oceans, BOEM personnel assisted with the collection of fish, benthic invertebrates, genetic samples, and oceanographic data in the Beaufort Sea. Scientists hope to learn more about the Arctic cod's vulnerability to impacts from offshore development and climate change by better understanding their habitat use. OCS Arctic cod fuel many predators in the food chain, but questions remain whether they constitute a single population, and whether their genetics help them adapt to retreating sea ice. The U.S. Geological Survey leads the lab research to find out. Two multi-year studies—*U.S.-Canada Transboundary Fish and Lower Trophic Communities* and *Genomics of Arctic Cod: A Sentinel Species in a Changing Environment*—represent major new international partnerships for BOEM.

A partnership with UAF's Coastal Marine Institute is also using technology to inform BOEM about marine, coastal, and human environments potentially affected by offshore energy exploration and extraction. *Testing the Use of Unmanned Aircraft Systems for Intertidal Surveys* is the first BOEM-funded study to use an unmanned aircraft system (UAS) in Alaska. A UAS delivers high-resolution imagery and provides a cost-effective, efficient approach to low altitude monitoring of intertidal communities compared to traditional methods.

Covering New Ground

Equally exciting is the opportunity to survey new locations, and *Ecological Processes in Lower Cook Inlet and Kachemak Bay: A Partnership in Monitoring* is bringing BOEM scientists together with the National Park Service, NOAA, U.S. Fish and Wildlife Service, and the Cook Inlet Advisory Council to do just that.

BOEM Marine Biologist Cathy Coon transits Kamishak Bay, Alaska. *Photo by Cook Inlet Ecological Processes project team.*

BOEM Oceanographer Carol Fairfield using the Big Eye binoculars. *Photo by NOAA.*

Intertidal sampling on Augustine Volcano, Cook Inlet, Alaska. *Photo by Neil Nickerson, crew, R/V Island C.*

BOEM Physical Oceanographer Heather Crowley aboard USCGC *Healy. Photo by Ken Dunton, University of Texas at Austin.*

A 2016 lease sale is proposed in the Cook Inlet Planning Area, but a NEPA analysis hasn't been done there in over a decade. The nearshore ecosystem provides, among other things, unique habitats for resident organisms and animals important to commercial and subsistence harvests.

GulfWatch Alaska, a multidisciplinary monitoring program, was established for areas affected by the *Exxon Valdez* oil spill, including Lower Cook Inlet. Collaborating with GulfWatch and partner organizations enables BOEM to leverage funds and obtain needed data. BOEM personnel, along with study partners, conducted intertidal and subtidal canopy kelp field assessments in Kamishak Bay in 2015, including detailed transects of unique intertidal habitats found during low tide and scuba diving transects in shallow subtidal areas.

Long-term Monitoring

The Arctic Nearshore Impact Monitoring in the Development Area (ANIMIDA) project, started in 1999, established benchmark data and monitoring for chemical contamination, turbidity, and benthic biota, in the Beaufort Sea OCS. *ANIMIDA III: Contaminants, Sources, and Bioaccumulation*, the third phase of the monitoring project, coincides with continued development and production decisions, as well as potential development. Areas previously sampled are resampled and new stations in the eastern Beaufort Region will provide new benchmarks, including deepwater cores for sediment work and transect lines for the Distributed Biological Observatories (DBOs).

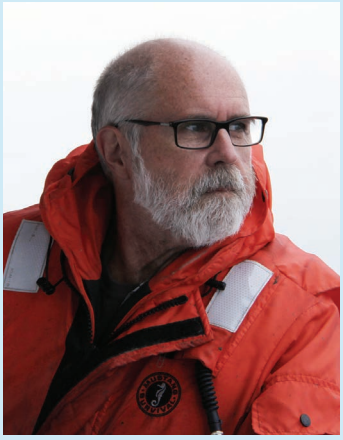
The *Hanna Shoal Ecosystem Study*, and subsequent work in the OCS leasing area of the Chukchi Sea, is a prime example of BOEM's ongoing research involving numerous partners. As the Arctic warms and sea ice retreats, it becomes increasingly important to observe and monitor measures of ocean biodiversity as an indicator of ecosystem health. Toward that end, BOEM launched a five-year partnership project in the Chukchi Sea with UAF, NOAA, and industry. The $6 million *Arctic Marine Biodiversity Observation Network* (AMBON) project builds on prior marine sampling strategies through DBO networks with the intention of extending gridded data collection in taxonomic and spatial coverage on the Chukchi shelf over the leased area. Notably, AMBON will add a significant new molecular component to previous biodiversity observations and will extend ongoing monitoring programs across the Chukchi Sea. The 2015 field season successfully involved 88 Conductivity, Temperature, Depth (CTD) casts, 71 zooplankton nets, 75 bottom trawls, and 30 mid-water trawls. Through multiple partnership arrangements, AMBON will make biodiversity data available to a broad audience of users and stakeholders, from local to pan-Arctic to global.

Currents not only affect species and their feeding patterns, they also affect BOEM's Oil-Spill Risk Analysis. BOEM partnered with UAF in the *Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas* study, which builds on surface circulation data involving long-range, high-frequency radar systems on the Chukchi and Beaufort Seas. Researchers hope additional equipment (e.g., radar at Cape Simpson, gliders, and surface drifters) will lend insight into the dynamics between the inner and outer Chukchi shelf and the upwelling of Atlantic Waters.

– By Alaska regional study team, BOEM; and Merlin Hayes, Schatz Publishing

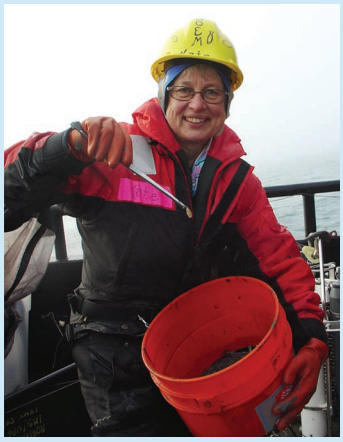
For More Information

Current Environmental Studies in BOEM's Alaska OCS Region
http://www.boem.gov/Alaska-Studies/



BOEM Wildlife Biologist Dan Holiday aboard R/V *Norseman II*. *Photo by ANIMIDA III project team.*

BOEM Wildlife Biologist Rick Raymond monitors an unmanned aerial survey flight. *Photo by Brenda Konar, University of Alaska Fairbanks.*



BOEM Fisheries Oceanographer Kate Wedemeyer aboard R/V *Norseman II*. *Photo by Beaufort Sea Monitoring project team.*

BOEM Physical Oceanographer Warren Horowitz at the Endicott Meteorological Station, North Slope, Alaska. *Photo by Hank Statscewich, University of Alaska Fairbanks.*

BOEM's Gulf of Mexico Region Evaluates Effects of the *Deepwater Horizon* Oil Spill

Scientists assess the health of a manatee. *Photo by Deborah Epperson, BSEE.*

Manatee. *Photo by U.S. Geological Survey (USGS).*

Leila Hamdan (George Mason University) and Melanie Damour (BOEM) in the ROV control room. *Photo by Roshan Patel, Montana State University.*

In the Gulf of Mexico (GOM), just as elsewhere, it is important to not only protect natural and cultural resources but to also understand how those resources could be impacted by BOEM's permitted activities. Our valued partnerships are allowing us to do just that.

Monitoring Endangered Species

BOEM produces information that, among other things, informs compliance with the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). The West Indian manatee, for example, which inhabits areas of the GOM, is an endangered species that receives protections under the ESA through the U.S. Fish and Wildlife Service.

An important three-year study that included northern GOM manatee distribution and use patterns involved an interagency agreement with the U.S. Geological Survey Southeast Ecological Science Center. The *Florida Manatee Movement and Habitat Use in the Northern Gulf of Mexico* study is timely as well, since the habitat characterization efforts include surveying available data—some of which was collected after the 2010 *Deepwater Horizon* (DWH) oil spill.

To learn more about habitats that manatees prefer in the northern GOM, BOEM scientists and other study partners are capturing individual manatees, assessing their health (temperature, respiration, pulse rate), and radio tagging them—generally in less than one hour—before releasing them. They also measure the manatees, determine their sex, and photograph scars for identification. Biological samples help quantify manatee health parameters and nutritional body condition, while the tags allow researchers to track manatee movements and infer use such as foraging, traveling, resting, or drinking fresh water, and predict their use of similar habitat. Photographed manatees are compared to those in a database to identify individuals that have shown previous movements westward during the warmer months of the year.

These data are important for monitoring ecosystem health because many marine mammals act as sentinels for identifying emerging threats to the ocean environment.

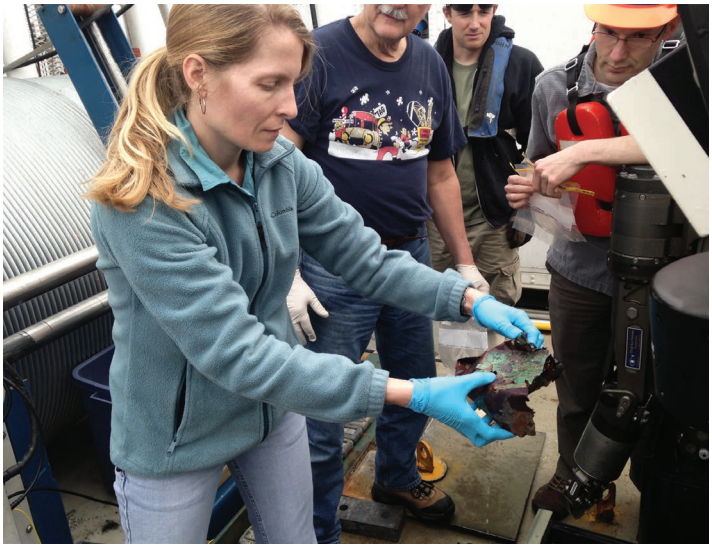
Oil's Effects on Archaeological Sites

Also in the Gulf, BOEM wants to know if the DWH oil spill affected deepwater historic shipwrecks and their biological communities, as well as how potential responses of resident microorganisms affect the long-term preservation of the shipwrecks. Various microorganisms colonize a shipwreck almost immediately after the vessel sinks and form communities on exposed wood and metal. These communities form biofilms which attract larger fauna such as corals, mollusks, crustaceans, fish, etc., thereby creating an artificial reef. If exposure to hydrocarbons—whether due to a spill or natural seeps—or post-spill dispersant harms the biofilm and causes metal or wooden-hulled vessels to degrade faster, the long-term survival of this small ecosystem and availability of suitable hard structure (shipwrecks) for future colonization may be at risk.

As part of the multidisciplinary *Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, and Archaeology Project* (GOM-SCHEMA), a team of Federal, academic, and private sector scientists documented the current condition of each site and deployed experiments to analyze and compare decay within and outside of the spill area. An innovative technology—three-dimensional (3-D) laser and sonar scans of the shipwrecks—allows archaeologists to observe and document macroscale changes at the sites (degradation) while microbial ecological data reveals microscale changes.

BOEM scientists and study partners collected water, sediment, wood, metal, and coral samples from shipwreck

BOEM Protected Species Biologists Jessica Mallindine and Tre Glenn, and BOEM Regional Supervisor Joe Christopher participated in manatee health assessment. *Photo by Deborah Epperson, BSEE.*



BOEM Marine Archaeologist Melanie Damour retrieves a copper sheathing sample collected by ROV during the GOM-SCHEMA study. *Photo by Rob Church, C&C Technologies, Inc.*

An archaeologist screens for artifacts at 16SMY17. *Photo by Samuel Huey, ULL.*

sites, relying heavily on Remotely Operated Vehicles (ROV). High-resolution photos and video footage (including 3-D video!) are used to create a digital record of their post-spill condition. Microbial action and resident biota at each study site help determine if exposure to hydrocarbons and dispersants cause any long-term impacts.

Similarly, in response to concerns of the State of Louisiana in the wake of the DWH spill, researchers excavated eight coastal archaeological sites, with perhaps more sites to be included before the study ends in late 2017. *Testing and Assessment of the Effects of an Oil Spill on Coastal Archaeological Sites* involves diverse experts in anthropology, archaeology, chemistry, environmental sciences, geology, and nuclear engineering from universities, Federal and State agencies, and private institutions through cooperative and interagency agreements.

Previously, the only data about the effects of a major oil spill on archaeological resources was after the *Exxon Valdez* spill in Alaska in 1989, which is an environment unlike the GOM. Site monitoring and remediation in the wake of the DWH spill has documented oil at many sites, but this is the first assessment of how the spill may have affected coastal archaeological resources.

Participants conducted surface collections, used hand-operated cores and augers, excavated test units to record stratigraphic profiles, and obtained samples to determine the following: if oil infiltrated subsurface archaeological deposits; how contamination may affect radiocarbon dating; how it affects ceramics, bone, and other materials; and whether oil affects analytical techniques. Besides the presence of oil, they may also be able to "fingerprint" the oil to determine its source. Researchers hope to learn the immediate and long-term impacts of the oil spill on Louisiana's prehistoric archaeological sites and provide recommendations to the State Historic Preservation Office on cultural resource management planning. Partners include the University of Louisiana at Lafayette (ULL), Louisiana Division of Historic Preservation, Gulf Coast Cooperative Ecosystem Studies Unit, and many others.

– By Rita Hess, Schatz Publishing

For More Information

Florida Manatee Movement and Habitat Use in the Northern Gulf of Mexico (GM-13-07)

www.boem.gov/GM-13-07

Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, and Archaeology Project (GOM-SCHEMA)

www.boem.gov/GOM-SCHEMA

Testing and Assessment of the Effects of an Oil Spill on Coastal Archaeological Sites

www.boem.gov/GM-14-04

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New Waves

Late-Breaking News & Information

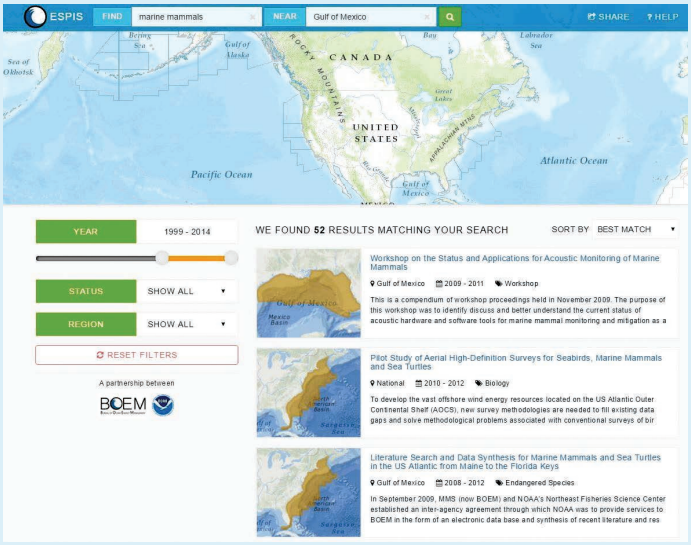
Visualizing Ocean Science through Geospatial Mapping Tools

BOEM relies on the ability to readily discover relevant scientific information and data analyses to make informed decisions based on science. Using the latest geospatial science and database technology, BOEM has reinvented the Environmental Studies Program Information System (ESPIS) to streamline searches, discovery, and retrieval of more than 40 years of environmental science. We partnered with NOAA's Office for Coastal Management to design and host the new ESPIS, building on the success of another BOEM/NOAA partnership, MarineCadastre.gov.

This innovation aligns BOEM with the federal government's move toward greater interoperability and openness of government research data and building a 21st Century digital government (OMB memorandum 2013).

Those preparing environmental reviews to comply with NEPA will find study reports with more precision by searching expanded metadata of BOEM-funded ocean research. Regional Planning Bodies can geo-reference study data more easily. Industry, academia, and NGOs will find archived study results to compare with BOEM's latest research.

Enhanced search tools enable users to submit text and map-based queries to find relevant study information, including downloadable study profiles, technical summaries, final reports, and links to associated publications and digital data.



Screenshot of ESPIS. Learn more and try out the new ESPIS at http://www.boem.gov/espis/

For More Information

OMB Memorandum on Open Data Policy-Managing Information as an Asset

https://www.whitehouse.gov/sites/default/files/omb/memoranda/2013/m-13-13.pdf