Annual Report on Technology Transfer

FY 2021 Activities

U.S. Department of the Interior

Description of Cover Photos:

Top Left: US Department of the Interior Secretary Haaland watches the launch of NASA/USGS's land remote-sensing satellite system (Landsat 9) from the Vandenberg Space Force Base in California. (Source: USGS)
Top Right: Landsat image of Tampa Bay, Florida taken from the National Satellite Land Remote Sensing Data Archive at the USGS Earth Resources Observation and Science (EROS) Center. (Source: USGS)
Bottom Left: Landsat image of Namibia as part of USGS's "Earth as Art" collection. (Source: USGS)
Bottom Right: USGS scientists map nutrients on Sacramento Delta. (Source: USGS)

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I. Executive Summary

This report identifies and describes how the Department of the Interior (DOI) advanced technology transfer in Fiscal Year (FY) 2021. These activities demonstrate the innovation, expertise, and dedication of DOI employees to help reduce risks to public health, safety, and the environment and to honor federal trust and treaty responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

During FY 2021, DOI continued to engage in a broad range of cooperative technology transfer activities –429 cooperative research and development agreements (CRADAs), 625 other cooperative research and development (R&D) activities, two new inventions, one new patent, and over 900 publications – to achieve the following outcomes:

- To advance the Nation's goals to transition to renewable energy, DOI issued a research lease for the first wave energy test facility in Federal waters offshore the U.S. West Coast.
- To reduce the risk of catastrophic wildfire, DOI developed modeling tools to predict fire behavior and evaluate alternative fuel treatments.
- To improve water quality measurement methods in high biofouling environments, DOI continued testing a device that greatly increases the length of unmanned or continuous monitoring deployments.
- To reduce Western drought impacts, DOI advanced water treatment technologies to create new water supplies from non-traditional sources (e.g., seawater, brackish groundwater, produced waters from oil and gas, municipal and industrial wastewater).
- To reduce risks to endangered black-footed ferrets, DOI entered into a licensing agreement to develop a technology to limit the spread of plague in prairie dogs, the main food supply for black-footed ferrets.
- To facilitate the use of science in decision-making, DOI synthesized and shared public lands data, information, and imagery in accessible databases.
- To increase economic development and access to energy and minerals in Indian Country, DOI expanded a Tribal software application to track and assist in resource management decisions.
- To enhance the results of coal mine reclamation, DOI worked with States and Tribes to test emerging technologies.
- To make offshore wind operations more efficient, DOI evaluated technologies for remotely inspecting, maintaining, and repairing offshore wind turbines.
- To improve offshore oil spill response, DOI developed an online tool to assist in applying dispersants.

II. Introduction

Each year, technology transfer at DOI advances the goals of the Technology Transfer Commercialization Act of 2000. In FY 2021, DOI strengthened the Nation's competitive ability in the global marketplace; built collaboration among government, industry, and universities that carry out the scientific enterprise; and improved the quality of life for the American people. Achieving these goals also helped advance DOI's mission:

- To protect and manage the Nation's natural resources and cultural heritage;
- To provide scientific and other information about those resources; and
- To honor our trust and treaty responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

The FY 2021 report shares examples of technology transfer activities at DOI in three categories:

- Publishing and exchanging scientific and technical information;
- Protecting and licensing intellectual property rights; and
- Sharing specialized scientific material and resources that DOI manages.

The report is the result of a cooperative effort by DOI's Departmental Working Group on Technology Transfer, which is coordinated by DOI's Office of Policy Analysis. The working group, which included bureau and office personnel involved with their respective research and development programs, provided the underlying data. DOI prepared this report using data compiled according to the most recent guidance from the Interagency Working Group on Technology Transfer.[1] Historical data (i.e., data before FY 2021) for new metrics introduced in the guidance are not available for comparison with FY 2021 data.

[1] The Technology Partnerships Office, National Institute of Standards and Technology, in conjunction with the Interagency Working Group on Technology Transfer, Guidance for Preparing Annual Agency Technology Transfer Reports Under the Technology Transfer Commercialization Act, April 2020. Available at: https://www.nist.gov/system/files/documents/2021/06/23/Final_2020_Metrics_Guidance.pdf

III. Advancing Technology Transfer in the Department of the Interior

DOI's FY 2021 enacted budget included over $1 billion for R&D. Most funding, about $769 million, was for applied R&D, while basic R&D received about $84 million and $170 million, respectively.[2] The programs supported through these funds generate new and improved knowledge, information, and technology, which are then transferred to resource managers within and beyond DOI, other stakeholders, and the public to help DOI meet its mission objectives.

DOI's bureaus have varying levels of involvement with scientific and technical research and innovation and technology transfer. In FY 2021, as in previous years, most technology transfer activities reported by DOI under the Federal Technology Transfer Act of 1986 (FTTA) were undertaken by the U.S. Geological Survey (USGS), which is DOI's largest R&D organization, both in terms of budget and personnel. Typically, USGS accounts for about two-thirds of DOI's R&D budget.

DOI advances the state of knowledge related to the resources it manages and ensures that this information is accessible to resource managers, private industry, and the public. The vast majority of DOI's technology transfer activities use traditional technology transfer mechanisms, such as publications of peer-reviewed papers and reports, webpage postings, fact sheets, and presentations at meetings and conferences. In 2021, Bureau of Reclamation (Reclamation or BOR), Bureau of Ocean Energy Management (BOEM), the Bureau of Land Management (BLM), and National Park Service (NPS) personnel authored or co-authored at least 900 reports, books, fact sheets and other publications disseminating mission-relevant scientific and other technical information to the public and peers in and out of government. (Other DOI bureaus do not collect this information in a readily accessible manner.)

Bureaus also use other conventional approaches to share scientific and technical resources and expertise with universities and other entities to address resource management issues. For example, 7 DOI bureaus are active participants in the Cooperative Ecosystem Studies Units (CESU) Network, a collaboration among 17 Federal agencies and more than 475 non-Federal partners (including universities, Tribes and Tribal organizations, State agencies, museums, aquariums, arboretums, and conservation organizations). The CESU Network extends across

[2] Estimates furnished by the Office of Budget, Department of the Interior, March 30, 2022.

biogeographic regions in all 50 States, the District of Columbia, and U.S. insular areas. Each CESU is hosted by a university.[3]

In addition, some bureaus and offices have offered prizes to help develop new or improve existing technologies. The bulk of the prize competition activities at DOI are undertaken by Reclamation's Prize Competitions Program.[4]

Bureaus that are active in R&D or have research capabilities that complement U.S. commercial interests may also utilize technology transfer agreements authorized by the FTTA to join forces with non-Federal partners. Such agreements allow DOI's bureaus and the non-governmental sector (including private entities) to pool their expertise and resources to jointly create and advance technologies that support agency missions while helping U.S. industries innovate and commercialize technologies that strengthen the economy and create jobs. This report focuses primarily on, but is not limited to, aspects of technology transfer related to the FTTA.

[3] Cooperative Ecosystem Studies Units National Network http://www.cesu.psu.edu/materials/default.htm

[4] *U.S. Department of the Interior Report on Prize Competitions FY 2019-20*.

IV. Overview of Technology Transfer Activities

During FY 2021, DOI continued to engage in a broad range of cooperative activities to develop and disseminate innovative technologies, including:

- Collaborated on 429 CRADAs, of which 139 were initiated in FY 2021. In addition, DOI engaged in at least 625 other collaborative R&D relationships.
- Disclosed two new inventions; one new patent application was filed; one new patent was awarded.
- Managed 58 active patent licenses for inventions and other intellectual property, which collectively earned $67,694.
- Published more than 900 reports, books, fact sheets, and other publications disseminating mission-relevant scientific and other technical information to the public and peers in and out of government.

DOI's bureaus used 12 mechanisms to transfer information, knowledge, and technology within and outside their agencies (Table 1).

Table 1: DOI Technology Transfer Activities By Bureau

	USGS	FWS	OSMRE	NPS	BSEE	BOR	BOEM	BLM	BIA
Technical/Scientific Publications	X	X	X	X	X	X	X	X	X
Workshops/Seminars	X	X	X	X	X	X	X	X	X
Educational Courses & Other Outreach	X	X	X		X	X	X	X	X
Cooperative Research and Development Agreements (CRADAs)	X	X		X		X	X		
Technical Assistance Agreements (TAAs)	X								
Facility Use/Service Agreements (FUSAs)	X					X			
Material Transfer Agreements	X			X		X			
Demonstration/Joint Projects	X				X	X	X	X	
Patents	X	X		X					
Licenses	X	X		X		X			X
Other Cooperative Ventures & Agreement Types	X	X	X	X	X	X	X	X	X
Web and Other Mechanisms	X	X	X	X	X	X	X	X	X

V. Technology Transfer Agreements

DOI's bureaus were involved in 429 active CRADAs in FY 2021, of which 139 were newly executed. See table 2.

TABLE 2: COLLABORATIVE RELATIONSHIPS FOR RESEARCH & DEVELOPMENT (FY 2021)

	USGS	BOR	BOEM	FWS	NPS	BLM	Total
CRADAs							
Total Active CRADAs	423	2	1	2	2	0	429
New CRADAs	138	1	0	0	0	0	139
New CRADAs Involving Small Businesses	0	1	0	0	0	0	1
Other collaborative R&D relationships							
Other Collaborative Agreements, total active in FY 2021	328	0	0	0	0	297	625

DOI disclosed two new inventions, filed one new patent application, and was issued one new patent in FY 2021. See table 3.

TABLE 3: DOI PATENT ACTIVITY (FY 2021)

	USGS	FWS	Total
Invention Disclosures			
Total Invention Disclosures Received	2	0	2
Patents			
Total Patent Applications Filed	1	0	1
US	1	0	1
Foreign	0	0	0
Total PCT Applications Filed **(NOTE: PCT = Patent Cooperation Treaty. See https://www.wipo.int/pct/en/)**	0	0	0
Total Patents Issued	0	1	1
US	0	1	1
Foreign	0	0	0

DOI managed 10 licenses in FY 2021 and averaged 30.5 months to grant licenses. See table 4.

TABLE 4 ACTIVE LICENSES MANAGED BY THE DOI'S BUREAUS

	USGS	BOR	FWS	BIA	Total
Invention Licenses, Total Active	7	2	1	0	10
New Invention Licenses	1	0	1	0	2
New Invention Licenses to Small Businesses	1	0	0	0	1
Income bearing licenses, Total Active	7	2	0	0	9
New Income Bearing Licenses	1	0	0	0	1
Exclusive licenses	7	0	1	0	8
Partially exclusive licenses	0	0	0	0	0
Non-exclusive licenses	0	2	0	0	2
Other Licenses, Total Active	41	0	0	7	48
New Other Licenses	41	0	0	1	42
New Other Licenses Granted to Small Businesses	40	0	0	0	40
Average (months)	4.5	0	26	0	30.5
Minimum (months)	3	0	26	0	29
Maximum (months)	6	0	26	0	32
Licenses terminated for cause	1	0	0	0	1

Total income in FY 2021 from all licenses amounted to $67,694 (from 9 income-bearing licenses), compared with $122,749 (from 14 income-bearing licenses) in the previous fiscal year. Under 15 USC § 3710c, for all inventions originating in a Federal agency, the agency must pay to the employee-inventors the first $2,000 per year in license income, and a minimum of 15% of the yearly income thereafter. Each agency has discretion to implement its own sharing scheme, but the maximum that a single inventor can receive per year is $150,000. Any residual funds are usually retained by the agency or laboratory where the intellectual property was developed.[5]

[5] https://www.govinfo.gov/content/pkg/USCODE-2011-title15/html/USCODE-2011-title15-chap63-sec3710c.htm

The scope and nature of DOI bureaus' technology transfer activities is a reflection of their missions. See table 5.

TABLE 5: SCOPE OF ACTIVITIES AND PLANS RELATED TO THE FTTA, BY BUREAU

Mission	Technology Transfer
U.S. Geological Survey (USGS). The mission of USGS is to serve the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.	USGS serves the Nation as an independent fact-finding agency that collects, monitors, and analyzes scientific and technical information to provide scientific understanding about natural resource conditions, issues, and problems. USGS makes this information and knowledge readily available to decision makers and the public. Thus, one of USGS's main thrusts is broad and open dissemination of its knowledge and information. USGS also pursues technology transfer opportunities under the FTTA and the Stevenson-Wydler Act in a variety of ways.
U.S. Fish & Wildlife Service (FWS). The mission of FWS is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.	FWS's R&D is primarily focused on providing the basis for effective conservation to meet its mission. For example, the FWS Fish Technology Centers (FTCs) were established in 1965 to develop and improve fish culture technology and to assist Federal and State agencies, Tribes, and other nations interested in aquaculture research and solutions. FTCs have worked with industry and government to improve aquaculture opportunities.
Office of Surface Mining Reclamation and Enforcement (OSMRE). OSMRE is responsible for ensuring, through a nationwide regulatory program, that coal mining is conducted in a manner that protects communities and the environment, restores the land to beneficial use following mining, and mitigates the effects of past mining by aggressively pursuing reclamation of abandoned mine lands.	OSMRE advances its mission by providing technical assistance, based on sound science and training, to its state and Tribal partners to enhance their ability to maintain effective programs. Although OSMRE has no formal R&D activities, its Technology Development and Transfer program promotes and disseminates information on technological innovations to better protect the environment during mining and in reclaiming and restoring active and abandoned mines. The program also provides training to ensure that States, Tribes, and OSMRE's other partners continue to administer their surface mining programs efficiently and effectively.
National Park Service (NPS). The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of current and future generations. NPS cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.	Technology transfer and employee inventions are addressed under the NPS benefits-sharing policy and procedural guidance. Benefits sharing occurs when NPS receives monetary or nonmonetary benefits from the commercial use of a discovery or invention resulting from research originating under an NPS Scientific Research and Collecting Permit or other NPS permit or authorization. Authorities under the FTTA are essential to the NPS benefits-sharing program.

Mission	Technology Transfer
Bureau of Safety and Environmental Enforcement (BSEE). BSEE works to promote safety, protect the environment, and conserve resources offshore through vigorous regulatory oversight and enforcement.	The BSEE R&D program activities operate through the Office of Offshore Regulatory Programs (OORP) Emerging Technologies Branch (ETB) and the Oil Spill Preparedness Division (OSPD) Oil Spill Response Research (OSRR) role. BSEE research is associated with operational safety, pollution prevention, and oil spill cleanup techniques and technologies. BSEE research results are used to inform regulatory decision-making and promote Best Available and Safest Technology on the U.S. Outer Continental Shelf (OCS).
Bureau of Reclamation (Reclamation or BOR). The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.	Reclamation has the lead Federal responsibility for water management and hydropower in the 17 Western States. Its research program is applied toward the development of solutions that increase efficiency, reduce maintenance costs, improve work safety, enhance infrastructure reliability, and increase the effectiveness of using desalination and other water treatment technologies to expand water supplies. The research programs use technology transfer fundamentals to help speed field deployment of new innovations.
Bureau of Ocean Energy Management (BOEM). BOEM manages the exploration and development of the Nation's offshore energy and mineral resources in an environmentally and economically responsible way. It seeks to appropriately balance economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development, and environmental reviews and studies.	BOEM's Environmental Studies Program develops, conducts, and oversees scientific research specifically to inform policy decisions regarding development of OCS energy and mineral resources. The research covers physical oceanography, atmospheric sciences, biology, protected species, social sciences, economics, submerged cultural resources, and environmental fates and effects. BOEM also funds research into offshore renewable energy technologies.
Bureau of Land Management (BLM). The BLM mission is to sustain the health, diversity, and productivity of America's public lands for the use and enjoyment of present and future generations. The Federal Land Policy and Management Act of 1976 (FLPMA) mandates that BLM manages public land resources for a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific, and historical values.	BLM's scientific and technical focus has been on place-based applications to improve public land management in accordance with FLPMA. BLM focuses on traditional technology transfer activities to help advance FLPMA's multiple-use mandate.

Mission	Technology Transfer
Bureau of Indian Affairs (BIA). The BIA's mission is to enhance the quality of life, to promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian Tribes and Alaska Natives.	BIA developed and shared at no cost the National Indian Oil & Gas, Energy and Minerals System (NIOGEMS), a software application, with Tribal offices and Federal agencies with Indian trust responsibilities. NIOGEMS allows users to track and make decisions on developing and managing resources on Indian lands with energy and mineral potential.

Subsequent sections briefly describe each bureau's technology transfer program and provide examples of their activities in FY 2021. The tabular data requested by OMB Circular A-11 are reported in section XVI, "Data Appendix."

VI. U.S. Geological Survey

The U. S. Geological Survey (USGS) is a science bureau within DOI whose mission is to serve the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. The USGS focuses on the following interdisciplinary mission areas: Ecosystems; Energy and Minerals; Natural Hazards; Water Resources; and Core Science Systems. The combined expertise from several earth-science disciplines (e.g., hydrology, geology, biology) addresses relevant issues of concern to people and other living things on the planet. Organization around these mission areas allows the USGS to better address the needs of the Nation, customers, and partners.

Delivery of science information is the USGS's primary mission. Technology transfer activities with the public and private sectors, including academia and nonprofits, are integral to fulfilling this mission. These efforts typically support knowledge dissemination, including the collection and transfer of scientific data. The USGS also cooperates with its public and private collaborators to help them maintain essential and necessary services, better understand the environmental consequences of their commercial and noncommercial activities and develop new products and services. The USGS has 283 major laboratories and several hundred field offices around the country.

Within the USGS, technology transfer extends beyond traditional publications, meetings, and conferences. It builds on the Stevenson-Wydler Innovation Act of 1980 and the Federal Technology Transfer Act of 1986 (FTTA) and is managed through the USGS Office of Policy and Analysis (OPA). OPA staff service USGS centers and offices throughout the country.

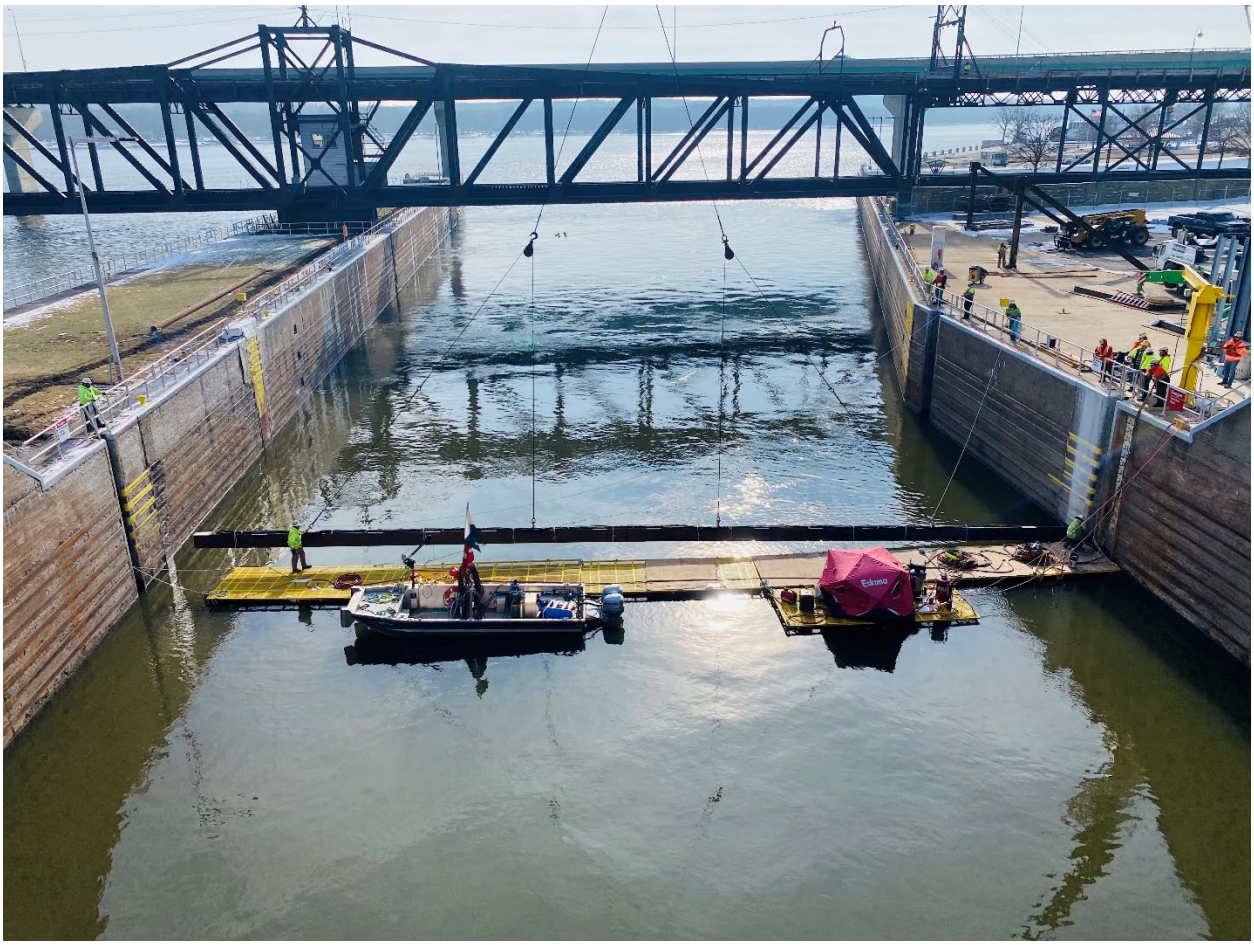
OPA, on behalf of the USGS, negotiates and drafts Cooperative Research and Development Agreements (CRADAs), including Technical Assistance Agreements, Facility Use Service Agreements, Material Transfer Agreements, and Data Use Licenses, and Patent Licenses. OPA also manages the USGS intellectual property and inventions program; markets USGS technology opportunities; and facilitates partnerships with industry, nonprofits, academic institutions, Tribal nations, and state agencies. OPA also provides training to USGS personnel on technology transfer and intellectual property matters.

In 2021, the USGS had 423 active traditional and nontraditional CRADAs, the majority of which (391) were nontraditional, including Technical Assistance, Facility Use and Service, and Material Transfer Agreements. By contrast, in FY 2020, it had 477 active CRADAs, including 450 nontraditional CRADAs. In addition, in FY 2021, the USGS executed 328 other collaborative agreements and managed a total of 48 active licenses. The USGS also filed one new patent application and received zero.

USGS science and research contributes to a broad range of collaborative projects in the private and academic sectors. The USGS provides unique analytical laboratory services to domestic, foreign, and academic partners through the USGS Facility Use Program. Examples include the following.

Experimental Invasive Carp - Partnerships that advance science are at the forefront of technology transfer activities at the USGS. On June 3, 2021, the Upper Midwest Environmental Sciences Center held an event to communicate the progress of an experimental deterrent developed in collaboration with the U.S. Army Engineer Research and Development Center (ERDC). The test is of a one-of-a-kind underwater Acoustic Deterrent System (uADS), which, could be used to limit invasive carps' passage at navigation locks at dams that present a population pinch-point. The experimental deployment of the uADS is underway at Mississippi River Lock 19 in Keokuk, Iowa; Lock 19 is a population pinch-point for invasive carp moving upstream as it is the only 'swimmable' path for fish around that high-head dam, which has been identified by managers as a critical control point. Researchers from the USGS, ERDC, U.S. Army Corps of Engineers (USACE), Illinois and Iowa Departments of Natural Resources, and U.S. Fish and Wildlife Service met with the public to answer questions and discuss the progress to move this experimental uADS from the laboratory to field implementation. Local and congressional representatives and stakeholders toured the installation and received firsthand experience with the engineering and research tools used to evaluate the efficacy of the uADS for deterring invasive carps and to determine if native fish behavior might be impacted by the deterrent operation.

The successful installation of the uADS was a result of the collaboration between the USGS, ERDC, USACE, and private contractors. As a result, the USGS-led design was built and installed. The multidisciplinary design and engineering team creatively designed the uADS installation to fit within a discharge lateral in the active navigation lock approach to reduce the potential for impacts from the environment and commercial and recreational traffic. The science and engineering planning processes and outcomes of this effort gives scientists, and ultimately resource managers, a better understanding and assessment of the engineering, maintenance, and logistical considerations associated with operating the uADS over an extended period. This information is critical to resource managers faced with deciding whether to install an invasive carp deterrent, the type of deterrent to install, the potential impacts of the deterrent to native species, and the economics of deterrent installation, maintenance, operations and repairs. The USGS and USACE scientists and natural resource managers can apply lessons from Lock 19 for future installations of this technology.



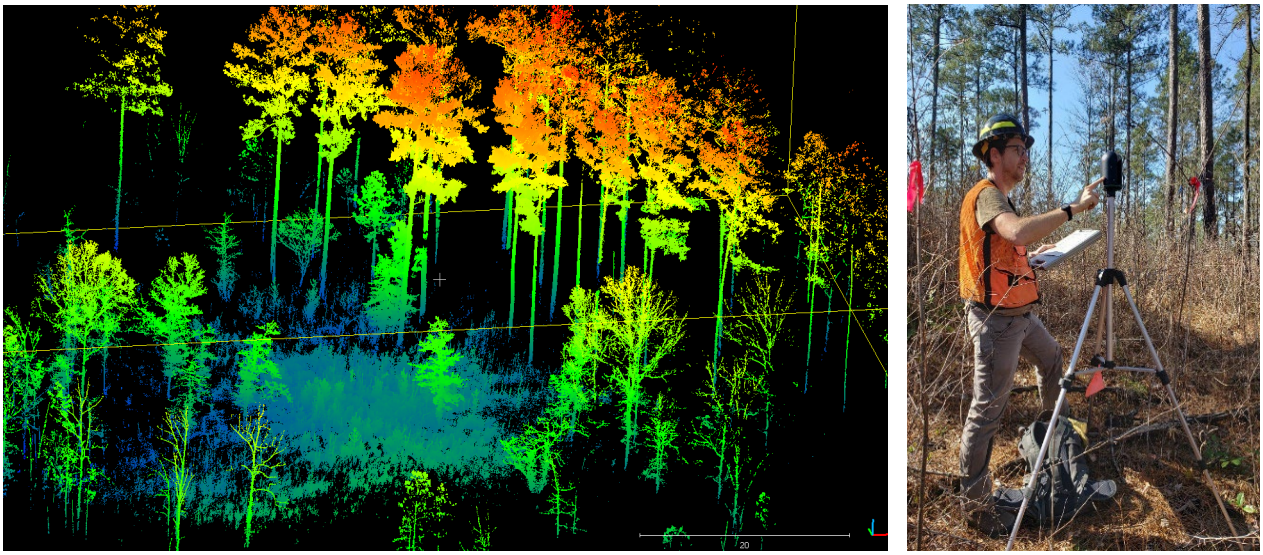
THE UADS SOUNDBAR, COMPRISING 16 UNDERWATER SPEAKERS AND SCIENTIFIC MONITORING EQUIPMENT, WAS INSTALLED IN THE LOWER LOCK APPROACH CHANNEL OF LOCK 19 ON THE UPPER MISSISSIPPI RIVER IN KEOKUK, IA, IN FEBRUARY 2021 (SOURCE: USGS)

This location also allows scientists and managers to assess whether commercial and recreational activities impact the uADS operations and whether mariners have concerns with the operation. An advantage of the uADS is that the sound stimulus is below hearing thresholds of concern for those above water – and swimming isn't allowed in a lock approach channel. Navigation continues to operate safely, without interference from the uADS. This technological breakthrough was made possible through sustained Federal investments in this research effort and the technology transfer authority that permits the USGS to collaborate with other science and management organizations.[6]

[6] Original Story - Media Availability: Study of Invasive Carp Deterrent Underway in Keokuk (usgs.gov), US Army Engineer and Research Development Center - ERDC (army.mil)

Supporting Advanced Fire Modeling and Monitoring of Fuel Treatments. Coupled fire atmospheric modeling tools are revolutionizing fire science with unprecedented ability to represent the complex variation of the fire environment and ecological outcomes of wildland fire. In a series of projects in partnership with Los Alamos National Laboratory and U.S. Fish and Wildlife Service, USGS scientists supported the advancement of the new fire-behavior model QUIC-Fire and the 3-dimensional terrestrial laser scanning (TLS) technology.

Along the southern border with Mexico, these tools were applied at Buenos Aires National Wildlife Refuge to assess the impacts of fuel (vegetation) treatments and exotic grass species on wildfire spread. The arid ecosystem with its patchy fuels challenge existing fire modeling tools. This process was repeated in sagebrush ecosystems impacted by cheatgrass invasion in the Soda Fire perimeter along the border of Idaho and Oregon. In each case, fine-scale details of vegetation and bare ground were required to accurately predict fire spread. To supply this fine-scale heterogeneity across a series of pilot landscapes, U.S. Fish and Wildlife Service, U.S. Forest Service, and the USGS deployed low-cost terrestrial lidar systems and a data repository to rapidly and repeatedly characterize the changes in vegetation, as needed for next generation modeling tools to predict fire behavior and fire effects.



LEFT: POINT CLOUD DATA CREATE 3-D VEGETATION STRUCTURE
RIGHT: TECHNICIAN COLLECTS POINT CLOUD DATA WITH LASER SCANNER
(SOURCE: E. LOUISE LOUDERMILK, USFS, USED WITH PERMISSION)

Together, these modeling tools represent a major advancement in realistically predicting fire behavior and the consequences of fuel treatments, obtaining the desired risk reduction and ecological fire effects. It is critical to assess scenarios of fuel treatment options that modify the 3D vegetation before implementation and monitoring treatments. The assessment of the

effectiveness and recovery after treatments will be critical for successfully implementing and monitoring the fuel treatment goals set under the Bipartisan Infrastructure Law.

The interagency partnerships among researchers and managers that contributed to this technology transfer have led to rapid adoption of monitoring protocols in a network of demonstration landscapes from the southeast U.S. to the pine barrens of New Jersey to Yosemite National Park, California.

Uncrewed High-Altitude Platform Stations. Sceye is an aerospace company from New Mexico that is developing a new class of uncrewed high-altitude platform stations (HAPS) for bridging the gap between ground- and space assets. They have developed and tested HAPS for long-endurance, high-payload missions in the stratosphere. Their HAPS is designed to lift payload in the 100s of kg and provide kilowatts of power, with opportunities to swap among a wide range of payloads as desired.

Since 1879, the USGS has provided the Nation with ever more detailed maps of its lands, waters, and ecosystems. USGS topographic maps illustrate that role. Over the last 141 years, USGS map production transitioned from mapping with plane tables, to air photo stereopairs, to airborne lidar. That journey improved mapmaking efficiency and accuracy, serving national interests in finding resources and reducing natural hazards. The USGS National Geospatial Program (NGP), National Land Imaging (NLI) Program and other elements of the USGS have a compelling national interest in operationalizing technologies that increase the accuracy and efficiency of mapping the Nation.

This CRADA gives Sceye and the USGS the authority to develop a concept of operations (ConOps) for lidar and hyperspectral imagery collection from an autonomous stratospheric HAPS. A robust ConOps will lower the barrier to the next steps of demonstrating lidar and hyperspectral collection from stratospheric HAPS, in partnership with Sceye and potentially the National Aeronautics and Space Administration. NLI and NGP leadership were briefed on the opportunity by the USGS National Innovation Center (NIC) and agreed that this partnership is worth pursuing. NGP staff scientist Jason Stoker is the USGS Principal Investigator, and NIC Director Jonathan Stock developed this partnership opportunity and will curate it.

Seismic Risk Management of Utilities. The Pacific Gas and Electric Company (PG&E), a publicly regulated utility providing service within northern and central California, is engaged in a long-term, multi-element, action-based seismic risk management program to reduce the impact of future damaging earthquakes on the performance of their gas and electric systems and to maintain acceptable levels of customer service. To enhance this program, PG&E partnered with the USGS Earthquake Hazards Program in a sequence of Cooperative Research & Development Agreements (CRADA) since 1992. The first CRADA (MOU-2-990-0175) was focused on rapid

earthquake notification and on earthquake hazards research in the San Francisco Bay Area from September 3, 1992, to December 31, 2001. Follow-on CRADAs were executed between PG&E and the USGS since 2003. In the current CRADA, PG&E seeks (1) the development and rapid application of data, methods, and technologies that improve earthquake hazard assessments in the regions where its electric power and natural gas facilities, service centers, and office buildings are located and where its customers live and work; (2) the improvement of emergency response to earthquake occurrence by incorporating real-time earthquake hazard information; and (3) more complete characterization of other (non-seismic) natural hazards and associated notifications.

The USGS Earthquake Hazard Program, under the auspices of the National Earthquake Hazards Reduction Program, includes a broad range of applied earthquake-hazards research, earthquake monitoring, data compilation and archiving, and distribution of earthquake information products and services. The Earthquake Science Center and Geologic Hazards Science Center of the USGS are responsible for managing and conducting Earthquake Hazards Program activities. Other USGS entities, such as the Geology, Minerals, Energy and Geophysics Science Center, the Coastal and Marine Geology Science Centers, the Volcano Science Center, and the California Water Science Center provide scientific capabilities that are leveraged in this CRADA.

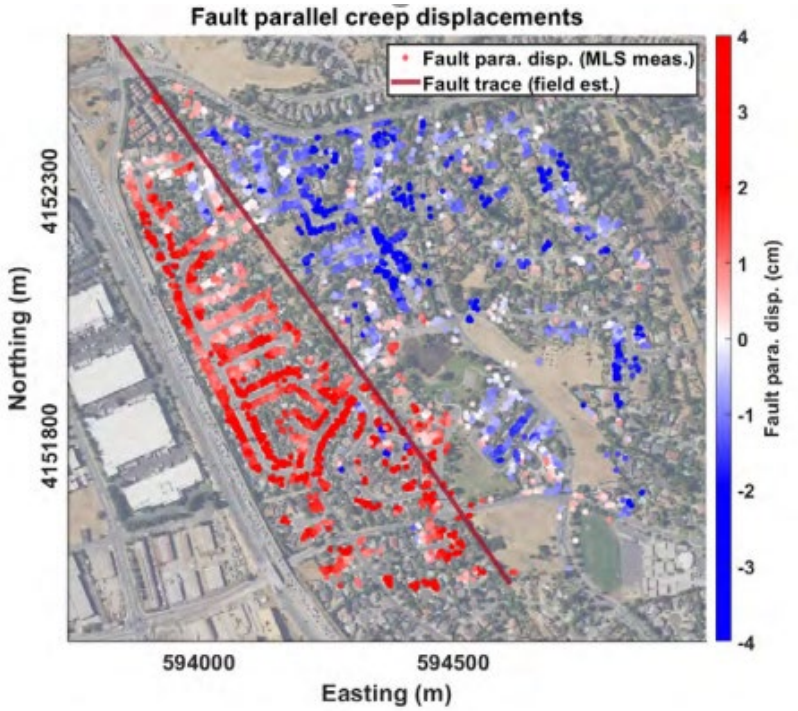
Research interests currently planned include:

Northern and Central California Seismic Hazards. PG&E and the USGS participated in a broad suite of data-gathering activities, data analyses, and modeling designed to update probabilistic hazard assessment in the northern- and central coast regions. These include earthquake monitoring and notification for the region, collecting and analyzing geologic and geophysical data both offshore and onshore, developing integrated three-dimensional geologic and seismic velocity models, data-visualization tools for evaluating regional seismic sources and earthquake-energy propagation, as well as conducting targeted geologic and geodetic field studies to refine fault characterizations, as well as providing improved inputs to probabilistic earthquake hazard analyses for the region. Additionally, the USGS developed methods and approaches for hazard assessment and earthquake early warning that are applicable to the Northern and Central California regions and are more broadly applicable to other regions as well. PG&E provides the USGS access to the large amount of existing earthquake-hazards data it has collected in these regions.

Focused studies are underway, and additional research is anticipated, to address particular aspects of seismic hazards (most in PG&E's service areas), as mutually agreed. Currently, geologic and geophysical studies of faults in the San Andreas Fault System, including the region east of the San Andreas Fault and north of the San Francisco Bay area, are being performed,

kinematic and dynamic modeling of rupture processes and attendant ground motions are being conducted, and geologic and geophysical studies in PG&E's service areas are occurring. Studies designed to better predict ground motions from a variety of earthquake sources (e.g., creeping faults) are a continuing interest to both PG&E and the USGS. Studies of earthquakes that occur outside of PG&E's service area, including post-earthquake reconnaissance, are also of interest to both parties due to the lessons that can be learned from events occurring elsewhere.

Other Natural Hazards. Other natural hazards, including ground failure (e.g., landslides, ground subsidence, liquefaction), coastal and riverine flooding, tsunamis, wildfires, as well as volcanic unrest and eruptions, threaten infrastructure and communities in California. Under the Disaster Relief Act ("Stafford Act" P.L. 93-288), the USGS has Federal statutory responsibility to provide notification for earthquakes, volcanic eruptions, and landslides to enhance public safety and to reduce losses through effective forecasts and warnings based on the best possible scientific information. The current CRADA was broadened to include work on non-seismic natural hazards within the scope of the USGS's statutory responsibilities and as mutually agreed by the Parties. Of immediate mutual interest is assessing (quantifying) uncertainties in natural hazards information to prioritize future earth-science research. Longer-term interests also include improvement of rapid-notification capabilities for other natural hazards to support risk management and emergency-response activities. A significant focus in recent years has been the study of post-fire slope instability and related hazards.



NEW MOBILE LASER SCANNING RESULTS FROM THE FREMONT AREA (12), ~0.75 KM SOUTH OF CROSSING L-303 AND L-107. RESULTS SHOW FAULT-PARALLEL DISPLACEMENT ACROSS THE PRINCIPAL TRACE OF THE HAYWARD FAULT FROM 2015 - 2017. (SOURCE: USGS)

VII. U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (FWS) is dedicated to the conservation, protection, and enhancement of fish, wildlife, and plants and their habitats. FWS is the only Federal agency whose primary responsibility is managing fish and wildlife resources for the American public. The National Wildlife Refuge System's 850 million acres of lands and waters includes 568 national wildlife refuges, waterfowl production areas in 209 counties managed within 38 Wetland Management Districts and 49 Coordination Areas, 7 National Monuments, and 760 million acres in Marine National Monuments. FWS also operates National Fish Hatcheries, which, in conjunction with Fish and Wildlife Conservation Offices, its Fish Health Centers and Fish Technology Centers, restore native aquatic populations, mitigate for fish lost as a result of Federal water projects, and support recreational fisheries throughout the United States.

Research and Development (R&D) within FWS is primarily focused on applying the latest scientific and technical information to fulfill its mission of working with partners to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. Transferring FWS's technology and knowledge to the public and collaborators accelerates the adoption and use of agency research while improving the economic and societal benefit from its R&D investments to help solve natural resource problems.

The technology transfer function of FWS is shared among several programs, including Science Applications, Fish and Aquatic Conservation (FAC), and Joint Administrative Operations (JAO). The majority of FWS's technology transfer is done via dissemination to the public and scientific community through traditional avenues such as peer-reviewed papers, presentations, reports, and fact sheets. Science Applications and JAO help coordinate technology transfer activities in the Service while other programs are more directly involved with partners.

FWS employees are actively involved in the larger scientific community and participate in scientific societies, meetings, and conferences and publish scientific research. Sharing scientific and technical information via public outreach and partnerships is a high priority for FWS. For example, FWS is a partner to all units within the 17 Cooperative Ecosystem Studies Units (CESU) Network, allowing FWS to be involved in interdisciplinary and multiagency research projects with the host university and other non-federal partners. Each year, FWS pursues dozens of projects through the CESU network, including surveying and monitoring efforts, climate change vulnerability assessments, streamflow projections, and many others.

Scientists within the agency published 498 scholarly articles, papers, or book chapters in publications focused on diverse topics such as ecology, biodiversity conservation, fisheries, zoology, ornithology, environmental sciences, and evolutionary biology. FWS also manages two

online peer-reviewed publications focused on the practical application and integration of applied science to wildlife conservation and management—the *Journal of Fish and Wildlife Management* and the *North American Fauna Monograph Series*. These electronic journals are in the public domain. FWS also uses its research to help inform a wide range of wildlife management decisions in the interest of the general public. For example, the National Wildlife Refuge Inventory and Monitoring Program systematically obtains a range of biological data about the status, trends, and management responses of species and habitats within the National Wildlife Refuge System.

Patents. FWS received U.S. Patent No. 10,478,276 in FY 2020 (November 19, 2019) for a pellet delivery mechanism. The mechanism was developed by an employee who co-invented it to distribute pellets to control fleas (a vector for plague) on prairie dogs. Prairie dogs are the main food supply for black-footed ferrets (*Mustela nigripes*). The black-footed ferret, once believed to be extinct but now rediscovered, is one of the most endangered mammals in the United States. The patent was issued to both the FWS and the co-inventor who was employed via contract with the World Wildlife Fund. On the day FWS received the patent on the pellet delivery mechanism, it filed a continuation patent application to pursue additional claims from the original description of the patent. The continuation application was issued as U.S. Patent No. 10,881,493 on January 5, 2021.

During FY 2021, FWS entered into an exclusive licensing agreement with World Wildlife Fund (WWF) for the pellet delivery mechanism described above (agreement executed September 28, 2021). The notice of intent to enter into the agreement was published in the *Federal Register* on June 24, 2021 (86 FR 33343). The agreement gives WWF the right to grant sublicenses to qualified commercial partners with the facilities, personnel, and expertise to bring the joint inventions to the point of practical application. At this time, FWS does not anticipate substantive royalties from manufacture.

CRADAs. In FY 2021, FWS maintained two CRADAs it has in place through the Aquatic Animal Drug Approval Partnership Program (AADAP) within FAC. On behalf of DOI, FWS also maintains a joint CRADA involving USGS and BOEM and Bird Studies Canada.[7]

Following is a brief description of FWS programs and entities engaged in technology development and transfer activities.

National Conservation Training Center. The FWS Conservation Library at the National Conservation Training Center (NCTC) in Shepherdstown, West Virginia, provides a searchable

[7] Because the FWS/USGS/BOEM/Bird Studies CRADA is already accounted for in the USGS tally of CRADAs, it is not included in the tallies for the other bureaus in Section V and the data tables in the Appendix.

collection of selected documents, images, historical artifacts, audio clips, publications, and videos, most of which are in the public domain. FWS also makes internal publications, reports, and other information available to the public through the FWS website.[8] Collections of current and legacy publications (including biological and technical publications) are available online from the NCTC library catalog and websites. NCTC also maintains links to biological and technical publications, as well as additional publications regarding birds, wetlands, fish hatcheries, and National Wildlife Refuges.

NCTC also hosts publicly accessible webinars dealing with a variety of scientific and technical issues that address the nation's fish and wildlife resources. During fiscal year 2021, NCTC hosted 100 online science, technology, and educational webinars and 177 e-courses related to managing the Nation's fish, wildlife, and plant resources. These are important components of FWS's traditional technology transfer activities.

Fish and Aquatic Conservation Program. FWS's primary research nexus with the private sector centers on programs and facilities within the Fish and Aquatic Conservation (FAC) Program. The program includes a network of National Fish Hatcheries, Fish and Wildlife Conservation Offices, Fish Health Centers, Fish Technology Centers, the Conservation Genetics Laboratory in Anchorage, Alaska and Whitney Genetics Laboratory in Onalaska, Wisconsin, and the Aquatic Animal Drug Approval Partnership (AADAP). These centers and programs provide assistance and support to conservation partners—including Federal, State, Tribal, and nongovernmental organizations (NGOs). Work that supports programs covers a broad range of disciplines, including biostatistics, population ecology, genetics, nutrition, and fish health and pathology. FWS's Fish Health Centers, Fish Technology Centers, and AADAP play an integral role in applied science and technology transfer.

FWS Aquatic Animal Drug Approval Partnership. AADAP is the only program in the United States singularly dedicated to obtaining U.S. Food and Drug Administration (FDA) approval of new medications needed for use in fish culture and fisheries management. Since the late 1990s, AADAP has contributed to virtually every new fish medication approved by the FDA. Ultimately, the AADAP program allows fisheries professionals to more effectively and efficiently rear and manage a variety of fish species to meet production goals, stock healthy fish, and maintain a healthy environment.

Fish Technology Centers. Starting in 1965, Fish Technology Centers (FTCs) were established in 1965 to develop and improve fish culture technology and to provide assistance and advice on fish culture to National Fish Hatcheries, other Federal and State agencies, Tribes, other Nations,

[8] https://www.fws.gov.

and the aquaculture industry. Today, seven FTCs provide applied science products and transfer technology related to fish and fisheries for the Nation. The FTCs have developed culture techniques and fish diets now used around the world, including dehydrated long-lasting feeds that revolutionized the fish-culture industry. Results of studies conducted by FWS scientists are published in peer-reviewed journals, and management recommendations are communicated within the FWS and its partners through conservation science partnerships.

Nutrition and Diet Development Laboratories. These facilities allow for the manufacture of experimental larval, fingerling, and broodstock fish feeds and the testing of different kinds of ingredients to improve fish nutrition, performance, and quality. This program also develops specialized diets for use in captive rearing of endangered fish species.

Physiology Laboratories. These laboratories support conservation and management needs of FWS and its partners, including understanding the physiological needs of fish to support conservation and commercial opportunities.

Conservation Genetics Laboratories. These laboratories support conservation and management needs of FWS and its partners, including (a) using genetic methods to meet real-time fishery needs to conserve and manage species; (b) assisting with Endangered Species Act status reviews and recovery planning via baseline data on genetic population structures and genetic monitoring and evaluation of listed populations and species; (c) establishing and maintaining genetic tissue and repositories for imperiled species; and (d) characterizing diversity within and among wild populations.

Ecology Laboratories. These laboratories focus on understanding the physiological requirements and tolerances of threatened and endangered species. Less invasive or noninvasive tools, such as measurement of plasma sex steroids and ultrasound, are used to determine gender, stage of sexual maturity, and spawn readiness of individual fish in wild and captive populations of threatened and endangered species. These laboratories also provide contract services to Federal and State agencies, universities, and NGOs for a variety of analyses employing these less invasive tools, as well as blood chemistry analysis, histology, proximate analysis, and radio-immunoassays.

Fish Health Centers. FWS's Fish Health Centers play an integral role in applied science and technology transfer. Their scientists are leaders, both nationally and internationally, in diagnosing wildlife diseases, contributing to the science of aquatic animal health, and developing and validating tests that benefit—and are adopted by—the aquaculture industry. Fish Health Centers work closely with Federal, State, Tribal, academic, and NGO partners to promote the scientific management of fisheries and aquaculture by reducing the effects of wildlife pathogens.

Aquatic Invasive Species. The FWS Aquatic Invasive Species program works to prevent the transfer and introduction of injurious and other potentially harmful non-native species and to develop early detection, rapid response, and control measures for such species. For example, the program worked with numerous partners to develop methods for detecting minuscule amounts of free-floating DNA (environmental DNA or eDNA) in water samples to confirm the presence (or absence) of species that are often undetectable by traditional sampling methods. This innovative technology is now being applied widely in monitoring programs and, as it continues to be further developed and refined, will significantly benefit both FWS programs and partners by allowing earlier detections of invasive species.

The Aquatic Invasive Species program is also applying rapid screening tools it has developed to help determine a species' risk for invasion. Knowledge of both low- and high-risk species will help industry, States, Tribes, and consumers make informed decisions about trading, transporting, or possessing a particular species. These tools will also help State agencies develop species watch list and work with industry to manage invasive species in their jurisdictions. For example, Michigan's Public Act 537 established new protections to minimize the risk of invasive species that require, among other things, the use of FWS's risk assessment protocol.

The FAC program also oversees injurious wildlife listing (under 18 U.S.C. 42 (a)) for DOI. More than 700 species are Federally listed as injurious wildlife because of harm they can cause to humans, agriculture, forestry, horticulture, wildlife, or wildlife resources of the United States. Using the regulatory process, FAC can add species to the list, which thereby prohibits the importation of those species and limits their transport within the United States, except by permit.

VIII. Office of Surface Mining Reclamation and Enforcement

The Office of Surface Mining Reclamation and Enforcement (OSMRE), established by the Surface Mining Control and Reclamation Act of 1977 (SMCRA), is responsible for ensuring that coal mining is conducted in a manner that protects communities and the environment and restores the land to beneficial use following mining, and mitigating the effects of past mining by aggressively pursuing reclamation of abandoned mine lands. OSMRE achieves this in part by providing technical assistance and technology transfer activities based on sound science and by offering training to its State and Tribal partners to enhance their ability to maintain effective programs.

The goals that underlie OSMRE's Technology Development and Transfer program include (a) increasing the technical knowledge of the reclamation of active and abandoned coal mines; (b) developing and enhancing working relationships among the bureau's partners in Federal, State, and Tribal governments and in industry and academia; and (c) leveraging its resources through partnerships. OSMRE accomplishes these goals via the Technical Innovation and Professional Services (TIPS) program, the National Technical Training Program (NTTP), and the National Technology Transfer Team (NTTT).

Technical Innovation and Professional Services (TIPS). TIPS is a national program that continues to research and apply emerging technologies to SMCRA workflows. Currently, TIPS assistance includes providing commercial software applications and hardware to State, Tribal, and OSMRE offices at considerable cost savings by sharing the commercial licenses for 20 commercially available software applications via the Internet and OSMRE wide area network. These software applications cover a wide range of regulatory and abandoned mine lands subjects. The customer base covers more than 60 State, Tribal, and OSMRE office locations throughout the country.

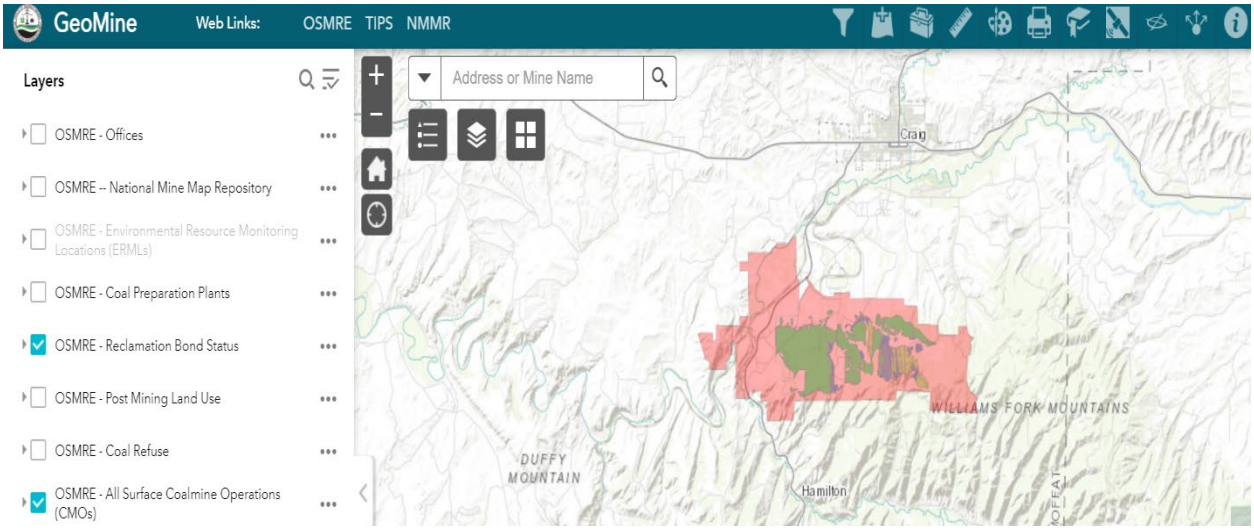
One goal of TIPS is to provide State, Tribal, and OSMRE personnel with a comprehensive set of analytical tools to aid in technical decision-making related to regulatory and reclamation processes. The services provided are centered on off-the-shelf scientific and engineering computer software and technical hardware supported by OSMRE in partnership with the States and Tribes. TIPS hardware is available to States and Tribes that regulate coal mining to advance reclamation projects nationwide.

The TIPS suite of scientific, hydrologic, and mapping core software aids the technical decision-making associated with a wide variety of tasks that surface mining agencies have to perform regularly: conducting reviews of permits, performing cumulative hydrologic impact assessments, quantifying potential effects of coal mining, preventing acid mine drainage, quantifying subsidence impacts, measuring revegetation success, assisting in the design of

abandoned mine lands projects, and providing the scientific basis for environmental assessments and environmental impact statements.

Demand for TIPS tools and support continues to increase, especially for geospatial data and mobile computing tools for field use. TIPS is offering more onsite training for State, Tribal, and Federal personnel to familiarize them with use of mobile computing devices by inspectors. Mobile computing increases efficiency in resolving State, Tribal, and industry issues. The following are additional details on the GeoMine Web Application and computing and mapping tools the TIPS program supports.

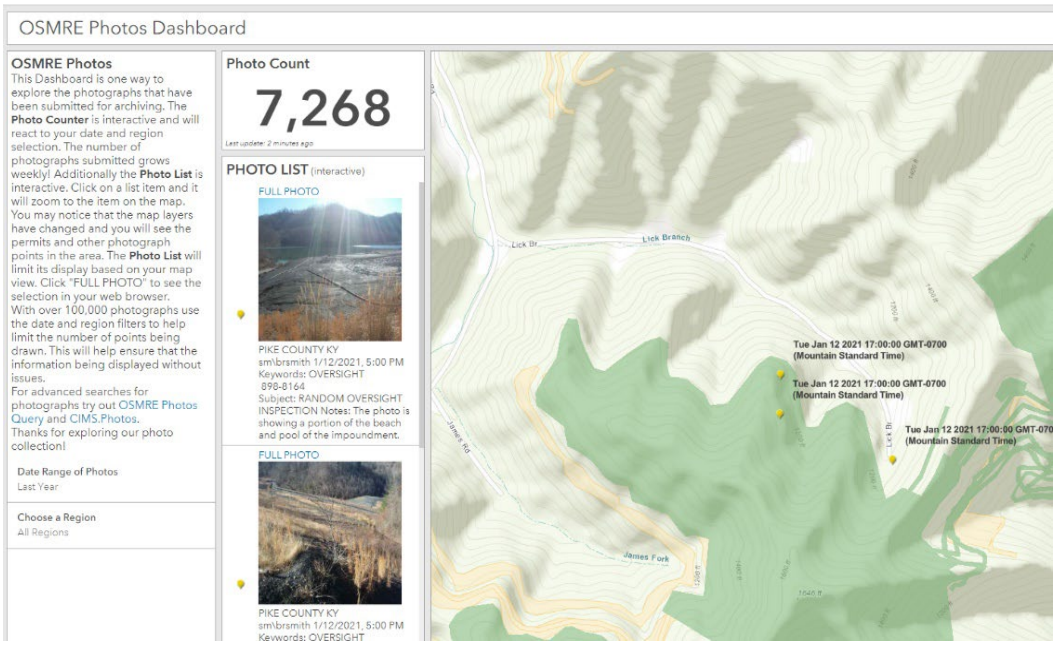
GeoMine Web Application. GeoMine provides authoritative data for surface coal mining operations across the country, merging data from numerous sources to create standardized, seamless layers that cross State and Tribal boundaries. OSMRE updated the GeoMine Web Application in 2021, adding two new layers and one new widget. The first new layer displays the DOI Unified Regional Boundaries of the 12 Interior Regions. The second new layer displays the winners of OSMRE's Abandoned Mine Land Reclamation awards, which are given annually to outstanding reclamation projects across the country. Incorporating this layer further highlights the success of those projects to both the SMCRA community and the public at large. GeoMine also now contains the Pictometry widget, which provides high-resolution aerial imagery from the EagleView Pictometry archive for certain large surface mines in the Western United States. This archive is a powerful new tool for mine teams to monitor mining and reclamation progress on the ground. Satellite imagery remains available in the app and is updated in near real time through a live feed.



AN EXAMPLE OF GEOMINE MINING-RELATED FEATURE CLASSES. (SOURCE: OSMRE)

All layers for GeoMine are publicly available and consist of data from State, Tribal, and Federal partners.[9] The data, which are updated as they are made available to OSMRE, are also linked to the national GeoPlatform, making data easily searchable and integrated with data published by other agencies. Altogether, this transparency allows the public to better understand the impacts of both coal mining and reclamation activities.

GIS Mobile Computing. In FY 2021, OSMRE continued the use of tablets and smartphones that can display and collect geospatial data while at mine or Abandoned Mine Land (AML) site investigations. Field photographs and notes enter a custom process that appends the data to a robust data base. Data collected in the field are synchronized to ArcGIS Online (AGOL), and applications allow for searching and viewing of current and historical photographs. Currently over 100,000 photographs are available for viewing and have been made available to States and Tribal partners within OMSRE's AGOL web platform. This information is critical to future investigations. The OSMRE Photos Dashboard allows the collection points to be easily viewed with varies base maps and GeoMine layers.



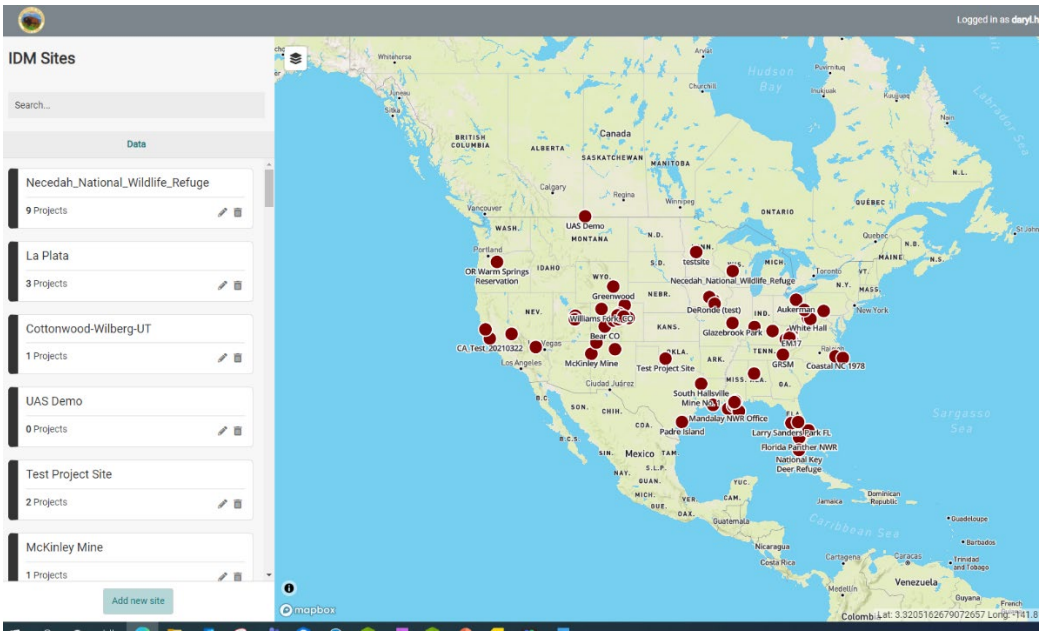
OSMRE PHOTOS DASHBOARD -4-MARCH-2022

Emerging Technology Testing (Photogrammetry, Cloud-based Data Processing and Ground-Based Light Detection and Ranging (LiDAR) Scanners). Photogrammetry software has been

[9] https://geomine.osmre.gov/

utilized successfully to create fully rendered surface models taken from satellites, manned aircraft, unmanned aircraft, and ground-based imagery. Cloud-based data processing of data and imagery is being piloted through GeoPlatform to realize efficiencies of server-side processing of large datasets. Ground-based LiDAR scanners are also being used in conjunction with these photogrammetric models to allow for accurate surface modeling for enforcement and reclamation design. Most SMCRA States have adopted programs to make use of these systems and the variety of sensors.

- Imagery Data Management (IDM) Platform**.** In FY 2021, OSMRE provided funding and staffing to continue the development of a new IDM platform that accommodates the upload of aerial photographs and processing to the Cloud-based services.



IDM VIEWER ON GEOPLATFORM -4-MARCH-2022

- Remote Sensing Training. A GIS Branch staffer piloted an Introduction to Remote Sensing course that covered the specifics of remote sensing to enable participants to quickly use remote sensing to support SMCRA applications. It was attended by 23 participants that included Federal and State government users as well as experts from Lawrence Livermore National Laboratory and the Civil Applications Committee. Participants completed online and hands-on field exercises that demonstrated proficiency in applying remote sensing observations.
- Remote Sensing. OSMRE monitored over 1,800 square kilometers (sq. km.) of high priority bond release areas and multiple AML requests. Some of the areas include Kayenta in Arizona (570 sq. km.), El Segundo in New Mexico (300 sq. km), and Centralia in Washington State (150 sq. km.).

ArcGIS Online. The ArcGIS Online web mapping system allows access to OSMRE and shared geospatial data. When mine inspectors conduct field work this system allows them to collaborate with SMCRA partners in near-real time. In 2021 the system had a growth rate of nearly 20%, with almost 600 accounts over nineteen States, more than half of which were designated to States and Tribes.

TIPS Training Program**.** The TIPS Training Program is a collaborative effort among OSMRE, States, and Tribes. Course developers and instructors are reclamation experts who use TIPS software to solve a wide range of complex permitting, enforcement, and abandoned mine land problems. Although most of the TIPS tools are off-the-shelf applications, TIPS training is tailored exclusively to mining and reclamation uses. TIPS courses are delivered onsite at the customer's request and in training centers in OSMRE's Regional Offices in Denver, Colorado; Alton, Illinois; and Pittsburgh, Pennsylvania.

In FY 2021, the TIPS training program received a customer satisfaction rating of 98 percent, exceeding the annual Government Performance and Results Act (GPRA) goal of 96 percent. No instructor-led classes were offered due to travel restrictions. Thirty-three virtual instructor-led classes were held in FY 2021 with 410 students completing class sessions. TIPS training reports show a 206 percent increase in students trained over FY 2020 despite travel restrictions due to the pandemic.

National Technical Training Program (NTTP). Established in 1985, NTTP is an ongoing training program designed to aid the bureau's mission by increasing the technical competence and professionalism of State, Tribal, and OSMRE regulatory and reclamation staff. The NTTP provides comprehensive training in the skills needed to carry out the mandates of SMCRA. The entire program, from the identification of training needs through course development and presentation, is a cooperative effort between State, Tribal, and OSMRE offices. The NTTP utilized 13 subject matter expert instructors from State, Tribal, and OSMRE offices in FY 2021 to deliver both online and in-person classes. The instructors are experts in mining regulatory and reclamation practices who keep abreast of changing technologies, evolving methodologies, and policies to ensure the training reflects the best protection and land restoration practices.

In FY 2021, the COVID-19 pandemic restricted operations for in-person training. In response, NTTP began designing, developing, and delivering online courses as a supplement to in-person courses. NTTP delivered 11 online courses and 4 special sessions to 236 students in FY 2021. The online courses will remain in the NTTP training portfolio and will continue to be offered as options to in-person course offerings.

The courses NTTP provides cover a wide variety of technical areas for a number of practical applications, including the design of abandoned mine land restoration, proper inspection tools and techniques, soils and revegetation, identification and handling of toxic/acid-forming materials, water-quality assessments, legal aspects of enforcement procedures, and

preparation of evidence and testimony. In FY 2021, the program achieved an overall effectiveness rating of 85 percent, based on student and supervisor responses regarding the value of the training for their current positions.

National Technology Transfer Team (NTTT). The OSMRE NTTT brings together members of OSMRE, State, and Tribal SMCRA programs, as well as representatives from the Interstate Mining Compact Commission and the National Association of Abandoned Mine Land Programs, to coordinate understanding of mining-related issues across the country. The team manages and promotes the Applied Science Program (ASP), whose goal is to develop and demonstrate improved technologies to address environmental issues related to the mining of coal and subsequent reclamation of the land. The program accomplishes this by funding studies conducted by universities, nonprofit organizations, and SMCRA Regulatory Authorities covering topics such as coal mine reclamation, revegetation, blasting, hydrology, coal mine voids and fires, soil productivity, acid mine drainage, rare earth elements, and other topics relevant to environmentally responsible mining and reclamation. These projects go beyond theoretical research and investigate application of existing theory to on-the-ground mining and reclamation issues. In FY 2021, all unfinished ASP projects funded in FYs 2015 and 2016 were completed. Reports and findings of completed projects are available at https://www.osmre.gov/programs/applied-science

In FY 2020, OSMRE issued a Notice of Funding Opportunity (NOFO) for the ASP and received 42 proposals in response. The proposals were evaluated based on scientific and technical merit, and the top eight proposals were selected for funding in FY 2021. The projects have a two-year term, but a no-cost time extension can be granted if warranted. Quarterly programmatic reviews for each funded project are being conducted by assigned Project Technical Representatives.

For FY 2021, OSMRE issued a NOFO for the ASP and received a total of 39 proposals in response. Currently, NTTT is undergoing its merit review process. The final funding announcement will be made in 2022.

The NTTT also hosts and participates in technology transfer activities such as workshops, forums, and symposia to collaborate with partners outside the SMCRA community. This aspect of the team's activities has been significantly impacted by the COVID-19 pandemic. In FY 2021, the team has created an interactive Applied Science GIS application that allows any interested party to access quarterly status reports for funded projects. The GIS application can be accessed at https://experience.arcgis.com/experience/ff3243e737cc476da6ab1368f4836b9c.

Another program that OSMRE uses to award cooperative agreements is the Acid Drainage Technology Initiative (ADTI), created in 1995 and renamed the Mine Drainage Technology Initiative (MDTI) in FY 2017 to reflect the need to address mine drainage (MD) issues beyond acidity. The purpose of the initiative is to build consensus among industry, Federal, and State

regulatory agencies on acidic and toxic drainage technology development and technology transfer issues. MDTI cooperative agreements, which are established under authorities other than the Federal Technology Transfer Act, provide a forum for collaboration and information exchange with the following goals: (1) developing an understanding of MD to better predict, avoid, monitor, and remediate MD; (2) developing innovative solutions to MD water quality problems; (3) identifying, evaluating, and developing "best science" practices to predict MD before mining; and (4) identifying successful remediation practices for existing MD sources, and describing the best preventive technologies.

In FY 2021, OSMRE had two MDTI cooperative agreements funding studies with universities that were in various stages of completion. Also in FY 2021, OSMRE issued another NOFO for an MDTI cooperative agreement, receiving 7 proposals in response and selecting one of the proposals to fund in FY 2022. Like the APS, MDTI cooperative agreements have a 2-year term that can be extended at no cost, if justified.

IX. National Park Service

As part of its mission, the National Park Service (NPS) actively manages the natural, cultural, and historical resources entrusted to it. This management includes preserving and maintaining these resources and, where necessary, preventing impairment, mitigating adverse impacts, or restoring these resources. Most of these activities are undertaken at the level of each individual park unit, but service-wide networks, programs, and centers make related scientific contributions in areas such as inventory and monitoring and preservation technology.

Scientific activities within NPS focus on improving the understanding and management of park natural and cultural resources. In cooperation with partners, NPS also works to preserve and interpret similar resources outside parks. The information generated by these activities is shared with park managers and stakeholders—including public and private land managers, as well as the broader public—largely through interpretive programs, exhibits, conferences, meetings, training, and standard publication media, such as reports, newspapers, journals, magazines, fact sheets, and webpage postings.

To expand the range of expertise and tools available to it, NPS participates in many collaborative ventures with universities and other governmental and nongovernmental organizations, including the Cooperative Ecosystem Studies Units Network.

NPS Cultural Programs include the National Center for Preservation Technology and Training (NCPTT), which Congress created to fill a fundamental need for research and technology transfer among Federal, State, and local historic preservation programs. The NCPTT serves as a research and development laboratory for historic preservation and advances the application of science and technology to preservation problems. The NCPTT also supports applied research, partners with professional and scientific organizations, publishes technical guidance for preservation professionals, and trains students and practitioners in the latest preservation techniques.

NPS encourages qualified scientists to undertake research on parks' physical, biological, and other resources under the aegis of park Scientific Research and Collecting Permits and other permits. Such permits are issued for scientific and educational purposes only. The collected specimens and other materials and components of such specimens and materials may not be used for commercial or other revenue-generating purposes. Parties proposing commercial use of research results must enter into an agreement to share benefits with NPS or an agreement in which NPS explicitly declines to share benefits. In accordance with the National Parks Omnibus Management Act of 1998, which authorizes the Secretary of the Interior to enter into negotiations with the research community and private industry for equitable, efficient benefits-sharing arrangements, NPS has developed policies and procedures to implement benefits

sharing. For each benefits-sharing agreement, NPS proposes to choose an applicable agreement type from among several available authorities. The CRADA, authorized by the FTTA, is one such option.[10]

Device to Facilitate Water Quality Measurement in High Biofouling Environments. The Gulf Coast Inventory and Monitoring Network, one of 32 NPS Inventory and Monitoring Networks, concluded work under a CRADA with In-Situ, Inc., to develop and test an NPS employee's invention and evaluate its potential for commercial manufacture and sale. The device enables currently available datasondes—which are used to measure water quality—to greatly increase the length of unmanned or continuous monitoring deployments in biofouling environments. It may also increase accuracy under turbulent flow conditions.

SINCE 2010, THE GULF COAST INVENTORY AND MONITORING NETWORK HAS CONTINUOUSLY MONITORED WATER QUALITY IN AN EXTREMELY HIGH BIOFOULING ENVIRONMENT IN THE LAGUNA MADRE AT PADRE ISLAND NATIONAL SEASHORE. UPON REPLACING THE STANDARD INSTRUMENTS WITH TWO NPS-*MODIFIED INSTRUMENTS, THE NETWORK REDUCED MAINTENANCE COSTS BY OVER 50 PERCENT.*

LEFT: PLATFORM WHERE THE INSTRUMENT IS DEPLOYED, WHICH IS PART OF THE TEXAS COASTAL OCEAN OBSERVATION NETWORK; (HTTP://WWW.CBI.TAMUCC.EDU/TCOON/); RIGHT: THE INSTRUMENT DEPLOYED IN THE WATER UNDER THE PLATFORM *(SOURCE: CONRAD BLUCHER INSTITUTE, NPS PARTNER, USED WITH PERMISSION)*

[10] For further information on NPS benefits sharing, see Benefits Sharing in the National Parks (U.S. National Park Service) (nps.gov).

The device modifies the calibration chamber of the sondes so that instrument/sensor drift—rather than water quality conditions—drives recalibration frequency requirements.

In FY 2021, the Gulf Coast Inventory and Monitoring Network continued operating two of the modified instruments at Padre Island National Seashore (PAIS). Modifications made to new instruments confirmed that the invention can be effectively deployed on a variety of instruments and is not brand-specific. Before the deployment of the invention at PAIS, instruments needed to be cleaned and maintained every 2 weeks to maintain data quality. These same instruments can now be deployed for more than 45 days without maintenance, resulting in significant savings to the Network. The goal is to make the invention available on the open market so others can benefit from using the device.

TWO WATER QUALITY INSTRUMENTS DEPLOYED SIDE BY SIDE SHOWING THE EXTENT OF BIOFOULING WITHOUT THE INVENTION (ABOVE) AND WITH THE INVENTION (BELOW). (SOURCE: JOE MEIMAN, NPS)

Benefits-sharing Agreement. Yellowstone National Park has a nontraditional CRADA with a small business that is commercializing research results from a study of microbial mats collected from a thermal area in the park. Food products based on its research are currently available in Chicago, New York City, and northern California. The company is providing nonmonetary benefits related to a genetic monitoring program for the purpose of disease detection and conserving genetic diversity of park wildlife. The company will provide monetary benefits to the

park upon successful commercialization of products or services it develops based on its discoveries.

DOUBLET POOL, FRINGED BY GEYSERITE, IN THE UPPER GEYSER BASIN OF YELLOWSTONE NATIONAL PARK. NATIONAL PARK SERVICE. RESEARCH ON MICROORGANISMS FOUND IN THE EXTREME ENVIRONMENTS CREATED BY YELLOWSTONE THERMAL FEATURES HAVE LED TO SOME SIGNIFICANT DISCOVERIES WITH PRACTICAL APPLICATIONS OF GLOBAL SIGNIFICANCE. (SOURCE: JACOB FRANK, NPS)

X. Bureau of Reclamation

The Bureau of Reclamation (Reclamation) is a water management agency whose mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Reclamation is the largest supplier and manager of water in the 17 Western States and the Nation's second-largest producer of hydroelectric power. Reclamation manages water for agricultural, municipal, and industrial uses and provides flood risk reduction and recreation for millions of people.

NEW YORK CANAL, IDAHO (SOURCE: BUREAU OF RECLAMATION)

Reclamation's activities, including hydropower, water deliveries, payroll and recreation, contributed more than $68.9 billion to the economy and supported 486,000 jobs.[11] Most of this production was associated with water deliveries for irrigation ($47 billion) and for municipal and industrial uses ($11.7 billion). Reclamation provides western farmers with irrigation water for 10 million farmland acres that produce 60 percent of the Nation's vegetables and one quarter of its fresh fruit and nut crops. Further, Reclamation delivers about 10 trillion gallons of water to 31 million people for municipal, residential, and industrial use. Through the process of providing water deliveries, Reclamation also generates hydropower through 78 owned power plants, 53 of which are operated and maintained by Reclamation. The latter 53 power plants account for 15 percent of the hydroelectric generating capacity in the United States and

[11] https://doi.sciencebase.gov/doidv/doi-bureau.html

generate roughly 40 billion kilowatt hours of electricity annually (valued at $2.7 billion in Fiscal Year 2019)[12] which is enough to supply more than 3.8 million U.S. households.

HYDROPOWER TURBINES AT SHASTA DAM ON THE SACRAMENTO RIVER NEAR REDDING, CA (SOURCE: BUREAU OF RECLAMATION)

Reclamation Research and Development (R&D). Reclamation's R&D is primarily focused on applications to identify and develop solutions related to the broad spectrum of water- and hydropower-related issues. Reclamation's R&D Office manages two appropriated R&D programs: the Science and Technology (S&T) Program and the Desalination and Water Purification Research (DWPR) Program.

The S&T Program is the primary R&D program for Reclamation and funds intramural research that spans the spectrum of its water-related technical challenges. In addition to supporting internally led research, the program enlists crowdsourced innovation via technology prize competitions addressing some of Reclamation's most difficult challenges in infrastructure, water availability, and environmental compliance. S&T Program goals are to identify and develop cost-effective solutions to the technical and scientific problems affecting the

[12] https://doi.sciencebase.gov/doidv/doi-bureau.html

accomplishment of Reclamation's mission and to communicate those solutions to Reclamation offices, its stakeholders, other water and power management officials, and the general public.

The DWPR Program invests in extramural R&D that advances the capabilities of water treatment technologies to enable them to be used more broadly for the creation of new water supplies from non-traditional sources (e.g., seawater, brackish groundwater, produced waters from oil and gas, municipal and industrial wastewater), nationwide or even globally. Such new supplies can relieve water stress on western communities, Tribes, western river basins supporting Reclamation projects, the Nation as a whole, and worldwide in water-constrained areas. The program also supports the operation and maintenance of the Brackish Groundwater National Desalination Research Facility, which hosts Federal and non-federal R&D clients conducting bench-scale studies to pilot-scale demonstrations.

Reclamation's Technology Transfer. Although Reclamation's R&D focuses on developing solutions that address Reclamation technical mission needs, such solutions can also have broad applicability beyond Reclamation's jurisdiction in the western United States. The transfer of Reclamation's technology and knowledge across the national and international communities of practice maximizes public benefits of Reclamation's R&D investments.

Most of Reclamation's R&D reports, data, and information on technology advancements are transferred through public dissemination via the R&D Office website (www.usbr.gov/research/) as well as through Reclamation's new open data sharing platform, the Reclamation Information Sharing Environment (https://data.usbr.gov/). For example, the R&D Office published outputs (i.e., reports, data products, etc.) from 50 concluding research efforts via its website in FY 2021.

Transfer of other technology advancements harnesses the capabilities and know-how of the private sector to mature, mass-produce, and otherwise commercialize the technology into market-ready products. Reclamation's research nexus with industry is typically in the area of hydroelectric power generation, water infrastructure, water conservation, and desalination/water purification technologies.

If an industry partner is needed to ultimately transfer the technology into a market-ready product, Reclamation utilizes the authorities available under Federal technology transfer legislation to protect intellectual property, as needed, and form research and licensing partnerships with U.S. manufacturing industries. Reclamation's R&D Office implements these authorities on behalf of the bureau and serves as the Bureau's Office of Research and Technology Applications (ORTA), as required by 15 U.S.C. § 3710(b).

Reclamation also works to increase awareness across U.S. industries and other nongovernmental organizations of the specialized research resources (people, lands, and facilities) that they can access through technology transfer agreements authorized by 15 U.S.C. § 3710a. In addition to physical research laboratories, Reclamation's R&D assets include engineering and scientific expertise, extensive water storage, water delivery, and hydropower

facilities that offer unsurpassed, real-world laboratories for field tests, evaluations, and demonstrations of new technologies and processes related to water and hydropower. Although many of its R&D activities do not involve the development of patents or industry involvement to mature technologies into viable products, the technology transfer activities that Reclamation conducts under the authorities of the Federal technology transfer legislation are an important subset of its technology transfer responsibilities and help transfer technology more rapidly and broadly.

Highlights of activities conducted under the Federal Technology Transfer Act during FY 2021 include the following.

An Evaluation of Experimental Cavitation-Resistant Coatings. One of the costliest maintenance items for Reclamation is cavitation damage. Reclamation's primary method for mitigating cavitation on hydropower turbines is by using stainless steel weld overlays. This procedure is time consuming, expensive, and requires significant downtime. The repair method does not have a desirable service lifetime because of corrosion and disbondment issues. Cavitation resistant materials research is being conducted for hydropower infrastructure, with an emphasis on coating materials used with weld overlays to extend the service life and improve reliability.

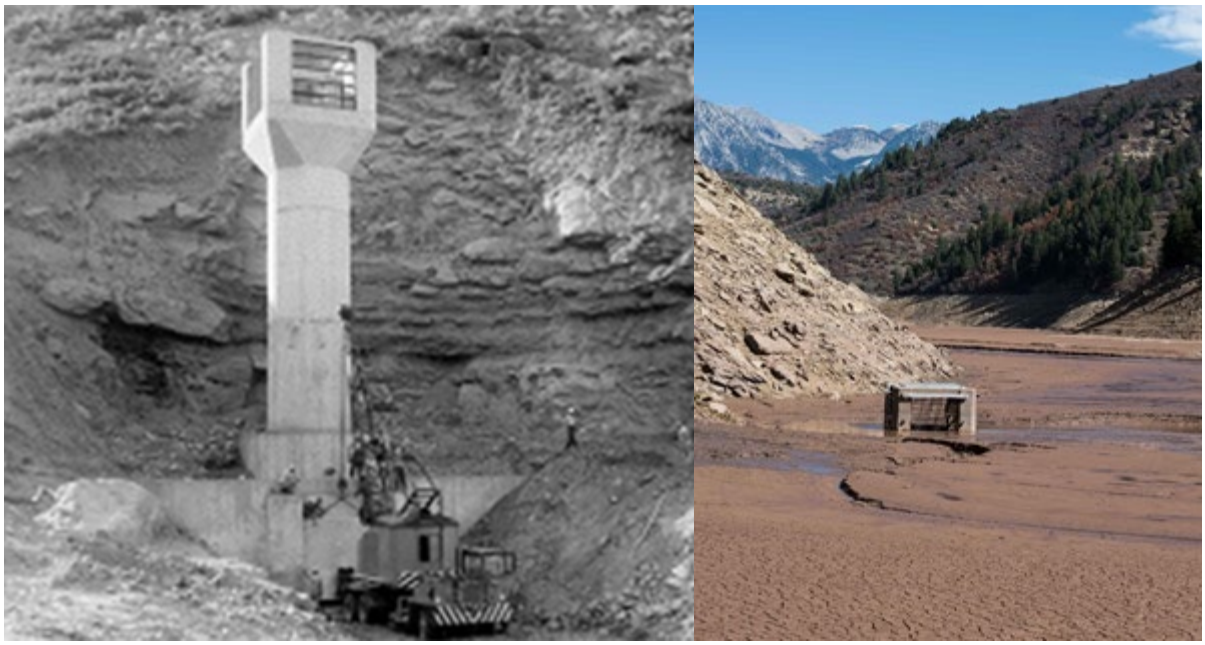
TURBINE RUNNER DAMAGE FROM CAVITATION (SOURCE: BUREAU OF RECLAMATION)

Reclamation entered into a material transfer agreement (MTA) with A.W. Chesterton Company (Chesterton) to evaluate experimental coating formulations designed for cavitation resistance, to be evaluated under laboratory test conditions. Reclamation uses MTAs to evaluate, verify, and rank materials to advance technology performance and provide results for further development or commercialization of products. In accelerated laboratory test, light frosting damage to stainless steel occurs after 40 hours of exposure to cavitation. Coatings with minimal degradation at 40 hours met criteria for cavitation resistance and are considered for scale-up in field trials.

In FY 2021, five unique material formulations were evaluated, with one formulation meeting the criteria of minimal damage after 40 hours of exposure in the accelerated cavitation testing. Reclamation and Chesterton are using the MTA to partner on coating optimization of cavitation resistance for field trials.

Enhancing prize competitions, bringing business and technology mentoring to Guardians of the Reservoir. Reservoir sedimentation can be a major issue at some Reclamation facilities, resulting in a range of issues from loss of storage capacity to infrastructure damage. Reservoir dredging has proven to be costly and sometimes infeasible for large and deep reservoirs, requiring the need to source technologies that can fundamentally change how we maintain our reservoirs. Through the Guardians of the Reservoir Challenge, a prize competition, Reclamation selected teams in the United States, Germany, Switzerland, and Australia to develop their proposed technologies to reduce the overall cost of reservoir dredging. As their solutions developed and improved, support grew for the solver teams to bring the ideas to market where Reclamation could be a potential end user.

Reclamation partnered with Hyperion Technologies, LLC (Fed Tech) to develop a customized accelerator program to help the five solver teams implement their technologies. This includes fostering industry connections with the cohort, providing educational programming, supporting teams with mentors, and executing individualized business development. The overall goal for using the accelerator model is to streamline the road from technological investment to implementation and help solve our Nation’s sedimentation challenges.



SEDIMENT ACCUMULATION AT PAONIA RESERVOIR IN COLORADO. LEFT: CONSTRUCTION OF THE INTAKE STRUCTURE (1961). RIGHT: INTAKE STRUCTURE SURROUNDED BY SEDIMENT (2017). (SOURCE: BUREAU OF RECLAMATION)

Developing Water Supplies Using Forward Osmosis (FO) Combined with Ion Exchange (IX). Reclamation engineers and scientists continue to develop technologies to develop water supplies from non-traditional sources. One challenge is to bring promising technologies through the patent process and into market-scale. To meet this challenge, partnerships which protect intellectual property and have a benefit to both the Federal Government and to private industry are needed.

There are an estimated 3,500 community water systems and 26,000 non-community water systems in the U.S. that use IX for softening, inorganic contaminant, and organic matter removal. IX efficiently removes the two most frequent inorganic contaminant violations of the Safe Drinking Water Act: nitrate and arsenic. If proposed regulations for hexavalent chromium are implemented, the number of utilities in search of economical treatment using established processes like IX will increase.

Reclamation and Ayon LLC entered into a CRADA in FY 2021 with the intent of producing a full-scale prototype to demonstrate combining FO and IX. Although IX is a best available technology for many contaminants, the cost and logistics of waste brine management dictate treatment feasibility. Inserting the FO process between the waste brine tank and salt saturator reduces the waste volume while extracting high quality, recyclable water for a subsequent IX regeneration. Additionally, while FO has been investigated for many water treatment applications over the past two decades, its potential for IX waste management has only recently been demonstrated.

TUBULAR MEMBRANES AT RECLAMATION'S YUMA DESALTING PLANT IN YUMA, ARIZONA (SOURCE: BUREAU OF RECLAMATION)

The CRADA developed between Ayon and Reclamation allows the government's novel intellectual property to be protected during the patent process while allowing partnership with a private entity to bring the solution to market.

XI. Bureau of Safety and Environmental Enforcement

The Bureau of Safety and Environmental Enforcement (BSEE) works to promote safety, protect the environment, and conserve resources offshore through vigorous regulatory oversight and enforcement. BSEE's R&D focus is on offshore energy issues and activities. These activities primarily involve two offices: the Office of Offshore Regulatory Programs (OORP) and the Oil Spill Preparedness Division (OSPD).

OORP develops regulations and incorporates industry standards to enhance operational safety and environmental protection for the exploration, development, and production of offshore oil, natural gas; the development of renewable energy; and other energy activity on the U.S. OCS. OORP drives and supports continual improvement in safety, environmental protection, and offshore resource conservation through data and risk analysis, safety improvement initiatives, regulatory development and maintenance, standards and stakeholder engagement, policy development and oversight, and emerging technology evaluations to provide strategic guidance in support of BSEE's regulatory oversight and enforcement mission.

OSPD ensures that owners and operators of offshore facilities are ready to mitigate substantial threats of, and to respond to, actual oil spills that may result from their activities. OSPD performs numerous functions to improve oil spill preparedness and response capabilities, including comprehensive contingency planning, equipment testing and inspection, quality training, unannounced exercises, R&D, and engaging with the stakeholders of the National Response System.

BSEE R&D programs operate through OORP's Emerging Technologies Branch (ETB) and OSPD's Response Research Branch. The ETB is the agency's focal point on operational safety and pollution prevention research. Such research has been conducted within DOI since the late 1970's. OSPD's OSRR in its Oil Spill Preparedness Program contributes to the interagency collaborative efforts formalized in Title VII of the Oil Pollution Act of 1990.

OSPD also operates Ohmsett, the National Oil Spill Response Research and Renewable Energy Test Facility in Leonardo, New Jersey. The Ohmsett facility provides independent and objective performance testing of full-scale oil spill response equipment and marine renewable energy devices. In addition, the facility is available to help improve existing technologies through R&D. Domestic and international researchers from government, industry, academia, and oil spill removal organizations use Ohmsett to test and advance their technologies and train personnel on the use of advanced response equipment.

The majority of BSEE's technology advances are shared with the public through reports that are publicly available on its website. BSEE also shares its research results at conferences, workgroups, and other fora, such as the triennial International Oil Spill Conference, the annual

Clean Gulf Conference, the Pacific States-British Columbia Oil Spill Task Force Annual Meeting, the National Response Team Science and Technology Committee, the Northern Oil and Gas Research Forum, the BSEE/U.S. Coast Guard (USCG) Response Work Group, BSEE/USCG Research Sharing meetings, industry meetings, and the Ocean Energy Safety Institute's Public Research Forum.

BSEE's primary research synergy is with State, Tribal, Federal, and international government organizations; the offshore energy industries; and oil spill removal organizations. Research is typically in areas pertaining to critical equipment and technology, environmental impact, and risk reduction and assessment tools and techniques applicable to the U.S. OCS to ensure that the best available science is utilized in regulatory decision-making. [13]

BSEE is a member of the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) and its Executive Steering Committee. Comprised of 16 Federal agencies, ICCOPR was established by Title VII of the Oil Pollution Act of 1990 to "coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the Federal agencies, in cooperation and coordination with industry, universities, research institutions, State governments, and other nations, as appropriate." ICCOPR publishes the Oil Pollution Research and Technology Plan (R&T Plan) that establishes the official Federal priorities to address research gaps in preparedness, prevention, response, and injury assessment and recovery for oil spills. Throughout FY 2021, BSEE led efforts by the Executive Steering Committee to organize the ICCOPR to update the FY 2015-2021 R&T Plan.

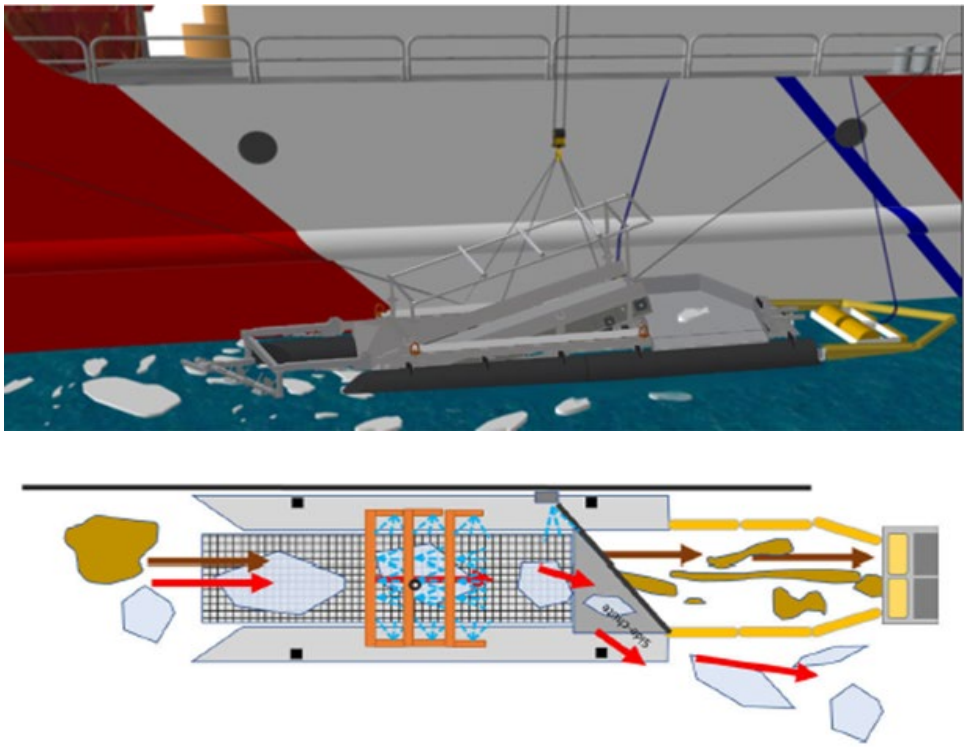
BSEE is a member of the International Regulators' Forum, which consists of members from 11 countries whose goal is to provide leadership on safety and safety-related regulatory matters for offshore energy activities. Other members include Norway, Canada, Brazil, and the United Kingdom.

The following are examples of FY 2021 completed or ongoing research projects that would, among other things, advance technological options and transfer knowledge about best technological practices to industries and regulators operating on the OCS.

Development of the BOWHEAD Vessel Ice Management System. BSEE contracted with Serco, Inc. to develop an ice deflection system called BOWHEAD to improve oil recovery in broken ice conditions. The BOWHEAD is deployed off the side of a vessel. As the vessel moves slowly forward, the BOWHEAD encounters oil and ice. Ice that enters between the pontoons is picked up by a conveyor belt. Oil remains in the water and is guided aft, where it is contained and

[13] Additional information and research deliverables are available at https://www.bsee.gov/what-we-do/research/tap and https://www.bsee.gov/what-we-do/oil-spill-preparedness/oil-spill-response-research.

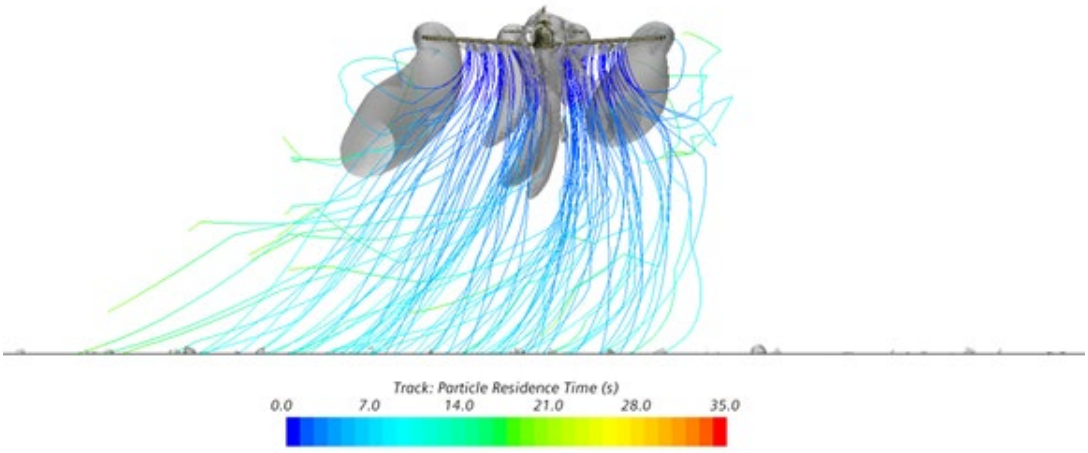
recovered by a standard boom and oil skimmer. The ice is cleaned as it moves up the belt and is then dumped out of the recovery area via an ice chute. Redirection of this ice allows the skimmer to operate in an ice-free zone. The BOWHEAD prototype was tested in 2021 in a simulated arctic ice environment. BSEE OSPD plans to enhance the BOWHEAD prototype and conduct additional testing in 2023 to quantify its ability to improve oil recovery in ice over current oil-in-ice response tactics.



CONCEPT OF BOWHEAD SYSTEM OPERATING OFF THE SIDE OF A VESSEL (SOURCE: SERCO, INC./BSEE, WITH PERMISSION)

BOWHEAD ENCOUNTERING OIL AND ICE AS IT TRAVELS DOWN THE TEST TANK DURING 2021 TESTING (SOURCE: BSEE/OHMSETT, WITH PERMISSION)

Developing an Innovative Dispersant Spray Drift Model. BSEE funded a project with AMOG Consulting Inc. to develop a decision support tool to assist in applying oil dispersants. The tool allows planners to identify operational windows and safety setback distances based on forecast meteorological conditions, spray drift patterns, aircraft types, and release rates. To create this tool, the contractor used Computational Fluid Dynamic (CFD) models to examine the forces and conditions experienced by a particular aircraft type during flight and how dispersants may behave as a result when released. The modeling created a library of data that informs predicted outcomes in an online display after the user inputs values for certain variables such as aircraft type, airspeed, and wind direction.



EXAMPLE OF DISPERSANT PARTICLE TRACK GENERATED FROM CFD MODELING FOR AN AT-802A MODEL AIRCRAFT EXPERIENCING A 90° MAXIMUM HEADWIND CONDITION (SOURCE: AMOG/BSEE, WITH PERMISSION)

The final report and the online calculator have been delivered and BSEE is preparing to submit them for peer-review before the end of calendar year 2022. Based on the feedback provided during the peer review process, BSEE may update the final report and the online tool before they are made available to the public.

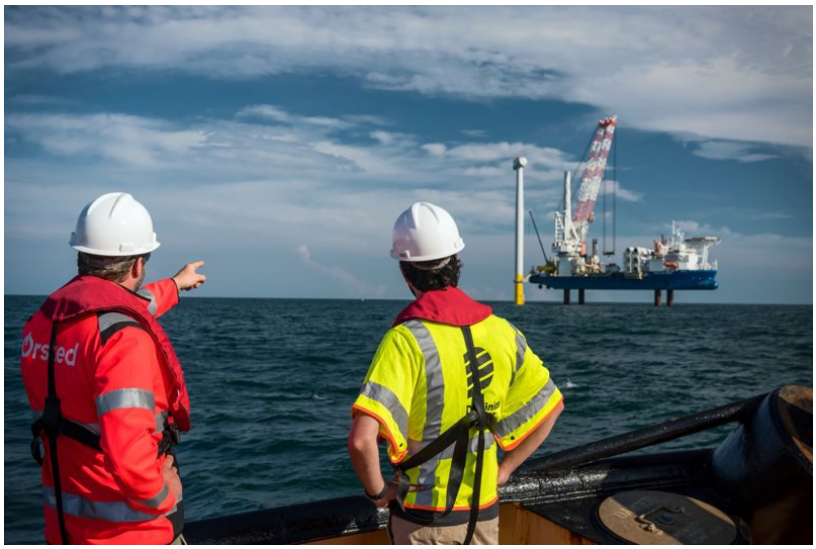
Ocean Energy Safety Institute (OESI). The OESI was established through a cooperative agreement between BSEE, the Department of Energy (DOE), and the Texas A&M Engineering Extension Service (TEES) that was initiated in FY 2021. OESI is a joint, collaborative initiative engaging the government, academia, industry, and scientific stakeholder communities. Its primary objective is to conduct cooperative research while building a collaborative model grounded upon principals of shared learning and promotion of dialogue and complementary research.

In support of OESI, TEES has assembled a consortium of industry, national labs, non-governmental organizations, and academia. The consortium includes 16 universities in 10 States, three national labs, and more than 20 stakeholders representing conventional and renewable energy. The OESI will support critical improvements for all offshore energy activities, including renewable and traditional energy, and support new offshore energy technology development.

CRANE INSTALLING AN OFFSHORE WIND TURBINE (SOURCE: BSEE RENEWABLE ENERGY PROGRAM)

BSEE and DOE are substantially involved in the institute through a Joint Steering Committee (JSC), which includes representatives from each agency with expertise related to oil and gas, offshore wind, and marine energy technologies. The JSC provides input to OESI on its technology roadmaps and annual plans and reviews and approves its significant deliverables.

Renewable Energy Remote Inspections. Today's offshore wind turbines are developed with real-time remote monitoring technologies that aid turbine operators with performing preventative maintenance, optimization, and diagnostics. These technologies have been successfully implemented in parallel industries such as offshore oil and gas to satisfy various asset inspection and maintenance requirements. A study, initiated in FY 2021, will evaluate the available options and economic benefits of conducting remote inspections, monitoring, maintenance, testing, and repairing offshore wind turbines above and below the waterline.



TWO EMPLOYEES WATCHING OFFSHORE WIND TURBINE INSTALLATION (SOURCE: BSEE RENEWABLE ENERGY PROGRAM)

Probabilistic Risk Assessment: Multiple shear rams (Casing Shear Ram (CSR) + Dual Blind Shear Ram (BSR)) Analysis. This risk assessment evaluates the benefit of adding a second piece of equipment to allow a drill ship to escape in an emergency. The Deadman/Autoshear (DMAS) sequence activates in the event of the death or incapacitation of the driller who is operating the equipment. This application analysis aims to quantify and compare the benefit to the loss of containment risk of adding a second shear ram. This analysis applies to exploration and development wells drilled by rigs using dynamic positioning systems. This assessment was completed in FY 2021. Results will be released following peer review.

Probabilistic Risk Assessment: Surface Blow Out Preventer w/Subsea Isolation Device phase 1 vs. dual BSR/CSR Dynamic Positioning Rig Analysis. BSEE undertook an analysis of a previously untried and complex configuration of equipment, and compared it to a known implemented

configuration. The analysis looked at the relative risk of a traditional dynamic positioning system drillship with a subsea blowout preventer (BOP) compared to that of a moored mobile offshore drilling unit with DP-assist with a surface BOP, high-pressure riser, and a Subsea Isolation Device. The risk analyzed pertains to uncontrolled hydrocarbon release during the completion of deepwater operations. This assessment evaluates the well-completion scenario. This assessment was completed in FY 2021. Results will be released following peer review.

XII. Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) manages the Nation's offshore energy and mineral resources in an environmentally and economically responsible way. It ensures access to, and the fair return for, conventional and renewable energy and mineral resources of the U.S. OCS to help meet the Nation's energy and mineral needs while protecting the human, marine, and coastal environments.

As the Nation's offshore energy and mineral resource manager, BOEM is committed to using the best available science across a range of relevant disciplines that provide the scientific and technical foundation and the human capital needed to make sound decisions at all levels of the organization. Management of the energy and mineral resources of the OCS is governed by the Outer Continental Shelf Lands Act, which establishes procedures for leasing, exploration, and development and production of those resources, including oil, gas, renewable energy, and marine minerals such as sand and gravel used for coastal restoration projects.

BOEM's Office of Environmental Programs (http://www.boem.gov/Environmental-Stewardship/) conducts environmental reviews, including National Environmental Policy Act analyses and compliance documents for each major stage of energy planning and development. These analyses inform BOEM's decisions on its National OCS Oil and Gas Leasing Program, as well as on a variety of other conventional and renewable energy leasing and development activities. In addition, BOEM's scientists conduct and oversee environmental studies to support decisions relating to the management of energy and marine mineral resources on the OCS through its Environmental Studies Program (ESP).

BOEM's three regional offices—located in New Orleans, Louisiana; Camarillo, California; and Anchorage, Alaska—manage oil and gas resource evaluations; environmental studies and assessments; leasing activities, including the review of plans for exploration, development, and production; fair market value determinations; and geological and geophysical permitting.

BOEM Environmental Studies Program. BOEM's ESP strives to apply the best science available for informed decision-making. It plans, conducts, and oversees world-class scientific research to inform policy decisions regarding leasing and developing OCS energy and mineral resources. BOEM works to manage the exploration and development of the Nation's offshore resources in a way that appropriately balances economic growth, energy development, and environmental protection through oil and gas leases, renewable energy development, and environmental reviews and studies. BOEM's environmental studies cover a broad range of disciplines, including archaeological resource protection, physical oceanography, meteorology and air sciences, biology, protected species, social sciences and economics, submerged cultural resources evaluation, and the overall environmental effects of energy development. BOEM continues to

be a leading contributor to the growing body of scientific knowledge about the Nation's marine and coastal environment.

BOEM oversees scientific research conducted through contracts, partnerships with other governmental bureaus, cooperative agreements with State institutions or universities, and interagency agreements. These arrangements enable the bureau to leverage resources, meet national priorities, and satisfy common needs for robust scientific information. Many of the bureau's studies are collaborations with partners under the umbrella of the National Oceanographic Partnership Program.

BOEM Technology Transfer. BOEM's technology transfer activities include disseminating information, knowledge, and technologies to the various regions and to commercial entities and other stakeholders with interests in the OCS. Virtually all these activities are undertaken using authorities provided to BOEM other than the FTTA. Studies undertaken by or through funding from BOEM are available to the public through the ESP Information System, which summarizes more than 1,800 ongoing and completed BOEM-sponsored environmental research projects and provides online access to more than 3,700 research reports (http://www.boem.gov/studies). In 2021, ESP completed 32 studies that accounted for approximately $44.5 million in BOEM-funded ocean research.

BOEM also partners with BSEE to select and fund renewable energy research to facilitate industry development and promote operational safety and pollution prevention through BSEE's Technology Assessment Program.[14]

BOEM also participates in and provides funds for interdisciplinary projects, including partnerships with other Federal agencies and academic institutions, as well as the private sector. These projects are directed toward offshore ecosystem studies that utilize state-of-the-art technologies, such as autonomous underwater vehicle (AUV) surveys, deep-water human-occupied submersibles, and remotely operated vehicles. These partnerships leverage expertise and technologies to meet common management goals.

The following are a few examples of BOEM's ongoing scientific R&D activities, including some conducted in cooperation with other parties.

Harnessing the Power of eDNA to Detect Arctic fish, Invertebrates, Birds and Mammals. Fish nets have typically been used as part of the Beaufort Sea long-term monitoring program. In 2021, BOEM entered a cooperative agreement with the University of Alaska Fairbanks (UAF) to augment this traditional fish catching method by installing water samplers on fish nets to carry

[14] More information on this research is available at https://www.boem.gov/Technology-Assessment/.

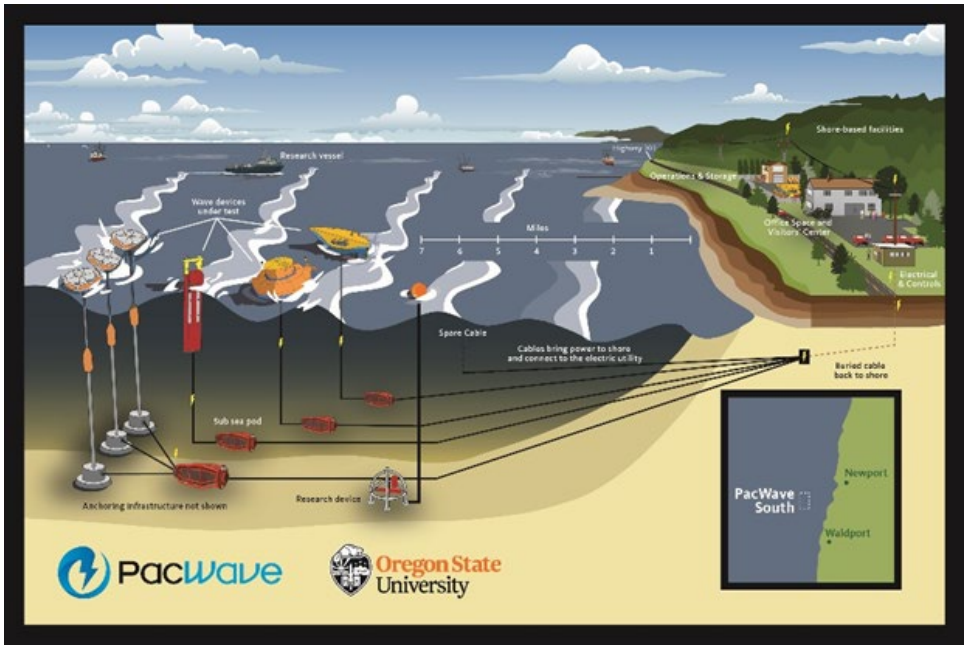
out eDNA sequencing from water samples at UAF facilities. The eDNA methodology will help scientists target and detect fish, invertebrates, birds, and mammals from the Arctic marine environment.

New York (NY) Bight Fish & Fisheries. BOEM completed a cooperative agreement with Rutgers University to synthesize data and literature about fish and fisheries in the NY Bight. A new cooperative agreement has been awarded for the next phase of this research, which will fill data gaps for applied marine minerals information needs that were identified during phase one of this project. Rutgers University proposed to use its AUV equipped with benthic mapping equipment to scan the NY Bight for fish, combining geophysical and biological sampling to provide a high-resolution snapshot of resident fish behavior in the marine minerals development areas. The analysis of AUV survey data will be supplemented with traditional fisheries trawls and fish tagging to monitor resident fish in the marine minerals development areas.

Field Evaluation of an Unmanned Aircraft System (UAS) for Studying Cetacean Distribution, Density, and Habitat Use in the Arctic. Manned aerial surveys are routinely used to assess cetacean distribution and density, often over large geographic areas. UAS can augment or replace manned aerial surveys for marine mammals. BOEM completed a pilot study in partnership with the National Oceanic and Atmospheric Administration and the U.S. Navy that flew UAS aerial surveys for cetaceans near Utqiagvik (Barrow), Alaska. Various technologies—such as a temperature and humidity sensor, a software system that provided near-term forecasts of highly variable weather, and a surface-based air traffic radar feed—directly contributed to the ability to conduct successful routine beyond-line-of-sight UAS flights under a variety of weather conditions. The study compared the costs of UAS to traditional aircraft surveys and recommended opportunities to streamline project planning and enhance researchers' ability to use UAS to collect data needed for ecological research.

Partnering with States on Offshore Renewable Energy Research. BOEM is working with Oregon, Rhode Island, Virginia, and Massachusetts on renewable energy research and development. On February 16, 2021, BOEM issued a research lease to Oregon State University for the PacWave South Project, the first wave energy test facility in Federal waters offshore the U.S. West Coast. The project will test wave energy devices to demonstrate their viability. BOEM funded research at the Nation's first offshore wind facility, located near Block Island, Rhode Island, to evaluate the environmental impacts during construction and early operations. In December 2020, this research resulted in a peer reviewed article on the lessons learned from the Block Island Wind Farm in a special issue of the journal *Oceanography*. BOEM also conducted underwater acoustic monitoring at the Coastal Virginia Offshore Wind pilot project in coordination with the Commonwealth of Virginia. BOEM partners with the Massachusetts

Clean Energy Center to conduct field surveys of marine mammals and turtles in wind energy areas and several studies addressing concerns of commercial fishing.



PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE (PACWAVE) GRAPHIC. (SOURCE: OREGON STATE UNIVERSITY, USED WITH PERMISSION.)

XIII. Bureau of Land Management

The Bureau of Land Management (BLM) manages approximately 245 million surface acres and 700 million subsurface acres in the United States. BLM's multiple-use and sustained yield mandate directs the management of public land resources for a variety of uses, such as recreation, wildlife conservation, energy and minerals development, livestock grazing, and timber harvesting, while also protecting a wide array of natural, cultural, scientific, and historical resources for the use and enjoyment of present and future generations. To support this dual mission, the BLM annually conducts and supports hundreds of research and development projects with diverse entities such as Cooperative Ecosystem Studies Units; colleges and universities; scientific societies and institutes; national laboratories; museums; botanic gardens and arboretums; Federal, State and Tribal government agencies; non-governmental organizations; and the private sector. These projects advance the state of knowledge and technology concerning all aspects of BLM resource management, and transfer those advances to entities and persons outside the BLM through publication of reports, technical references, scientific journal articles, data releases, fact sheets, presentations, web-based products, books, and more. Examples of FY 2021 technology transfer activities include the following bureau-wide and program-specific efforts.

BLM Library and Publishing. BLM provides essential support to technology transfer by offering a full range of publication services encompassing research support, consultation, and planning; writing and editing; design and layout; external publication; and coordination of printing and distribution. Librarians, writer/editors, visual information specialists, and printing specialists work in concert to provide publication assistance for a broad spectrum of BLM communication products. The BLM Library helps the public find BLM publications and a wide array of other publications and information

Quality Data. BLM regularly gathers, maintains, and publishes various types of data to inform stakeholders and the public about its resources and stewardship responsibilities. These data include detailed information on the commercial uses of the public lands, recreational activities, wild horse and burro management, cadastral (mapping) surveys, the extent and quality of BLM managed resources, and data for units of the BLM's 32-million-acre National Conservation Lands system. These data also include information on the socioeconomic impacts and benefits of public land management.

Much of these data are synthesized and published annually as tabular data in BLM's *Public Lands Statistics Report*, and as graphics and summaries in *The BLM: Sound Investment For America*. These data are also often published as geospatial data. BLM Navigator provides a centralized location to discover and access BLM's geospatial data from project, State, and

national levels. The Landscape Approach Data Portal is the source for public geospatial data, maps, models, and reports produced by BLM's landscape initiatives, including the Assessment, Inventory & Monitoring (AIM) strategy; BLM National Data, Fire & Invasives Assessment Tool (FIAT) program; Greater Sage-Grouse (GRSG); Integrated Rangeland Fire Management Strategy (IRFMS); and Rapid Ecoregional Assessments. The BLM also provides data to clearinghouses maintained by the Federal Government, such as data.gov, recreation.gov, and data.doi.gov, and provides historic and newly acquired imagery to the public via the U.S. Geological Survey's Earth Resources Observation and Science Center (USGS-EROS).

Joint Fire Science Program (JFSP). The JFSP is a joint agency and interdepartmental research, development, and science partnership between the U.S. Department of the Interior and the U.S. Department of Agriculture Forest Service. The JFSP provides funding for studies associated with managing wildland fire, fuels, and fire-impacted ecosystems to prepare for the emerging needs of managers, practitioners, and policymakers from local to national levels. The program provides leadership to the fire science community by identifying high-priority fire science research to meet management objectives. Transferring research findings to managers, practitioners, and policymakers is one of the main objectives of the program. The JFSP accomplishes most of its science delivery through an organized, national network of regional fire science exchanges named the Fire Science Exchange Network. The Fire Science Exchange Network brings together fire managers, practitioners, and scientists to address common needs and challenges and provides access to the latest science through publications, webinars, workshops, field tours, discussion forums, and other activities that promote interactions between resource managers and researchers.

In FY 2021, BLM employees contributed to approximately 31 research projects funded by the JFSP as collaborators or partners. In addition, BLM landscapes were used in approximately 74 on-going JFSP research projects, with research themes including fuels treatment effectiveness, future shifts in plant distribution, post-fire community dynamics, and management strategies to create resilient landscapes. The JFSP program Director, Tech Transfer Specialist, Budget Analyst, and one Governing Board member are all BLM employees.

BLM's National Conservation Lands. BLM's National Conservation Lands collectively comprise a natural scientific "laboratory," attracting scientists from around the world to investigate topics ranging from geology, paleontology, archaeology, history, biology, botany, and ecosystem studies. These scientific projects inform the decision-making process of BLM managers, and public outreach is emphasized. In FY 2021, nationwide efforts included continued improvements to systems for tracking research efforts and updating standardized resource condition monitoring systems and datasets. Other FY 2021 highlights include research evaluating effects of post-fire restoration on native pollinator success, investigating impacts of human activity on migratory bird mortality, updating methods for monitoring birds of prey

populations in the intermountain west, understanding influences on regional-scale seabird population along the Pacific Northwest coast, establishing a water quality baseline for Wild and Scenic Rivers, and investigating the presence of per-and polyfluoroalkyl substances and microplastics in hot springs of the Great Basin.

Cultural Heritage and Paleontology. The BLM Cultural Heritage and Paleontology programs partner with museums, universities, and others to conduct research, inventory the public lands, learn about the location and significance of cultural and paleontological resources, manage important cultural and scientific collections of artifacts and specimens from the public lands, and share research results with the public and across research communities. In addition, BLM partners with State historic preservation offices, State geological surveys, Indian Tribes, museums, and universities to facilitate research and gather location-specific information to better manage and place into context cultural and paleontological sites on BLM lands. Archaeological and paleontological research conducted in FY 2021 included a focus on the impacts of past disturbances, such as volcanic eruptions, on human lifeways, and recovering paleontological and archaeological resources impacted by natural erosion and climate change. BLM's participation in and support of programs such as "Project Archaeology" helps ensure educators can communicate the value of archaeology and inspire students to continue to protect and value our heritage.

Assessment, Inventory, and Monitoring (AIM). BLM's AIM strategy is a standardized process to collect quantitative information on the status, condition, trend, amount, location, and spatial pattern of resources on the Nation's public lands. AIM data are used by the BLM and a wide variety of Federal and State agencies, universities, nongovernmental organizations, private industry, and the public. 7829 AIM data points were sampled in FY 2021.

National Aquatic Monitoring Center (NAMC). The National Aquatic Monitoring Center is a cooperative venture between Utah State University and the BLM. NAMC's primary foci are the use of aquatic macroinvertebrates as bioindicators of freshwater biological integrity under the Clean Water Act and the development of scientifically defensible aquatic monitoring and assessment tools. NAMC processes macroinvertebrate and water samples for more than a dozen State and Federal agencies and supports web-based interfaces to publicly share monitoring data. NAMC also identifies and documents the distribution of aquatic invasive invertebrates to help control or ultimately prevent their spread.

XIV. Bureau of Indian Affairs

The Bureau of Indian Affairs (BIA) is the oldest agency of the United States Department of the Interior. Established in 1824, it is responsible for the administration and management of 55 million surface acres and 57 million acres of subsurface minerals estates held in trust by the United States for American Indians, Indian Tribes, and Alaska Natives. BIA's mission is to enhance the quality of life, promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian Tribes, and Alaska Natives. BIA primarily provides technical and financial assistance to achieve these ends. BIA also prepares technical reports, conducts seminars, and provides training.

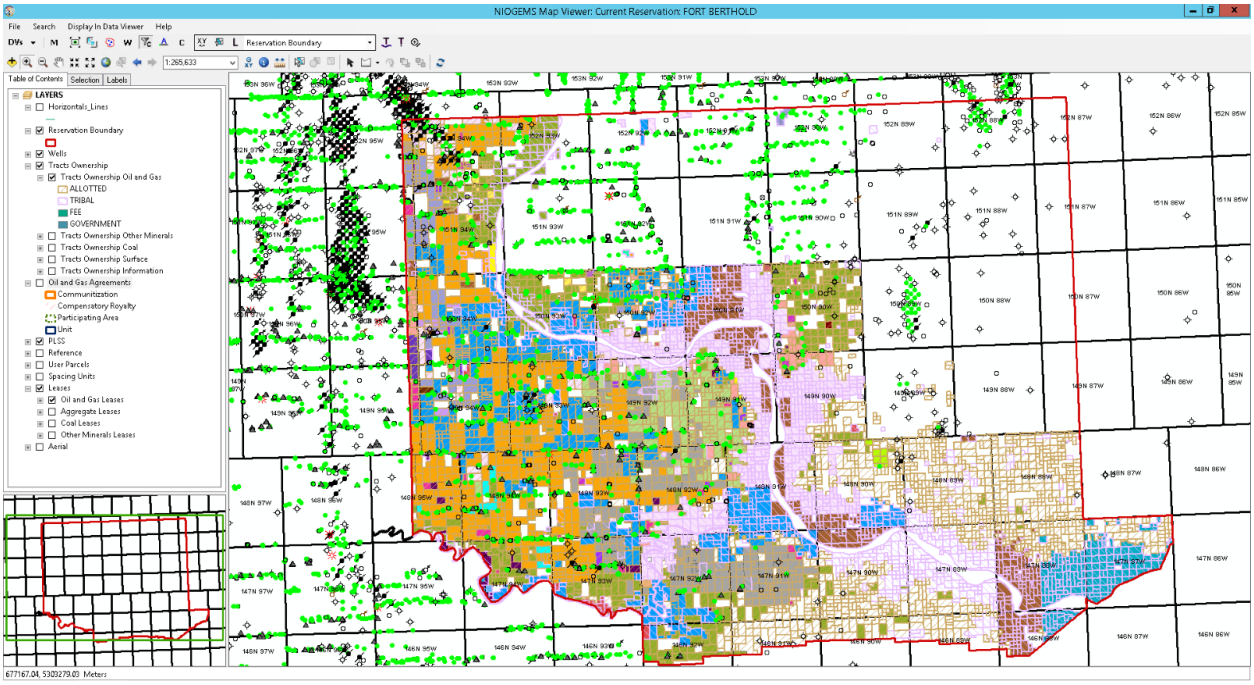
National Indian Oil & Gas, Energy and Minerals System (NIOGEMS). NIOGEMS is a software system available only to Tribal offices and Tribal-supporting Federal entities. NIOGEMS allows users to track and make decisions on developing and managing resources by readily accessing financial, realty, and geo-technical information of Indian lands with energy and mineral potential.

The BIA's Division of Energy and Mineral Development (DEMD) developed the NIOGEMS system. NIOGEMS is a map-oriented computer application for managing reservation oil and gas leases and wells, production data, and other energy/mineral resources. The system is designed to assist both oil and gas producing Indian Tribes as well as Tribes with other energy/mineral resources. NIOGEMS is an application that uses data obtained, prepared, and combined from other systems and sources. NIOGEMS consolidates and regularly updates many types of data for a reservation from a variety of sources, allowing the generation of reports, sharable maps, and data extractions for use in other analytical software.

DEMD issues an End User License Agreement (EULA) to set forth the terms of agreement with Tribal organizations, within which there are multiple approved Tribal users. Tribes are only given access to their own Tribal data. Tribal-supporting Federal entities do not require EULAs, however, they must be approved and their access to Indian trust data is restricted. Tribal entities provide the server hardware, operating system, server applications, including Remote Desktop Services, and any other software desired by the Tribe necessary to run the NIOGEMS system. Tribes provide all required maintenance to their hardware and software, except for the NIOGEMS application and database. The installation and updates to the application, user training, and digital data are provided to participating Tribes at no cost.

NIOGEMS currently includes data for 74 Indian reservations. The cost of installing NIOGEMS for all of these Tribes is prohibitive. However, NIOGEMS, continues to grow in the number of uses, users, and functionality. Until very recently, NIOGEMS was focused exclusively on oil and gas.

NIOGEMS is now expanding to include renewables, hard rock minerals, and rights-of-ways. In FY 2021, NIOGEMS added 57 new users (15 Tribal and 42 Tribal supporting Federal agencies), for a total of 239 users (189 Federal and 50 Tribal). In FY 2021, NIOGEMS added one new EULA (Osage Mineral Council, for a total of seven EULAs); and upgraded core GIS components. More updates, to include data for soils, aggregate exploration, and rights-of-way, are expected in the future. Below is a NIOGEMS screen shot for Fort Berthold Reservation highlighting the wells, leases, and mineral ownership datasets.



NIOGEMS SCREEN SHOT FOR FORT BERTHOLD RESERVATION -9-MARCH-2022

XV. Conclusion

During FY 2021, DOI's technology transfer activities provided critical information and technologies to improve our understanding of and ability to address key issues such as climate change, drought, wildland fire, threatened and endangered species, etc. During FY 2021, DOI's technology transfer activities included the following activities:

- Engaged in 429 Cooperative Research and Development Agreements (CRADAs) and at least 625 other collaborative R&D relationships.
- Disclosed two (2) new inventions, filed one (1) new patent application, and received one (1) new patent.
- Managed 58 active licenses for inventions and other intellectual property, which collectively earned $67,694.
- Published over 900 reports, books, papers, fact sheets, and other documents.

XVI. Data Appendix

The following tables provide cumulative data for DOI from FY 2017 through FY 2021. Data for individual bureaus are available online.

Data are provided if they are collected and readily available. Note that a blank cell or "N/A" indicates either zero, the data are not collected, or the data are otherwise unavailable. These tables include updates to previous years' data, where appropriate.

Table 1: Disclosures and Patents

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
	Invention Disclosures					
1	Invention Disclosures Received	13	9	8	4	2
	Patents					
2	Total Patent Applications Filed	6	7	3	4	1
3	*US*	1	1	0	2	1
4	*Foreign*	0	0	0	0	0
5	Total PCT Applications Filed. (**NOTE**: PCT = Patent Cooperation Treaty. See https://www.wipo.int/pct/en/)	0	0	0	0	0
6	Number of patents Issued	3	6	1	3	1
7	*US*	0	0	0	0	1
8	*Foreign*	0	0	0	0	0

Table 2: Licenses

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
9	Invention Licenses, Total Active	2	2	2	2	10
10	*New Invention Licenses*	0	0	0	0	2
11	*New Invention Licenses to Small Businesses*	0	0	0	0	1
12	Income bearing licenses, Total Active	13	15	16	14	9
13	*New Income Bearing Licenses*	0	0	0	0	1
14	*Exclusive licenses*	7	8	7	7	8
15	*Partially exclusive licenses*	0	0	0	0	0
16	*Non-exclusive licenses*	6	8	9	6	2

17	Other Licenses, Total Active	0	0	0	0	48
18	*New Other Licenses*	0	0	0	0	42
19	*New Other Licenses Granted to Small Businesses*	0	0	0	0	40
	Elapsed Amount of Time for Granting Invention Licenses					
20	Average (months)	7.5	7	7	7	30.5
21	Minimum (months)	3	7	7	7	29
22	Maximum (months)	12	7	7	7	32
23	Licenses terminated for cause	0	1	0	1	1

Table 3: License and Royalty Income

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
24	**Invention License Income**	$50,090	$50,925	$42,168	$122,749	$67,694
25	**Other License Income**					
26	**Total Earned Royalty Income (ERI)**	$50,090	$50,925	$42,168	$122,749	$67,694
27	*ERI from top 1% of licenses*					$53,630
28	*ERI from top 5% of licenses*					$53,630
29	*ERI from top 20% of licenses*					$53,630
30	Minimum Earned Royalty Income					$3,195
31	Maximum Earned Royalty Income					$53,630
32	Median Earned Royalty Income					$10,925
	Disposition of ERI					
33	Percent of ERI distributed to inventors	51%	62%	64%	39%	36%
33A	Amount of ERI distributed to inventors	$25,695	$31,770	$27,121	$47,872	$24,045
34	Percent of ERI distributed to the agency or laboratory	14%	38%	36%	34%	37%
34A	Amount of ERI distributed to the agency or laboratory	$7,244	$19,156	$15,047	$41,735	$24,762

Table 4: CRADAs

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
	CRADAs					
35	Total Active CRADAs	843	741	470	489	429
36	New CRADAs	479	422	352	237	139
37	New CRADAs Involving Small Businesses			2	2	1
	Other collaborative R&D relationships					
38	Other Collaborative Agreements, total active in the FY	247	249	269	353	625

XVII. Acronyms

AADA	Aquatic Animal Drug Approval Program
AADAP	Aquatic Animal Drug Approval Partnership
ADTI	Acid Mine Drainage Initiative
AGOL	ArcGIS Online
AML	Abandoned Mine Lands
AIM	Assessment, Inventory and Monitoring
ASP	Applied Science Program
AquADat	Aquatic Assessment, Inventory and Monitoring Database
AUV	Autonomous Underwater Vehicle
BHA	Bottom Hole Assembly
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BOP	Blowout Preventer
BOR	Bureau of Reclamation
BSEE	Bureau of Safety and Environmental Enforcement
BSR	Blind Shear Ram
CadNSDI	Cadastral National Spatial Data Infrastructure
CESU	Cooperative Ecosystem Studies Units
CFD	Computational Fluid Dynamics
CO_2	Carbon Dioxide
ConOps	Concept of Operations
CRADA	Cooperative Research and Development Agreement
CSR	Casing Shear Ram
DOE	Department of Energy
DEMD	Division of Energy and Mineral Development (within BIA)
DOI	Department of the Interior
DMAS	Deadman/Autoshear
DP	Dynamic Positioning
DWPR	Desalination and Water Purification Research
EDNA	Environmental DNA
EDS	Energy Dispersive x-ray Spectroscopy
EPA	Environmental Protection Agency
ERDC	U.S. Army Engineer Research and Development Center
ERI	Earned Royalty Income
ESA	Endangered Species Act
ESP	Environmental Studies Program
ETB	Emerging Technologies Branch

EULA	End User License Agreement
FAC	Fisheries and Aquatic Conservation
FDA	Food and Drug Administration
Fed Tech	Hyperion Technologies LLC
FIAT	Fire and Invasives Assessment Tool
FLPMA	Federal Land Policy and Management Act of 1976
FO	Forward Osmosis
FTC	Fish Technology Center
FTTA	Federal Technology Transfer Act of 1986
FUSA	Facility Use/Service Agreement
FWS	Fish and Wildlife Service
FY	Fiscal Year
GHG	Greenhouse Gas
GIS	Geographic Information System
GRSG	Greater Sage Grouse
HAPS	High Altitude Platform Stations
ICCOPR	Interagency Coordinating Committee on Oil Pollution Research
IDM	Imagery Data Management
IRFMS	Integrated Rangeland Fire Management Strategy
IX	Ion Exchange
JAO	Joint Administrative Operations
JFSP	Joint Fire Science Program
JSC	Joint Steering Committee
K- 12	Kindergarten through 12th grade
Landsat	Land Remote-Sensing Satellite System
LiDAR	Light Detection and Ranging Scanners
MCL	Materials and Corrosion Laboratory
MD	Mine Drainage
MDTI	Mine Drainage Technology Initiative’
MTA	Material Transfer Agreement
NAMC	National Aquatic Monitoring Center
NCL	National Conservation Lands
NCPTT	National Center for Preservation Technology and Training
NCR	Natural and Cultural Resources
NCTC	National Conservation Training Center
NY Bight	New York Bight
NGA	National Geospatial Intelligence Agency
NGO	Nongovernmental Organization
NGP	National Geospatial Program
NIC	National Innovation Center
NIOGEMS	National Indian Oil & Gas, Energy and Minerals System
NOFO	Notice of Funding Opportunity

NPS	National Park Service
NTTP	National Technical Training Program
NTTT	National Technology Transfer Team
OCS	Outer Continental Shelf
OESI	Offshore Energy Safety Institute
OMB	Office of Management and Budget
OORP	Office of Offshore Regulatory Programs
OPA	Office of Policy and Analysis (within USGS)
OSMRE	Office of Surface Mining Reclamation and Enforcement
OSPD	Oil Spill Preparedness Division
OSRR	Oil Spill Response Research
PAIS	Padre Island National Seashore
PG&E	Pacific Gas and Electric Company
PLSS	Public Land Survey System
Reclamation	Bureau of Reclamation
R&D	Research and Development
R&T	Research and Technology
R&T Plan	Oil Pollution Research and Technology Plan
S&T	Science and Technology
SMCRA	Surface Mining Control and Reclamation Act of 1977
SO	Secretarial Order
TAA	Technical Assistance Agreement
TEES	Texas A&M Engineering Extension Service
TerrADat	Terrestrial Assessment, Inventory and Monitoring Database
TIPS	Technical Innovation and Professional Services
TLS	Terrestrial Laser Scanning
uADS	underwater Acoustic Deterrent System
UAF	University of Alaska Fairbanks
USACE	U.S. Army Corps of Engineers
UAS	Unmanned Aircraft Systems
USCG	U.S. Coast Guard
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USGS - EROS	United States Geological Survey Earth Resources Observation and Science Center
WGA	Western Governors' Association