

U.S. Department of the Interior

Annual Report on Technology Transfer

FY 2020 Activities

July 22, 2021

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I. Introduction

Technology transfer for the Department of the Interior (DOI) includes a range of activities designed to disseminate scientific and technical information and knowledge between DOI, other Federal agencies, and non-Federal entities. It includes, but is not limited to, publishing and exchanging scientific and technical information, protecting and licensing intellectual property rights, and sharing—or otherwise making available—for scientific or technical purposes the expertise and specialized scientific material and resources that DOI manages. The technology transfer activities within DOI are consistent with its mission to protect and manage the Nation’s natural and cultural resources, to make available scientific and other information about those resources, to honor trust responsibilities to Tribes, and to protect, manage, and conserve resources for the future.

This report describes the actions that DOI took in Fiscal Year (FY) 2020 to advance technology transfer. These range from developing new technologies that would help identify various substances in water to improved methods to measure water quality in high biofouling environments. These activities demonstrate the innovation, expertise, and dedication of DOI’s employees, including its many scientists and engineers, to help reduce risks to public health, safety, and the environment from natural and man-made hazards. The Data Appendix provides cumulative data tables requested by the Office of Management and Budget (OMB) and the National Institute of Standards and Technology for FYs 2016–2020. These tables include updates to previous years’ data, where appropriate.

This report is the result of a cooperative effort by the Departmental Working Group on Technology Transfer, coordinated by DOI’s Office of Policy Analysis.

II. Advancing Technology Transfer in the Department of the Interior

DOI's FY 2020 enacted budget included \$986.4 million for research and development (R&D). The majority of the funding was for applied research (\$739.0 million), while basic research and basic development received \$82.0 million and \$170.0 million, respectively.¹ The programs supported through these funds generate new and improved knowledge, information, and technology, which are then transferred to resource managers within and outside DOI, other stakeholders, and the general public in order 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 2020, as in previous years, the majority of 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's scientists, engineers, and other technical personnel advance the state of knowledge related to the resources it manages and ensure that this information is accessible to resource managers, private industry, and the general 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 2020, Bureau of Reclamation (Reclamation or BOR), Bureau of Ocean Energy Management (BOEM), Fish and Wildlife Service (FWS) and National Park Service (NPS) personnel authored or co-authored at least 720 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 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, seven DOI bureaus are active participants in the network of 17 Cooperative Ecosystem Studies Units (CESUs), a collaboration among 16 Federal agencies and more than 470 non-Federal partners (including universities, Tribes and Tribal organizations, State agencies, museums, aquariums, arboretums, and conservation organizations). The CESU Network extends across biogeographic regions in all 50 states, the District of Columbia, and U.S. insular areas. Each CESU is hosted by a university.

In addition, some bureaus and/or 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. From FY 2019-2020, DOI bureaus completed, had

¹ Estimates furnished by the Office of Budget, Department of the Interior, December 2019.

underway, or launched 14 prize competitions, which included competitions led by Reclamation, BOEM, and FWS; an additional competition was led by the National Invasive Species Council and included contributions from NPS, FWS, and USGS.²

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.

² [*U.S. Department of the Interior Report on Prize Competitions FY 2019-20.*](#)

III. FY 2020 Accomplishments

During FY 2020, DOI's scientific, technical, and engineering personnel continued to engage in a broad range of cooperative activities to develop and disseminate innovative technologies, including:

- Collaborating on 489 Cooperative Research and Development Agreements (CRADAs), of which 237 were initiated in FY 2020. In addition, DOI engaged in at least 457 other collaborative R&D relationships.
- Engaging in 353 nontraditional CRADAs, such as material use and facility use agreements, under the FTTA.
- Disclosing four (4) new inventions; four (4) new patent applications were filed; three (3) new patents were awarded.
- Managing seventy-one (71) active patent licenses for inventions and other intellectual property, earning about \$123,000 collectively. The large increase in licensing activity from 18 to 71 from FY 2019 to FY 2020 is mainly due to the demand from various authorities for pilot agreements and licenses to use and operate USGS's ShakeAlert systems.
- Reclamation, BOEM, FWS and NPS personnel authored or co-authored at least 720 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.

IV. Overview of Technology Transfer Activities

Table 1 shows that DOI’s bureaus use or are contemplating using a variety of mechanisms to transfer information, knowledge, and technology within and outside their agencies.

Table 1: Principal Technology Transfer Mechanisms Identified by Each Bureau

	USGS	FWS	OSMRE	NPS	BSEE	BOR	BOEM	BLM
Technical/Scientific Publications	X	X	X	X	X	X	X	X
Workshops/Seminars	X	X	X	X	X	X	X	X
Educational Courses & Other Outreach	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
Patents	X	X		X		X		
Licenses	X	X		X		X		
Other Cooperative Ventures & Agreement Types	X	X	X	X	X	X		
Web and Other Mechanisms	X	X	X	X	X	X	X	X

V. Technology Transfer Agreements

Table 2 provides a summary of DOI’s new and active technology transfer agreements undertaken in FY 2020. There was a total of 489 active CRADAs in FY 2020, of which 237 were newly executed. In FY 2019 there were a total of 470 CRADAs (including 352 new ones).

Table 2: Collaborative Relationships for Research & Development (FY 2020)

	USGS	BOR	BOEM	FWS	NPS	Total
CRADAs						
Active CRADAs ¹	477	8	1	2	2	489
New CRADAs	233	4	0	0	0	237
Active CRADAs with Small Business Involvement					2	2 ⁶
Number of Small Businesses Involved in Active CRADAs					2	2 ⁶
Traditional CRADAs²						
Active CRADAs	27	2	1	2	1	32 ⁵
New CRADAs	8	0	0	0	0	8
Nontraditional CRADAs³						
Active	450	6	0	0	1	457
New	225	4	0	0	0	229
Other Collaborative R&D Relationships⁴						
(Collaborative Agreements) Total Active in the FY	353	0	0	0	0	353
New in the FY	125	0	0	0	0	125

(1) “Active” = legally in force at any time during the FY. “Total active” is comprehensive of all agreements under CRADA authority (15 U.S.C. § 3710a).

(2) CRADAs involving collaborative research and development by a Federal laboratory and non-Federal partner.

(3) CRADAs used for special purposes, such as material transfer or technical assistance that may result in protected information. For USGS, Technical Assistance Agreements (TAAs) and Facility Use/Service Agreements (FUSAs) fit in this category.

(4) Based on available data. These figures do not account for the majority of collaborative agreements that bureaus engage in under authorities other than the FTTA.

(5) This number is one less than the sum of the preceding columns because one CRADA is counted in both the USGS and BOEM tallies.

(6) Only NPS has collected data on small business participation.

Table 3 summarizes invention and patent activity within DOI during FY 2020, broken out by bureau. The table indicates that eight new inventions were disclosed, three new patent applications were filed, and two new patents were issued.

Table 3: Invention Disclosure and Patent Activity (FY 2020)

	USGS	BOR	FWS	Total
Invention Disclosures				
New Inventions Disclosed	3	1	0	4
Patents				
New Applications Filed	1	2	1	4
Patents Received	2	0	1	3

Table 4 provides a summary of the number of active licenses managed by the DOI’s bureaus.

Table 4: License Activity (FY 2020)

	USGS	BOR	Total
Licenses, Total Active	69	2	71
New Licenses	17	0	17
Invention Licenses, Total Active	69	2	71
New Invention Licenses	1	0	1
Income-Bearing Licenses, Total Active	7	2	9
Income-Bearing Exclusive Licenses	5	0	5

Total income in FY 2020 from all licenses amounted to about \$123,000 (from 9 income-bearing licenses), compared with \$42,000 (from 18 income-bearing licenses) in the previous fiscal year. Under 15 USC 3710c, a federal agency must pay the first \$2,000 per year in license income and a minimum of 15% of the yearly income thereafter from all inventions to the inventors. 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.³

Table 5 provides a summary of the scope and nature of technology transfer activities and mechanisms that DOI’s bureaus implement currently or might implement in the future.

³ <https://www.govinfo.gov/content/pkg/USCODE-2011-title15/html/USCODE-2011-title15-chap63-sec3710c.htm>

Table 5: Scope of Activities and Plans Related to the FTTA, by Bureau

Mission	Technology Transfer
<p>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.</p>	<p>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.</p>
<p>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.</p>	<p>FWS’s Research and Development (R&D) is primarily focused on providing the basis for effective conservation to meet its mission. For example, the FWS Fish Technology Centers were established in 1965 to develop and improve fish culture technology and to provide assistance to Federal and State agencies, Tribes, and other nations interested in aquaculture research and solutions. They have worked with industry and government to improve aquaculture opportunities.</p>
<p>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.</p>	<p>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 research and development 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.</p>
<p>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.</p>	<p>Technology transfer and employee inventions are addressed under the NPS benefits-sharing policy and procedural guidance (available at http://www.nps.gov/applications/npspolicy/DOrders.cfm). 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.</p>
<p>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.</p>	<p>The BSEE R&D program activities operate through the Office of Offshore Regulatory Programs (OORP) Emerging Technologies Branch (ETB) and the Oil Spill Response Research program (OSRR) in the Response Research Branch. 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 to promote the use of Best</p>

Table 5: Scope of Activities and Plans Related to the FTTA, by Bureau

Mission	Technology Transfer
	Available and Safest Technology on the U.S. Outer Continental Shelf (OCS).
<p>Bureau of Reclamation (Reclamation). 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.</p>	<p>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.</p>
<p>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.</p>	<p>BOEM’s Environmental Studies Program (ESP) 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.</p>
<p>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.</p>	<p>BLM’s scientific and technical focus has been on place-based applications to improve the management of public lands, in accordance with FLPMA’s multiple-use mandate. Accordingly, BLM focuses on traditional technology transfer activities to help advance its multiple-use mandate.</p>

Subsequent sections briefly describe each bureau’s technology transfer program and provide examples of their activities in FY 2020. The tabular data requested by OMB Circular A-11 are reported in the Data Appendix, to the extent data are available.

VI. U.S. Geological Survey

The United States 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. 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 USGS to better address the needs of the Nation, customers, and partners.

Delivery of science information is 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. 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. USGS has 361 major laboratories and several hundred field offices around the country.

Within 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 1980 (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 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 2020, USGS had 477 active traditional and nontraditional CRADAs, the majority of which (450) were nontraditional (including material transfer, technical assistance, and facility use agreements). By contrast, in FY 2019, it had 457 active CRADAs, including 415 nontraditional CRADAs. In addition, in FY 2020, USGS executed 353 other collaborative agreements and managed a total of 69 active licenses. USGS also filed one (1) new patent application and received two (2) patents.

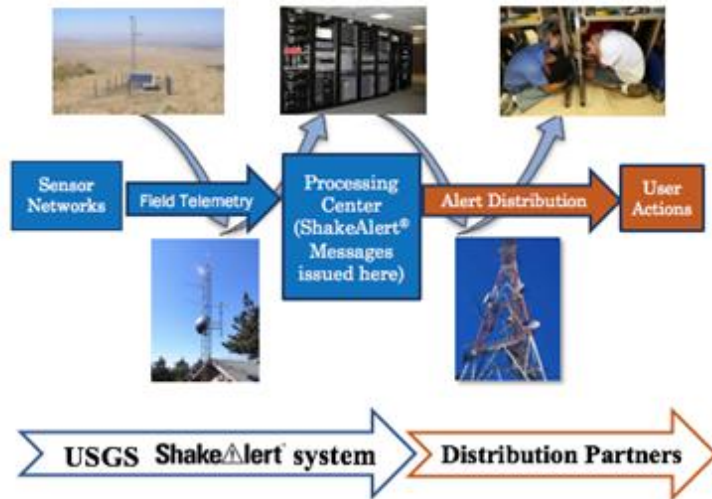
USGS science and research contributes to a broad range of collaborative projects in the private and academic sectors. USGS provides unique analytical laboratory services to domestic, foreign, and academic partners through the USGS Facility Use Program. Examples include—

ShakeAlert Earthquake Early Warning System. ShakeAlert is an earthquake early warning system that generates and provides rapid earthquake warning messages, providing the public valuable time to take protective actions. In the case of earthquakes, even seconds can make a difference to human life and the operational safety of critical systems. ShakeAlert is comprised of a network of seismic sensors, advanced high-speed computers, rapid internet pathways, earth science data, and specialized software algorithms.

The USGS, in collaboration with universities and state emergency management agencies, developed the ShakeAlert system in the states of California, Washington, and Oregon. Primary project partners are the California Governor’s Office of Emergency Services, California Geological Survey, California Institute of Technology, University of California Berkeley, University of Washington, University of Oregon, ETH Zurich, and the Gordon and Betty Moore Foundation. To encourage adoption of the technology by States and the private sector, the USGS created a licensing model that streamlines the previous agreement pathway. There are two licensing phases: 1) the Pilot and 2) the License to Operate phases. Once licensees demonstrate successful use of the ShakeAlert system with their alerting products during the Pilot phase, they may exercise the License to Operate conversion clause, incorporated to the Pilot license agreement, to become fully operational. As of the end of fiscal year 2020, the USGS executed eight (8) Licenses to Operate and approximately 60 Pilot agreements with our technical partners. As a result of these partnerships, the public receives earthquake early warning on their cell phones and while commuting on trains. Multiple fire departments and 911 dispatch centers utilize “alerting” products powered by ShakeAlert to deploy services and to raise situational awareness. Utility services also employ ShakeAlert powered devices to help protect the utility infrastructure.

USGS formed the ShakeAlert Joint Committee for Communication, Education, and Outreach (JCCEO) to provide consistent guidance regarding the ShakeAlert system’s human interface. The JCCEO coordinates development of the guidance and resources that are fundamental to successful and sustained user uptake of the system to maximize life-safety and property protection impacts. The JCCEO also provides the sharing and coordination platform for independent communication, education, and outreach programs among the three states (Oregon, Washington, and California).

West Coast Earthquake Early Warning System Components



West Coast earthquake early warning system components. Photos: USGS.

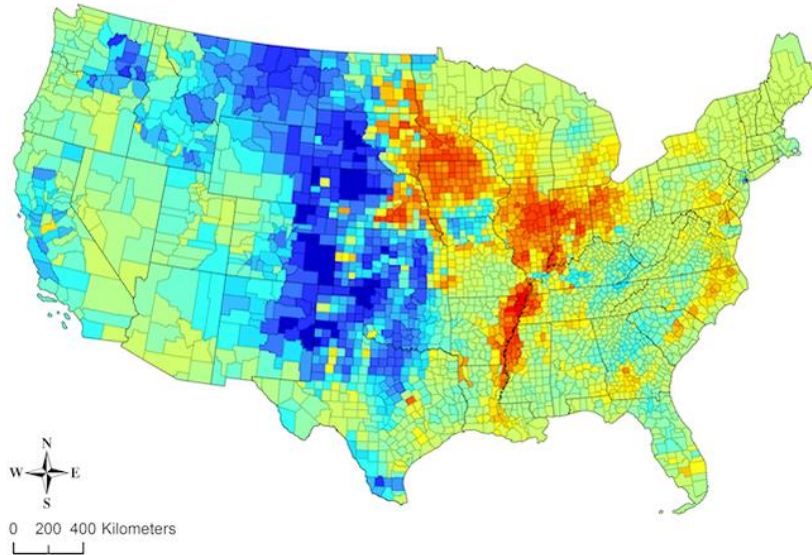
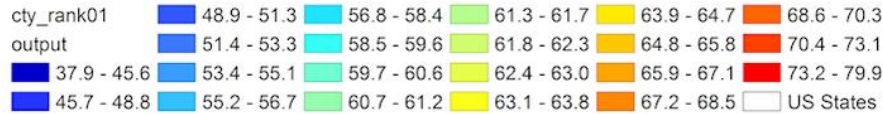
Gazelle™ COVID-19 Screening Test. On April 17, 2020, the U.S. Geological Survey entered into a cooperative research and development agreement with Hemex Health and PAI Life Sciences to develop a rapid COVID-19 screening test. The test will use an assay based on antibodies produced from COVID-19-vaccinated juvenile sea lamprey to detect the virus in human saliva samples. This test could be an invaluable resource for healthcare professionals in the fight against the ongoing global pandemic.

The new screening tool differs from other diagnostic coronavirus tests in that it detects the shed protein of COVID-19 rather than the virus's nucleic acids. Because the lamprey antibodies, or "lampr antibodies," used in the development of the tool are stable at a wide range of temperatures, the actual test would not require continuous refrigeration. Removing this step would make the test invaluable in low-resourced areas around the world.

As of January 2021, USGS scientists have successfully produced a lampr antibody positive control to an irrelevant protein as part of the screening process. To date, the laboratory has processed thousands of lampr antibody samples from vaccinated lamprey. The lead scientist has created genetic libraries encompassing the lampr antibody response post-vaccination with SARS-CoV-2 proteins and continues to screen these libraries for virus-specific lampr antibodies to use in the test. Due to setbacks in laboratory access, staffing, and resources during the pandemic, the project has progressed slower than expected. Partners are planning to discuss next steps and possible new

objectives for the project. This work continues to provide strong partnership between biotech companies and government scientists.

Monarch Conservation Science Partnership. The Monarch Conservation Science Partnership (MCSP) was formed to address concerns relating to the monarch butterfly, a migratory species which each year winters in Mexico and migrates to areas in the U.S and Canada for the warmer season. Its population has declined by more than 80% in the last two decades. The species is being considered for listing as Threatened under the Endangered Species Act. The MCSP, organized and led by the USGS, is a consortium of government and non-government organizations, scientists, land managers, and conservationists, academic scientists, and citizen science program coordinators. Through the MCSP, science producers and users worked collaboratively to define research questions and to develop and deliver ecological research, resulting in improved environmental decision-making to advance conservation of monarchs. The MCSP conducted, among other activities, the extinction risk research used by the U.S. Fish and Wildlife Service (FWS) to establish a minimum overwintering population size required to sustain the eastern migratory monarch. This standard was subsequently adopted as the trinational goal of Canada, US, and Mexico. The MCSP served as the model for the Trinational Science Partnership supported by the Trilateral Commission for Environmental Cooperation. The MCSP developed scenarios for the recovery of monarchs to former levels of abundance, leading to the highly publicized “All Hands on Deck” call for conservation effort across all sectors of society. This research provided a strong basis for the recently completed Candidate Conservation Agreement with Assurances (CCAA) that the FWS entered into with more than 45 companies in the energy and transportation sectors across 48 states –the largest agreement ever of its kind. Similarly, this research informed the Midwest Fish and Wildlife Agencies’ Mid-America Monarch Conservation Strategy, a conservation planning effort spanning from the Dakotas through Kentucky and Ohio and from Canada through to Mexico. The MCSP is an example of technology transfer accomplished through authorities available outside of the FTTA.



The above graphic displays priority of monarch butterfly conservation areas derived by using the County Ranking Tool for prioritization. The County Ranking Tool gives users the ability to prioritize counties within the conterminous United States according to multiple input field prioritization criteria for monarch butterfly conservation. A spatial data layer representing U.S. counties was assembled and attributed with information for each input criteria. Image: USGS.

Patents. In FY 2020, USGS was awarded two patents:

- U.S. Patent 10,800,497 was awarded to the USGS for a novel means of controlling invasive species transmitted by ballast water in cargo ships, boats, and other vessels. The introduction of nonindigenous species such as the zebra mussel is having significant negative economic and environmental impacts in several areas, including the Great Lakes Region. This novel approach involves the use of an innovative system to destroy invasive species within ballast water. Means of destroying the invasive organisms include changing the parameters of the ballast water through pH, salinity, and CO₂ concentration until the ballast water environment is lethal to the invasive species. This technology should aid in efforts to control and prevent the spread of aquatic invasive species.
- U.S. Patent 10,816,442 was awarded for an automated technique of measuring and monitoring greenhouse gas (GHG) emissions in wetlands. Wetlands vegetation is critical in the earth's ecosystem and is very important in the delicate balance of CO₂ and methane and their effects on global warming. Inexpensive and adaptable methods of monitoring these emissions are needed to address this worldwide environmental challenge. USGS scientists are developing a robotic and automated sampling system to measure GHG emissions from a variety of activities for use by agencies such as the EPA as well as

researchers to advance knowledge in climate change research and mitigation. The invention allows researchers to continuously measure gas flux rates from multiple chambers with little or no need for personnel in the field, which increases efficiency and reduces costs. The invention is compatible with any high-frequency analyzer or vial filler and most chamber designs.

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 agency in the Federal Government whose primary responsibility is managing fish and wildlife resources for the American public. It manages more than 855 million acres of lands and waters in the National Wildlife Refuge System, including seven national monuments, 568 National Wildlife Refuges, and 211 Waterfowl Production Areas. FWS also operates National Fish Hatcheries, which, in conjunction with its Fish Health Centers and Fish Technology Centers (including the Conservation Genetics Lab in Alaska), 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 Policy, Economics, Risk Assessment, and Analytics. 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, reports, and fact sheets.

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 343 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 Refuge System. Those data inform and improve the conservation of fish, wildlife, and plant natural resources.

Patents. FWS received U.S. Patent No. 10,478,276 in FY 2020 (November 19, 2019) for a pellet delivery mechanism developed by an employee who co-invented it to distribute pellets to control fleas on prairie dogs, and which would indirectly benefit 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.

CRADAs. In FY 2020, FWS maintained two CRADAs it has in place through the Aquatic Animal Drug Approval Program (AADAP) within FAC. FWS also maintains (on behalf of DOI), a joint CRADA involving USGS and BOEM and Bird Studies Canada.⁴

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 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.⁵ 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 affect the nation's fish and wildlife resources. During FY 2020, NCTC hosted 111 online science, technology, and educational webinars and 84 e-courses related to managing the Nation's fish, wildlife, and plant resources. These are important components of FWS's traditional technology transfer activities.

⁴ 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.

⁵ <https://www.fws.gov>.

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 Fish Hatcheries, Fish and Wildlife Conservation Offices, Fish Health Centers, Fish Technology Centers, the Conservation Genetics Laboratory in Anchorage, Alaska, and the Aquatic Animal Drug Approval Partnership (AADAP). These centers and programs provide assistance and support to conservation partners of FWS—including Federal, State, Tribal, and nongovernmental organizations (NGOs)—that cover 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. Most of the 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, and the aquaculture industry. The 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-related needs of FWS and its partners, including understanding the physiological needs of fish to support conservation and/or commercial opportunities.
- **Conservation Genetics Laboratories.** These laboratories support conservation- and management-related needs of FWS and its partners, including (a) using genetic DNA 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/DNA 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, exotic, introduced, nonnative, and other potentially harmful species and to develop early detection and rapid response capabilities. 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 at levels 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 Division of Fisheries and Aquatic Conservation (FAC) 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 more responsible choices about which species to acquire and use. Also, these tools will help State agencies make decisions on potentially invasive species 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, restores the land to beneficial use following mining, and mitigates the effects of past mining by aggressively pursuing reclamation of abandoned mine lands. OSMRE achieves this in part by providing technical assistance 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 22 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 90 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

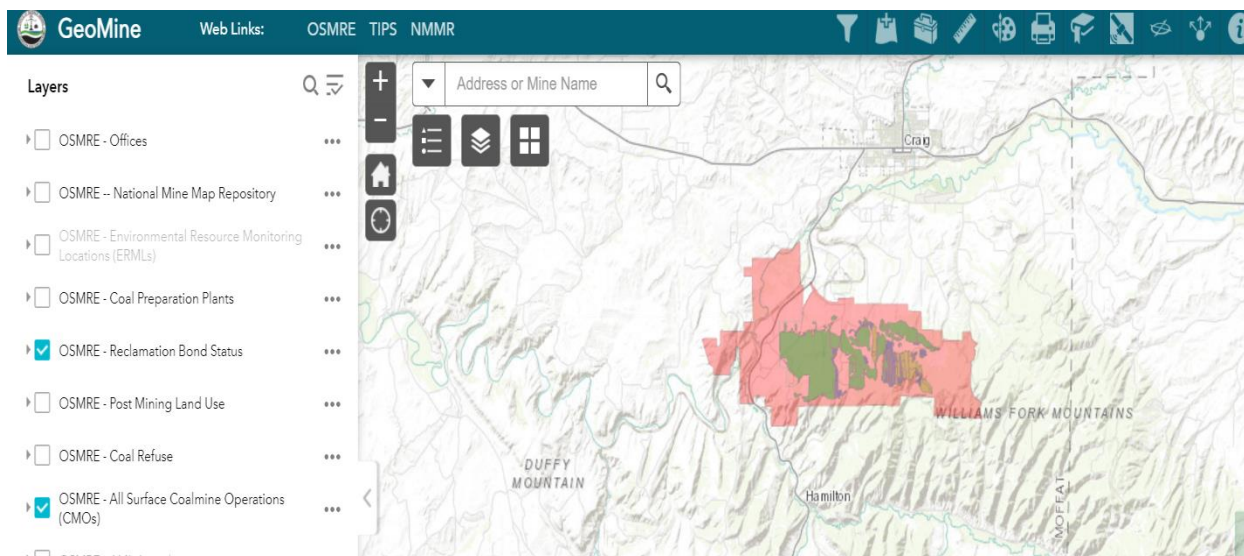
lands projects, and providing the scientific basis for environmental assessments and environmental impact statements.

Demand for TIPS tools and support continues to increase, especially in geospatial data and mobile computing tools for field use. TIPS is offering more onsite training to accommodate the use of mobile computing devices by inspectors. Mobile computing increases efficiency in resolving State, Tribal, and industry issues.

The TIPS program continues to develop and enhance the GeoMine Web Application, an interactive web-based mapping application of coal mining and reclamation activities within the United States. The TIPS program also trains State, Tribal, and Federal personnel to ensure that all agencies with SMCRA responsibilities are using the same advanced software and hardware tools to conduct the business required by the Act. These activities include:

- GeoMine Web Application: GeoMine is designed to provide 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 2020 to improve functionality, especially for mobile device optimization. In 2020, OSMRE added two layers to the GeoMine web application. The first layer displays the DOI Unified Regional Boundaries which were finalized on August 22, 2018. The Unified Regional Boundaries are the result of the reorganization of DOI from 49 regions across 8 bureaus to 12 Interior Regions, based on watersheds, but generally drawn along state lines to simplify coordination with external partners. The second layer was the 2020 abandoned mine lands (AML) reclamation layer which displays the locations of abandoned mines. All layers for GeoMine are publicly available and consist of data from State, Tribal and Federal Partners and available via the GeoMine website.⁶ Satellite imagery is updated in near real time through a live feed. 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. This transparency allows the public to better understand the impacts of both coal mining and reclamation activities.

⁶ <https://www.tips.osmre.gov/geospatial/geoMine.shtm>



An example of GeoMine mining-related feature classes. Image: OSMRE.

- **GIS Mobile Computing:** In FY 2020, OSMRE continued the use of tablets and smartphones that can display and collect geospatial data while at a mine site. The base data for the systems comes from GeoMine allowing field personnel to display data along with their Global Positioning System (GPS) location. Data collected in the field is synchronized to the GIS server and was made available to anyone in the OSMRE network via a web map.
- **Emerging Technology Testing (Photogrammetry, Cloud-based Data Processing and Ground-Based LiDAR Scanners):** Photogrammetry software has been 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 the DOI GeoPlatform to realize efficiencies of server-side processing of large datasets. Ground-based Light Detection and Ranging (LiDAR) scanners are also being used in conjunction with these photogrammetric models to allow for accurate surface modeling for enforcement and reclamation design. In FY 2020, most SMCRA States had adopted or were in the process of setting up programs to make use of these systems and the variety of sensors.
- **ArcGIS Online:** In 2020, the ArcGIS Online web mapping system continued to be available to SMCRA States. Twenty-seven States are participating in the web mapping system allowing States and OSMRE to share geospatial data.
- **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: Denver, Colorado; Alton, Illinois; and Pittsburgh, Pennsylvania.

In FY 2020, the TIPS training program received a customer satisfaction rating of 99.5 percent, exceeding the annual Government Performance and Results Act goal of 96 percent. One instructor-led and 14 virtual instructor-led classes were held in FY 2020, with 174 students completing class sessions. Ninety-one percent of students trained in FY 2020 completed an online TIPS course. TIPS training reports shows a 11 percent increase of students trained over FY 2019, and a 75 percent increase of personnel trained online versus FY 2019, because of travel restrictions due to Covid-19.

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 15 subject matter expert instructors from State, Tribal, and OSMRE offices in FY 2020 to teach 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 2020, the pandemic severely restricted operations for in-residence training. As a result, the number of students from State, Tribal, and OSMRE programs trained by the NTTP declined from 601 in FY 2019 to 70 in FY 2020. It offered 4 training sessions in FY 2020, as opposed to 36 in FY 2019, covering technical, legal, and programmatic subjects ranging from best practices and technologies to protect society and the environment from the adverse effects of surface and underground mining to methods to restore land use capabilities. Course subjects cover a wide variety of technical areas for a variety 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 assessment, legal aspects of enforcement procedures, and preparation of evidence and testimony. In FY 2020, the program achieved an overall effectiveness rating of 88 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, 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 has accomplished this by funding studies 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, and other topics relevant to environmentally responsible mining and reclamation. Since its inception in 2005, the Applied Science Program has funded 88 projects. These projects go beyond theoretical research and investigate application of existing theory to on-the-ground mining and reclamation issues. In FY 2020, three projects funded in FY 2015 and five projects funded in 2016 were completed; leaving no unfinished projects.

During FY 2020, OSMRE issued a Notice of Funding Opportunity for the Applied Science Program 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. As of this writing, cooperative agreements are being drafted for these eight projects. Upon award, the projects will have a two-year term, but a no-cost time extension can be granted, if warranted. Reports of findings of completed projects and investigations are available at <https://www.osmre.gov/programs/tdt/appliedscience/projects.shtm>.

The NTTTT 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 2020, the NTTTT activities have expanded to take advantage of newer, web-based options, such as webinars, YouTube, and social media, including Twitter, Facebook, Instagram, and Snapchat. The team has created an interactive map on its webpage to enable interested parties to access information on completed projects by selecting the location of the institution that conducted the project work. The map can be accessed at <https://www.osmre.gov/programs/tdt/appliedScience.shtm>.

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) develop an understanding of MD to better predict, avoid, monitor, and remediate MD; (2) develop innovative solutions to MD water quality problems; (3) identify, evaluate, and develop "best science" practices to predict MD before mining; and (4) identify successful remediation practices for existing MD sources, and describe the best preventive technologies.

In FY 2020, OSMRE had three MDTI cooperative agreements with universities that were in various stages: one MDTI cooperative agreement scheduled to be completed in June 2020, was granted a no-cost-extension until December 31, 2020, due to Covid-19; a second MDTI cooperative agreement began in July 2020; and a third MDTI cooperative agreement awarded in September 2020, began October 1, 2020. Like the Applied Science Program, MDTI cooperative agreements have a 2-year term which, however, 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 servicewide 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.⁷

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, has 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. 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 2020, the COVID-19 pandemic impacted In-Situ's operations, delaying existing projects and reducing the overall market demand for water monitoring instruments. The Gulf Coast Inventory and Monitoring Network continued operating two of the modified instruments at Padre Island National Seashore (PAIS). 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.

⁷ For further information on NPS benefits sharing, see <http://www.nps.gov/applications/npspolicy/DOrders.cfm>.



Since 2010, the Gulf Coast Inventory and Monitoring Network has continuously monitored water quality in an extremely high biofouling environment at Padre Island National Seashore. Upon replacing the standard instruments with two NPS-modified instruments, the Network reduced maintenance costs by over 50 percent. These images show the results of a 6-month proof-of-concept deployment: above left, biofouling on the outside of the instrument; above right, the instrument after scraping material off the outside; and above center, the sensors on the inside of the instrument with no other cleaning or maintenance. Photo: Conrad Blucher Institute, NPS partner.

Benefits-Sharing Agreement. Yellowstone National Park has a nontraditional CRADA with a small business that plans to commercialize research results from a study of microbial mats collected from a thermal area in the park. 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.



Hot springs in Norris Geyser Basin, Yellowstone National Park. 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. Norris, one of the hottest and most acidic of Yellowstone's hydrothermal areas, harbors microbes of interest to diverse researchers—from astrobiologists to food scientists. Photo: NPS/Jim Peaco.

X. Bureau of Reclamation

The Bureau of Reclamation (Reclamation or BOR) 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.



Roza Dam, Yakima River above Selah, Washington. Photo: Kristen Strough/Bureau of Reclamation.

According to DOI's Economic Report for Fiscal Year 2019, Reclamation's activities, including hydropower, water deliveries, payroll, and recreation, contributed more than \$68.9 billion to the economy and supported 468,000 jobs.⁸ Most of this production was associated with water deliveries for irrigation (\$47 billion) and for municipal and industrial uses (\$11.7 billion). 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. These 53 power plants account for 19 percent of the hydroelectric generating capacity in the United States and generate roughly 36.5 billion kilowatt hours of electricity in 2019 (valued at \$2.7 billion in Fiscal Year 2019),⁹ which is enough to supply more than 3.8 million U.S. households.

⁸ <https://doi.sciencebase.gov/doi/v/doi-bureau.html>

⁹ Ibid.



*Hydropower Turbines at Glen Canyon Dam on the Colorado River near Page, AZ
Photo: Alexander Stephens/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 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 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 website¹⁰ as well as through Reclamation’s new open data sharing platform, the Reclamation Information Sharing Environment.¹¹ For example, the R&D Office published outputs (i.e. reports, data products, etc.) from 37 concluding research efforts via its website in FY 2020.

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. While much of Reclamation’s efforts to develop technologies are internally led, mission-focused, and do not depend on external partnerships, there are exceptions where patent protection, or engaging industry through technology transfer authorities, are important to speed the deployment of new technologies to Reclamation’s use in the field or to the broader marketplace. For example, Reclamation seeks patent protection when commercialization is needed to mature a Reclamation invention to enable

¹⁰ <https://www.usbr.gov/research/>

¹¹ <https://data.usbr.gov/>

broader use. In FY 2020, Reclamation filed U.S. Patent Application No. 16/873,717, “Method for Purifying and Recovering Solvent from Ion Exchange Processes,” to advance efforts of the water treatment industry to offer more effective water supply options for regions facing water scarcity. Likewise, Reclamation seeks industry partners to further mature innovation ideas and develop subject inventions within the protections of technology transfer agreements (with several examples to follow in this section). 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 2020 include the following.

Developing Monitoring Technologies to Measure Online Cavitation Impacts and Residual Stress of Installed Materials in Hydropower Turbines. In 2017, Reclamation and General Electric (GE) entered a three-year CRADA to conduct research at Grand Coulee Powerplant. The first objective of this research was to develop technologies for online measurement and analysis of damaging cavitation occurring within a Reclamation generator turbine. The second objective was to measure residual stress in machine materials to determine remaining useful life of welded hydropower components. In both areas, great progress was made that will improve powerplant operation and extend component life, thereby reducing future costs to consumers.

To assess damaging cavitation, several tests and inspections were performed, focusing on generator turbine runners. Model test data depicting different cavitation types, regions, and operational zones were examined and analyzed. A cavitation monitoring system was designed and installed on a test unit and an initial cavitation damage algorithm based on model and test data was developed and integrated into the detection system. Future work will focus on comparing results of data acquired from the monitoring system to actual cavitation damage measured during maintenance inspections of the generator turbine runner. Such results will be used to improve the algorithm and predict the amount of damage incurred over a given time and operation regime.

During this cavitation research, the team focused additional attention on one cavitation case associated with the violent collapse of cavitating “rope vortices” within the turbine unit. These are helical vortices composed of spinning fluid particles which are created when turbines operate in conditions away from their design point. This creates violent pressure fluctuations caused by a helical vortex within the turbine, which can damage the turbine.¹² When these vortices collapse, loud and violent shocks are produced that stress the turbine unit and plant structure. Operators constrain the range of turbine operation to avoid operating zones where these vortices occur. In

¹² Rajan GK, Cimbala JM. Computational and theoretical analyses of the precessing vortex rope in a simplified draft tube of a scaled model of a Francis turbine. *Journal of Fluids Engineering*. 2017 Feb 1;139(2).

response, the research team developed and evaluated schemes to inject air at various turbine locations to reduce their occurrence. It was determined that a small amount of injected air at specific locations could effectively mitigate these cavitating rope vortex risks and provide the benefit of expanding the turbine's range of suitable operation, thereby helping increase the amount of electricity generated at minimal cost. Based on these results, an automated air injection system was developed and installed on the test unit.

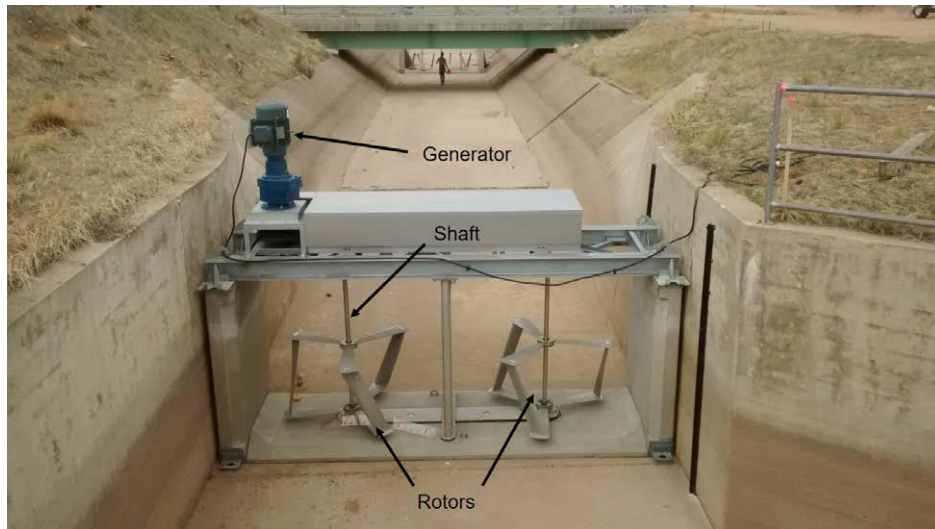


*Conducting residual stress measurements on Grand Coulee turbine runner.
Photo: General Electric. Used with permission.*

Lastly, methods for measuring residual stress of installed hydropower welded components were investigated. Residual stress provides a sense about a material's remaining service life. Different non-destructive test (NDT) measurement techniques included Magnetic Barkhausen Noise (MBN), X-ray diffraction, and hole-drilling techniques were performed on a runner in the GE shop as well as on a Francis turbine runner, pump-turbine runner, and rotor spider at Grand Coulee.

X-ray diffraction is a direct measurement technique that is relatively accurate but more costly and complex to implement whereas MBN is a new, indirect residual stress measurement technique but needs calibration against X-ray diffraction measurements to allow the conversion of magnetic parameter readings into stress readings. MBN measurements would need to be taken on a regular basis and compared to the prior one. The MBN technique was found to offer reasonable accuracy and favorable ease of implementation relative to the X-ray diffraction technique and could be well-suited for monitoring installed hydropower welded components. These CRADA successes have led Reclamation and GE to enter a successor CRADA to continue research into cavitation detection and monitoring.

Evaluating Impacts of Installing Hydrokinetic Power Generators in Water Delivery Canals. In 2017, Reclamation and Denver Water entered a three-year CRADA to explore impacts of installing hydrokinetic devices in water delivery canals. The research team evaluated safety, operation, and hydraulics. The CRADA cooperator, Denver Water, purchased ten hydrokinetic devices and oversaw installation and operations of the canal. Reclamation performed testing and provided input as to device locations based on data needed to perform complete assessments of impacts.



*Dual rotor hydrokinetic unit installed in the downstream of a canal transition zone.
Photo: Bureau of Reclamation.*

Several tests were performed with differing hydrokinetic device locations, spacing, and different numbers of devices in the canal. Numerical models were also developed and used in the analysis. In addition to technical analyses, field observations of operational devices yielded various maintenance insights to avoid risks of device clogging and backed-up water levels in the canal. This collaborative project provided important considerations and guidelines for incorporating hydrokinetic devices in canals that help preserve the safety and effective operation of existing canal systems.



Debris clogged in the hydrokinetic generator's rotors. Tarp transitions were cut to relieve upstream water levels. Photo: Bureau of Reclamation.

Experimental Mussels-Resistant Coatings for Reclamation Infrastructure. Reclamation conducts research across a broad portfolio of technologies for reducing fouling of infrastructure by mussels. Today's commercially available foul release coatings are a soft silicone material (like bathroom caulk) that can easily be damaged by debris or gouging action. Such coatings prevent or reduce the growth of mussels on their surface. Reclamation continues to seek coating materials that discourage mussels settlement, have improved foul-release properties, and have better durability.

Reclamation's Technical Service Center, Materials and Corrosion Laboratory (MCL) enters into material transfer agreements (MTAs) with private sector and academic cooperators to test experimental durable foul release coatings. MCL's goals are to use these engagements to advance Reclamation's technology awareness and capability, offering cooperators the service of verifying formulation reproducibility and efficacy in real-world field trials. Since 2012, Reclamation's MCL has executed ten unique MTAs with Universities, National Laboratories, and Coating manufacturers to investigate durable foul release coatings.

In FY 2020, MCL was engaged with three MTA cooperators, including North Dakota State University (NDSU). Reclamation's MTA with NDSU has been on-going since 2012, twice being renewed as a result of the continued successes and formulation advancements. In all, NDSU has submitted three rounds of materials for 13 total formulations, 9 of which prevented mussel fouling. Formulations tested include a hybrid polyurethane/silicone material that is resistant to this damage mechanism. These formulations are unique in their ability to reduce mussel fouling while providing the needed performance durability.



NDSU sample C4-20 installed May 2012, Photo taken July 2019. Mussels do not adhere to the coating surface but can attach to the algae that is on the coated surface. Mussels are firmly attached to surrounding, non-coating surfaces. Photo: Bureau of Reclamation.

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 oil, gas, and renewable energy issues.

Within BSEE, the Office of Offshore Regulatory Programs (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, and the development of renewable energy on the U.S. Outer Continental Shelf (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.

The Oil Spill Preparedness Division (OSPD) is responsible for developing standards and guidelines to ensure that offshore operators are prepared to respond to oil spills. OSPD also ensures that operators' Oil Spill Response Plans comply with regulatory requirements. OSPD plays a critical role in the review and creation of policy, guidance, direction, and oversight of activities related to the agency's role in ensuring the industry's preparedness for oil spill response. The Division oversees the Oil Spill Response Research (OSRR) program and works closely with sister agencies, such as the U.S. Coast Guard, the National Oceanic and Atmospheric Administration (NOAA), and the Environmental Protection Agency to continually enhance response technologies and capabilities.

BSEE R&D programs operate through OORP's Emerging Technologies Branch (ETB) and OSPD's Response Research Branch (RRB). 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 program is a major part of the federal oil pollution research program formalized in Title VII of the Oil Pollution Act of 1990 (OPA 90) to research oil spill response technologies and operational techniques. OSPD also operates Ohmsett, the National Oil Spill Response Research and Renewable Energy Test Facility in Leonardo, New Jersey. The Ohmsett facility is available to provide 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 research and development. Domestic and international researchers from throughout government, industry, academia, and oil spill response organizations (OSROs) 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 transferred through public dissemination. In addition to making the final reports of research projects publicly available on its [website](#), BSEE also makes its research results available via conferences, workgroups, and other fora such as the triennial International Oil Spill Conference (IOSC), the annual Clean Gulf Conference, the Pacific States-British Columbia Oil Spill Task Force Annual Meeting, NRT Science and Technology Committee, Northern Oil and Gas Research Forum, BSEE/USCG Response Work Group, BSEE/USCG Research Sharing meetings, API Spill Control meetings, and the Ocean Energy Safety Institute's Public Research Forum. BSEE is a major sponsor and organizer of the IOSC, with OSPD also serving as the planning and organizing Chairs of Presentation Sessions, Poster Sessions, and the Technology Demonstration event where attendees can view technology related to all aspects of oil spill response.

BSEE's primary research synergy is with the State, Federal, and international government organizations; the oil/gas and renewable 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. 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>.

BSEE also served as a member of the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) and its Executive Steering Committee. Comprised of 15 Federal agencies, ICCOPR was established by Title VII of OPA 90 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 2020, BSEE led efforts by the Executive Steering Committee to organize the ICCOPR efforts to update the FY 2015-2021 R&T Plan.

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

The following are examples of FY 2020 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.

Joint Industry Projects (JIPs) to Advance Remote Visual Inspection and Oil Spill Cleanup.

Significant technological advances, commercialization and increased use of Autonomous Unmanned Vehicles (AUVs) over the past 20 years are yielding greater opportunities for DOI to augment the manned safety inspection and cleanup programs undertaken by or on behalf of BSEE. Similar to the successes by the US DOI's Office of Aviation Services which has an extensive Unmanned Aircraft Systems (UAS) Program utilizing aerial drones to fly missions for DOI agencies to combat wildfires and provide insight for the nation's natural resources, wildlife and cultural heritage, BSEE is researching opportunities to utilize similar technologies for use offshore. AUVs (robotic vehicles that travel without or with only minimal real-time input from an operator) are self-propelled vehicles that can be manually operated and/or pre-programmed to navigate 3-dimensional missions for an extended period. AUVs are deployed from a surface vessel (or from shore) to operate independently in performing surface and underwater missions from a few hours to several months in duration over distances of 1000 miles and depths to 15,000 ft. Following are two example JIPs that BSEE is involved in.

Remote Inspection of Oil and Gas Infrastructure. BSEE is exploring the use of AUVs to inspect oil and gas infrastructure (including pipelines) along the seafloor as well as fixed and floating facilities located hundreds of miles offshore and in water depths of 8000+ feet (e.g., offshore oil platforms and ancillary facilities). AUVs have the ability to operate 24/7, 365 days a year, including bad weather days (fog, rain, high winds) that often hamper and/or prevent manual inspections, without endangering BSEE staff. AUV technology can be applied to maintain future wind turbines and associated infrastructure installed on the Outer Continental Shelf (OCS) as part of BSEE's wind-energy program. They can augment BSEE's existing inspection program by enabling inspection of submerged, damaged, poorly maintained or other problematic attributes (e.g., platforms without functioning helidecks that would otherwise require inspectors to enter by a boat and swing rope). They can also free up personnel to focus on higher consequence facilities.

Remote Oil Spill Collection Systems. BSEE has also entered into a JIP to develop a new Remotely Operated Unmanned Surface Vehicle (ROUSV) for airborne deployment for oil spill herding agents (i.e., spill collecting agents) and igniters that will burn off the collected oil. The Oil Spill Recovery Institute (OSRI) is administering the JIP and Tactical Electronics (Tulsa, OK) has been subcontracted to develop an operational prototype of the technology. In addition to BSEE, JIP partners include ExxonMobil, Shell, Oil Spill Response Limited (OSRL), and the North Caspian Operating Company.



Conceptual illustrations of the remotely operated unmanned surface vehicle (ROUSV) being deployed to an oil slick via a helicopter. Credit: ExxonMobil.

The ROUSV will allow more time on station with the potential to carry larger loads of herders and igniters to conduct a minimum of five *in situ* burn operations simultaneously. The ROUSV will be capable of being deployed from the shore, a boat, a fixed-wing airplane, or helicopter. This JIP builds upon previous efforts to develop an aerial herder ignition system and will include flight trials and testing of the full system.

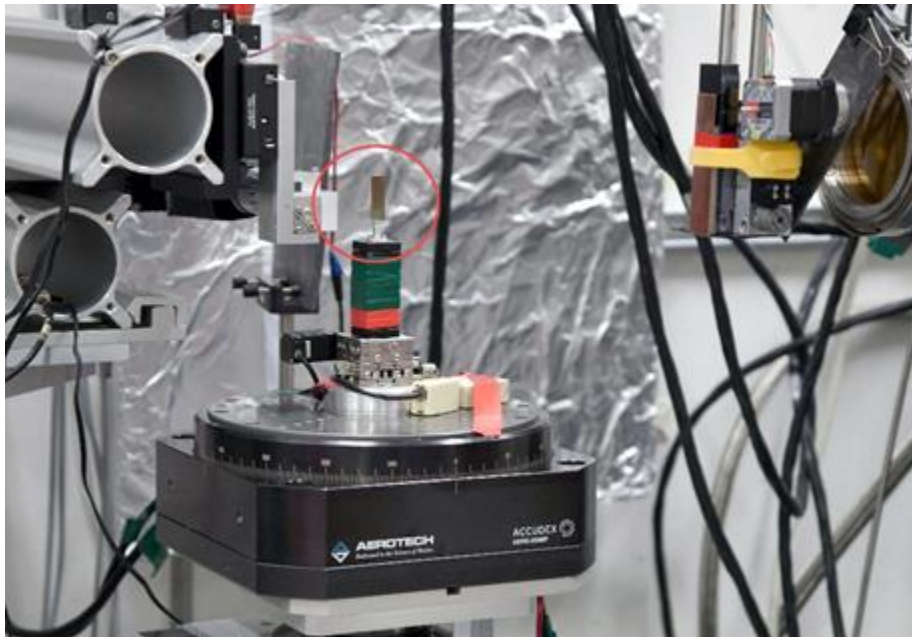
Tomography: Laboratory Experimentation and Metallurgical Analysis of a Subsea Bolt.

Bolts are used throughout the oil and gas industry to secure all types of equipment, including critical safety equipment. Although bolt failures have not yet resulted in any significant losses or damages, had they gone undetected they could have resulted in major adverse events.



Subsea stud cut for X-Ray Characterization. Credit: BSEE/Argonne National Laboratory (ANL) Research

This study is to metallographically analyze and evaluate a 2-inch diameter stud (shown in the figure above), threaded on both ends, that had failed in subsea service for inclusions and microcracking. This report presents technical information from detailed examination of the un-failed region of the stud thread area. Reported examinations follow similar examinations of the failed end (threaded area) of the same stud. Techniques used for this study include tomography from high-intensity radiation in the Advanced Photon Source at Argonne National Laboratory (as shown in the following figure); conventional microscopy including scanning electron microscopy and energy dispersive x-ray spectroscopy (EDS); x-ray fluorescence (XRF); and micro-hardness measurements. These analyses provide information on the metallurgical situation of the sample stud.



Test Setup for Specimen Characterization in Advanced Photon Source (APS) Beamline. Credit: BSEE/ANL Research

The results of this project will be published to help industry understand the microstructures of bolts and develop methods to ensure that the bolts perform per expectations in the challenging ocean environment they will be used in. Results of this study should help reduce the possibility of a major event occurring from bolt failures.

Probabilistic Risk Assessment (PRA) with NASA. The objective of this interagency agreement is to expand and enhance BSEE's capabilities and expertise regarding quantitative risk management related to operational risk in the offshore energy development industries. Through this agreement BSEE is adopting the unique methods and technologies developed by NASA for humans, hardware, and technology operating in extreme environments. Probabilistic Risk Assessment (PRA) is a technique used at NASA to quantitatively model risk. BSEE is leveraging NASA's experienced PRA analysts, in cooperation with BSEE's subject matter experts, to model

operational risks associated with complex offshore energy development operations quantitatively.

Advancing the Recovery Efficiency Sensor: It is important to oil spill responders to conduct efficient oil recovery operations, minimizing water collection and maximizing temporary recovered fluid storage capacity. The Recovery Efficiency (RE) sensor provides percentage of oil and water in a recovered fluid across multiple salinities, multiple oils, and across the entire oil/water cut in real time, allowing a responder to adjust operations to maximize oil collection. When paired with a flow meter, this sensor can also provide data on overall amount of oil recovered. This sensor is currently in Phase II development to enhance accurate accounting for air in the recovered fluid and provide wireless communication of data in real time. The contractor has received multiple patents on this technology including three in FY 2020. The Phase II sensor will be tested in Spring, 2021 and multiple units will be delivered along with a technology commercialization plan. The Phase II sensors will be made available to oil spill removal organizations for further evaluation and feedback.

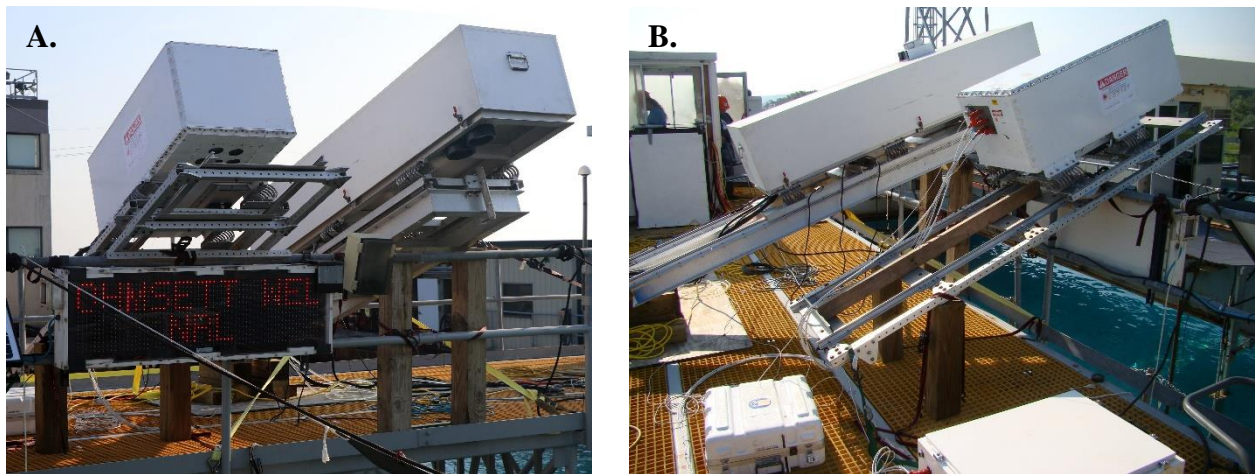


Left: Recovery Efficiency sensor system including sensor, ruggedized tablet, and other components will be packaged in pelican case for fast deployment and operation. Image: Battelle Memorial Institute.

Right: Conceptual View of Handheld Sensor. Image: American University of Beirut.

Estimating Oil Slick Thickness with LiDAR Remote Sensing Technology. The purpose of this study was to assess and evaluate the capabilities and limitations of two above-water laser systems owned and operated by Naval Research Lab, to detect and characterize oil layers of varying thickness on the surface of the water, in conjunction with an acoustic sensor for in-water detection (oil in the water column). The objectives of the proposed scope of work were to: (1) Evaluate above-water Light Detection And Ranging (LiDAR) technologies to characterize oil slicks and oil/water emulsions; and (2) Develop and validate new measurement protocols and new algorithms, using LiDAR, optical, and acoustic data sets, individually and in combination, to differentiate oil types and estimate oil thickness. LiDAR remote sensing can detect and measure the presence of oil at the surface or underwater, and can retrieve a wide range of oil

thickness, from a few microns up to several mm thick. In addition, fluorescence provides an unambiguous signature of the presence of oil.



*NRL LiDAR systems deployed on the railing on the auxiliary bridge at Ohmsett. A. Front view. B. Rear view.
Photo: BSEE.*

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. Outer Continental Shelf (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, offshore 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 (NEPA) analyses and compliance documents for each major stage of energy development and planning. These analyses inform BOEM’s decisions on its National OCS Oil and Gas Leasing Program, as well as 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—strategically 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 Environmental Studies Program (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 or about the OCS. Virtually all these activities are undertaken using authorities provided to BOEM other than the Federal Technology Transfer Act of 1986 (FTTA). Studies undertaken by or through funding from BOEM are available to the public through the Environmental Studies Program Information System (ESPIS), 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 2020, ESP completed 34 studies that accounted for approximately \$23 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. More information on this research is available at <https://www.boem.gov/Technology-Assessment/>.

BOEM also participates in, and provides funds for interdisciplinary projects, including partnerships with other Federal agencies and academic institutions, as well as private companies. These projects are directed toward offshore ecosystem studies that utilize state-of-the-art technologies, such as autonomous underwater vehicle 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 research and development activities, including some conducted in cooperation with other parties.

Wind Tunnel Experiments for Oil and Gas Platforms and Drilling Rig Downwash. BOEM is responsible for regulating air emissions from oil and gas activities (exploration, development and production) on the OCS in the Western and Central Gulf of Mexico to prevent these activities from significantly impacting any State's air quality. Dispersion models are critical to

understanding how pollutants released from oil production platforms and different types of drilling rigs can be carried through the air to nearby onshore areas and possibly impact air quality and human health. This study will employ laboratory wind tunnel testing to better parameterize BOEM's dispersion models and help fill this important information need in BOEM's air quality management approach.

Spatial and Temporal Distribution of Cetaceans in the California Current Ecosystem Using Drifting Archival Passive Acoustic Monitoring. BOEM is planning renewable energy activities on the Pacific Coast that may affect areas that are inhabited or visited by charismatic and protected marine mammals within the California Current Ecosystem Long Term Ecological Research site located off the southern coast of California, extending from San Diego north to San Luis Obispo and westward over 500 km. This ecosystem includes the California Current, the eastern current of the North Pacific Gyre. Scientists who assess marine mammal populations traditionally depended on visual surveys for understanding population abundance and distribution. However, acoustics surveys have long been sought as an alternative for marine mammal assessments because the vocalizing behaviors of this class of charismatic megafauna allows identification of mammals to a species level and provides complementary information to the traditional visually based surveys. BOEM embarked on a study to test a new kind of floating hydrophones that were deployed to drift in the California Current. This study will test whether these hydrophones, if deployed at scale, could provide the improved geographic and temporal characterization of marine mammals that BOEM needs to perform its renewable energy assessments.

Arctic Marine Biodiversity Observing Network (AMBON). The Marine Biodiversity Observing Network is a National effort to develop sustainable integrated ocean biodiversity monitoring using innovative techniques, such as developing satellite remote sensing products and state of the art genetic techniques that complement traditional approaches for monitoring ocean biodiversity. In 2020, BOEM funded an expansion of the Network to enable scientists' participation in cruises in the Beaufort Sea to continue work at stations that AMBON had previously visited in the Bearing and Chukchi Seas. Water and sediment samples will be collected at cruise stations and analyzed for genetic signatures from small-sized ocean organisms to assess biodiversity in these areas. Such organisms include microbes, nano and microplankton, and meiofauna. [Meiofauna are intermediate in size between micro- and macro-invertebrates that live in marine and freshwater environments.] Genetic detection of their fractions of the Arctic biodiversity will help scientists assess and monitor patterns of change at the base of the food web that may otherwise go undetected.

Understanding of Atlantic Sturgeon Migratory Patterns – Integrating Telemetry and Genetics. Atlantic Sturgeon are listed under the Endangered Species Act. They inhabit the ocean and rivers along the East Coast and have been found in areas under consideration for offshore

renewable energy development. BOEM has performed numerous studies using tagging and genetic techniques to understand their movements through these areas. Of particular interest for conservation is the population structure of the affected species. This study will model existing telemetry and genomic data to determine which of the five distinct population segments are likely to be impacted by BOEM's renewable energy activities.

Smithsonian Barcoding Study. Over the past 40 years, the Smithsonian's National Museum of Natural History, Department of Invertebrate Zoology (NMNH-IZ) has partnered with BOEM to provide professional collection management services for the long-term curation of marine invertebrate specimens. During the last decade of this partnership, NMNH-IZ's biorepository facility has brought BOEM's specimen collections into the 21st century and enhanced BOEM's long-term collections by complementing voucher specimens with corresponding viable, cryogenically preserved tissue samples that are barcoded for CO1 gene sequence and preserved for future genomic research. The Smithsonian deployed a genomic sampling strategy that targeted missing families of marine invertebrates and between 2018 and 2020 closed the gap in genomic coverage from 12% to 31% representation in genomic repositories.¹³ This accomplishment reinforces the importance of collections-based research to understand and better manage ocean biodiversity.

¹³ <https://www.boem.gov/environment/environmental-studies/partnering-smithsonian-institution>

XIII. Bureau of Land Management

The Bureau of Land Management (BLM) manages approximately 245 million surface acres and 700 million subsurface acres, which amounts to more than 1-in-10 acres of the surface land and about 1-in-3 acres of the subsurface land in the United States. BLM's multiple-use and sustained yield mandate, set forth in the Federal Land Policy and Management Act of 1976, directs the management of America's public land resources for a variety of uses, such as energy and minerals development, livestock grazing, recreation, and timber harvesting, while also protecting a wide array of natural, cultural, and historical resources for the use and enjoyment of present and future generations. BLM works with partners to promote multiple uses of those lands through shared conservation stewardship and facilitates opportunities for energy development that create jobs, help support local communities, and establish America's energy dominance.

In FY 2019, the latest year for which data have been compiled, the diverse activities authorized on BLM-managed lands generated \$111 billion in total economic contributions throughout the country—more than any other DOI bureau and an increase from \$105 billion in FY 2018.¹⁴ In FY 2019, this economic activity supported approximately 498,000 full- and part-time jobs, up from 471,000 jobs in the previous fiscal year. This activity also generated substantial revenue for the U.S. Treasury and State governments, mostly through royalties on minerals, and through taxes on economic activities.¹⁵

BLM regularly gathers, maintains, and publishes various types of data to inform stakeholders and the general public about its stewardship responsibilities. Those data include detailed information on the commercial uses of the public lands (e.g., energy development, livestock grazing, mining, and timber harvesting); recreational activities (e.g., hunting, fishing, wildlife viewing, hiking, and camping); revenues from these activities; wild horse and burro management; cadastral (mapping) surveys; and the extent and quality of rangeland resources for more than 870 special units, such as wilderness areas, that are part of the BLM's 32-million-acre National Conservation Lands system. The data also include information on the socioeconomic impacts of public land management. Much of this information is published annually in BLM's [*Public Lands Statistics Report*](#).

Examples of FY 2020 technology transfer activities include the following bureau-wide and program-specific efforts.

Maintaining and Publishing Quality Land Management Data. BLM compiles, maintains, and publishes approximately 20 sets of national data, including the Public Land Survey System (PLSS), which is a detailed, nationwide information system on BLM Administrative Unit

¹⁴ [U.S. Department of the Interior Economic Report, FY 2019](#).

¹⁵ *Ibid.*

Boundaries, the Surface Management Agency, Grazing Allotments, and Wild Horse and Burro Herd Areas, among others. The PLSS dataset is used, maintained, and published in partnership with other Federal agencies, as well as Tribal, State, and local governments. The Western Governors' Association (WGA) recognizes the published PLSS dataset (also referred to as Cadastral National Spatial Data Infrastructure [CadNSDI]), land record modernization, and cadastral data as “critical for maintaining livable communities, encouraging economic development and developing tools that give community leaders the ability to manage both.”¹⁶ The States of Utah and Montana host PLSS data on their websites for publication and distribution, and the data are used by the Bureau of Census to standardize the mapping of State, county, and other jurisdictional boundaries. This PLSS dataset also serves as the basis for automating the mapping of land transactions such as oil and gas leasing, permitting, timber sales, and the withdrawal of lands for military use or preservation.

Increased Access to and Use of Data and Information. BLM increased public access to data and information through a variety of technologies and applications, including BLM's geographic information system (GIS) transformation project; [Landscape Approach Data Portal](#); [BLM Navigator](#), a one-stop shop for keyword and geospatial search of BLM data; and the BLM Library.

The [BLM Library](#), located at the [National Operations Center](#) in Denver, exists to serve BLM employees and to assist members of the general public. The [BLM Library](#) provides access to BLM's extensive library catalog, publications, journals, databases, and subject guides. The BLM Library provides researchers with access to BLM's online catalog, journal subscriptions, databases, digitized publications, agency publications, and historical photo collection. Since fiscal year 2018, the number of website views has remained consistent at about 40,000 views per year. Online users spent an average of 2 minutes, 13 seconds using the library's web resources in FY 2020. Currently, 8,748 items are available on [Internet Archive](#) to both BLM and the public. In the past fiscal year 2020, BLM librarians provided access to an average of 65 requested library items per week. The BLM Library's [Historical Photo Collection](#) contains 3,386 photos documenting BLM lands and personnel from the 1930s to 1960s and was viewed an average of 10 times per day in FY 2020.

On June 24, 2020, the Library of Congress FEDLINK Awards [recognized the Bureau of Land Management \(BLM\) Library](#) as the “Small Library of 2019.” This award is given to a small library (staff of 10 or fewer employees) for outstanding, innovative, and sustained achievements in fulfilling its organization's mission, fostering innovation in its services, and meeting the needs of its users. The BLM Library was recognized for creativity in improving the user experience by making it easier for users to find documents that are responsive to their needs and by expanding

¹⁶ Western Governors' Association (WGA), Policy Resolution 00 – 005, reprinted as Appendix B, in WGA, Western Cadastral Data and Policy Forum Final Report, <http://nationalcad.org/download/2000-WGA-Final-Report.pdf>.

virtual collections to increase library use. In fiscal year 2019, the BLM Library implemented a journal link resolver that improves searches for subscription journal titles, helps users identify sought-after resources in a growing collection of digitized documents and relevant new journals, and facilitates research through the Library’s website and catalog. The BLM Library also spearheaded an initiative to preserve historic and rare bureau documents. It created a collection of directives from 1964 to 1995 comprising more than 31,000 files and 250,000 pages, and expanded its historical photo archive. The BLM Library also provides access to the latest annual *Public Land Statistics Report*.

BLM provides data to clearinghouses maintained by the Federal Government, such as data.gov, recreation.gov, and data.doi.gov. These tools make it easier for the public to view, explore, and acquire data that the BLM uses to help disseminate information on—and help manage public lands for—multiple uses, such as energy development, livestock grazing, recreation, and cultural resources.

BLM provides all its historic and newly acquired imagery to the public via the U.S. Geological Survey’s Earth Resources Observation and Science Center ([USGS-EROS](https://eros.usgs.gov)). To assist people in using this information, BLM also initiated a learning outreach effort to its State and field offices regarding the use of Google Earth Engine for scientific resource management. Google Earth Engine is an online program that allows the processing, analysis, and derivation of management products from remotely sensed imagery and other geospatial information about BLM lands across the United States. In addition, BLM provided photogrammetric training for terrestrial and unmanned aerial systems projects to a variety of constituencies, including Federal agencies, nonprofit organizations, universities, and K–12 student groups. These classes focus on the proper capture, processing, analysis, and use of imagery for natural and cultural resource management.

Assessment, Inventory, and Monitoring (AIM). BLM’s Assessment, Inventory, and Monitoring (AIM) strategy provides a standardized process for BLM to collect quantitative information on the status, condition, trend, amount, location, and spatial pattern of resources on the Nation’s public lands. BLM uses AIM data to make necessary management adjustments to meet resource management objectives described at the project, activity plan, resource management plan, and National program levels. AIM data are available through the public-facing versions of the Terrestrial AIM Database (TerrADat) and the Aquatic AIM Database (AquADat). Various State Government agencies—such as the Nevada Department of Wildlife, Wyoming Game and Fish, and the Alaska Department of Environmental Conservation—are engaged in data collection that is compatible with AIM. AIM data are used by a wide variety of Federal and State agencies, universities, nongovernmental organizations, private industry, and the public.

BLM partners with other Federal agencies (e.g., NPS, USFS, USFWS) and Utah State University to support the National Aquatic Monitoring Center (NAMC). NAMC encourages and fosters scientifically sound aquatic monitoring activities on public lands. 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 processed more than 1,300 macroinvertebrate and water samples in FY 2020 for more than a dozen State and Federal agencies and supported web-based interfaces to publicly serve all monitoring data. NAMC also identifies and documents the distribution of aquatic invasive invertebrates to help control or ultimately prevent their spread.

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 and history to biology, botany and ecosystem studies. Much of the research on the National Conservation Lands is conducted through partnerships with scientists and scientific organizations including universities, government agencies, American Indian tribes, special-focus groups and non-governmental organizations. Scientific projects inform the decision-making process of BLM managers and public outreach is emphasized.

In FY 2020, nationwide efforts included improvements to systems for tracking research efforts and updating standardized resource condition monitoring systems and datasets in areas such as Wild & Scenic Rivers and National Scenic and Historic Trails. These improvements build upon BLM systems identified in previous DOI Technology Transfer Reports. Two volumes of guidance (methods and field guide) were released in 2020 to help assess projects on the tens-of-thousands of miles of trails. These guides drew upon decades of inventory, assessment, and monitoring research to inform stewardship across large networks and across multiple landscape scales.

Research and development efforts on National Conservation Lands frequently have broad landscape-level application. Highlights from FY 2020 include research informing post-fire restoration of sagebrush/sage grouse habitat; pollinator habitat studies providing cross-cutting insight into the relation between flora, fauna, and land use; night-sky research informing the impacts of land use change on dark-skies; paleontological and archaeological resource inventories that increase our knowledge of the Nation's shared heritage; wetland condition assessments; and rare species assessments.

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 geologic surveys, Indian Tribes, museums, and universities, as appropriate, to facilitate research and gather location-specific information to better manage and place into context cultural and paleontological sites on BLM lands. The relationship is often reciprocal, with scientific data shared by BLM and partners. These partnerships address requirements of the National Historic Preservation Act of 1966, the Archaeological Resources Protection Act of 1979, and the Paleontological Resources Preservation Act of 2009.

XIV. Conclusion

During FY 2020, DOI's technology transfer activities included:

- Engaging in 489 Cooperative Research and Development Agreements (CRADAs) and at least 353 other collaborative R&D relationships.
- Executing 457 nontraditional CRADAs, such as technical assistance, material use, and facility use agreements.
- Disclosing four (4) new inventions, filing four (4) new patents, and receiving three (3) new patents.
- Managing 71 active licenses for inventions and other intellectual property, which collectively earned about \$123,000.
- Publishing more than 720 reports, books, papers, fact sheets, and other documents.

XV. Data Appendix

The following tables provide cumulative data for DOI from FY 2016 through FY 2020. Data for individual bureaus are available online at <https://www.doi.gov/techtransfer/annual-reports>.

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. Also, note that only NPS has data on small business participation (lines 23 and 24).

Accompanying Tables for Guidance for Preparing Annual Agency Technology Transfer Reports Under the Technology Transfer Commercialization Act

Table 1: Invention Disclosures and Patents

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
Invention Disclosures						
1	Number of new inventions disclosed	8	13	9	8	4
Patents						
2	Number of patent applications filed	4	6	7	3	4
3	Number of patents received	1	3	6	2	3

Table 2: Income Bearing Licenses

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
Income Bearing Licenses						
4	Number of income bearing licenses	17	13	15	16	14
5	Exclusive licenses	8	7	8	7	7
6	Partially exclusive licenses	0	0	0	0	0
7	Non-exclusive licenses	9	6	8	9	6

Table 3: Licensing Income (\$)

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Total income (all licenses active in FY)	82,997	50,090	50,925	42,168	122,749
Total income distributed	81,559	49,990	43,190	33,588	116,603
Total income from patent licenses	82,997	50,090	50,925	42,168	120,739
Total income distributed	81,559	32,557	50,925	27,211	92,953
Disposition of Earned Royalty Income					
17 Total amount of Earned Royalty Income received (\$)	81,997	50,090	50,925	42,168	122,749
Total amount of ERI distributed (\$)	81,559	48,990	43,190	27,211	92,953
18 Percent of Earned Royalty Income distributed to inventors	68%	51%	62%	64%	39%
19 Percent of Earned Royalty Income distributed to the agency or laboratory	32%	14%	38%	36%	34%
20 Licenses terminated for cause	0	0	1	0	1

Table 3A: License Activity

Metric	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Licenses, Total Active	22	15	17	18	71
New Licenses	0	0	2	2	17
Invention Licenses, Total Active	20	13	15	16	71
New Invention Licenses	0	0	2	2	1
Income Bearing Licenses, Total Active	17	13	13	16	9
Income Bearing Exclusive Licenses	8	7	8	7	5

Table 4: CRADAs

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
	CRADAs					
21	Number of active CRADAs	873	841	742	470	489
22	Number of newly executed CRADAs	511	477	422	352	237
23	Active CRADAs with small business involvement				2	2
24	Number of small businesses involved in active CRADAs				2	2
	<i>Traditional CRADAs</i>					
25	Active traditional CRADAs	37	58	55	45	32
26	Newly executed traditional CRADAs	9	13	5	9	8
	<i>Non-traditional CRADAs</i>					
27	Active non-traditional CRADAs	836	783	687	425	457
28	Newly executed non-traditional CRADAs	505	466	418	343	229
	<i>Other collaborative R&D relationships</i>					
	(Collaborative Agreements), total active in the FY	319	247	249	269	353
	New, executed in the FY	126	89	117	149	125

XVI. Acronyms

AADA - Aquatic Animal Drug Approval Program
AADAP - Aquatic Animal Drug Approval Partnership
AML - Abandoned Mine Lands
AIM - Assessment, Inventory and Monitoring
AMBON - Arctic Marine Biodiversity Observing Network
AquADat - Aquatic Assessment, Inventory and Monitoring Database
AUV - Autonomous Unmanned Vehicles
BLM - Bureau of Land Management
BOEM - Bureau of Ocean Energy Management
BOR - Bureau of Reclamation
BSEE - Bureau of Safety and Environmental Enforcement
CCAA - Candidate Conservation Agreement with Assurances
CESU - Cooperative Ecosystem Studies Units
CO₂ - Carbon Dioxide
CRADA - Cooperative Research and Development Agreements
DOI - Department of the Interior
DWPR - Desalination and Water Purification Research
EDNA - Environmental DNA
EDS - Energy Dispersive x-ray Spectroscopy
EPA - Environmental Protection Agency
ERI - Earned Royalty Income
ESA - Endangered Species Act
ETB - Emerging Technologies Branch
ESP - Environmental Studies Program
FAC - Fisheries and Aquatic Conservation
FDA - Food and Drug Administration
FLPMA - Federal Land Policy and Management Act of 1976
FTC - Fish Technology Center
FTTA - Federal Technology Transfer Act of 1986
FUSA - Facility Use/Service Agreement
FWS - Fish and Wildlife Service
GE - General Electric
GHG – Greenhouse Gas
GIS - Geographic Information System
ICCOPR - Interagency Coordinating Committee on Oil Pollution Research
ICRARD - International Committee on Regulatory Authority Research and Development
IRF - International Regulators' Forum
JCCEO - (ShakeAlert) Joint Committee for Communication, Education, and Outreach
JIP - Joint Industry Project

LiDAR - Light Detection and Ranging Scanners
MBN - Magnetic Barkhausen Noise
MCL - Materials and Corrosion Laboratory
MCSP - Monarch Conservation Science Partnership
MDTI - Mine Drainage Technology Initiative
MTA - Material Transfer Agreement
NAMC - National Aquatic Monitoring Center
NASA - National Aeronautics and Space Administration
NCPTT - National Center for Preservation Technology and Training
NCR - Natural and Cultural Resources
NCTC - National Conservation Training Center
NDSU - North Dakota State University
NDT - Non-Destructive Test
NEPA - National Environmental Policy Act
NGA - National Geospatial Intelligence Agency
NGO - Nongovernmental Organization
NPS - National Park Service
NRL - Naval Research Laboratory
NMNH-IZ - Smithsonian's National Museum of Natural History, Department of Invertebrate Zoology
NTTP - National Technical Training Program
NTTT - National Technology Transfer Team
OCS - Outer Continental Shelf
OEPC - Office of Environmental Policy and Compliance
OMB - Office of Management and Budget
OORP - Office of Offshore Regulatory Programs
OPA - Office of Policy and Analysis (within USGS)
ORTA - Office of Research and Technology Applications
OSMRE - Office of Surface Mining Reclamation and Enforcement
OSPD - Oil Spill Preparedness Division
OSRI - Oil Spill Recovery Institute
OSRL - Oil Spill Response Limited
OSRR - Oil Spill Response Research
PAIS - Padre Island National Seashore
PLSS - Public Land Survey System R&D-Research & Development
PRA - Probabilistic Risk Assessment
RE - Recovery Efficiency
Reclamation - Bureau of Reclamation
ROUSV - Remotely Operated Unmanned Surface Vehicle
RRB- Response Research Branch

S&T - Science and Technology

SMCRA - Surface Mining Control and Reclamation Act of 1977

SO - Secretarial Order

TAA - Technical Assistance Agreement

TerrADat - Terrestrial Assessment, Inventory and Monitoring Database

TIPS - Technical Innovation and Professional Services

UAS - Unmanned Aircraft Systems Program

USGS - United States Geological Survey

USGS-EROS - United States Geological Survey Earth Resources Observation and Science Center

XRF - X-ray Fluorescence