U.S. Department of the Interior

Annual Report on Technology Transfer

FY 2015 Activities

January 2016

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I. Introduction

Technology transfer for the Department of the Interior (Department) includes a range of activities designed to disseminate scientific and technical information and knowledge between the Department and other Federal and non-Federal entities. It includes but is not limited to publications, exchange of 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 which the Department manages. In general, technology transfer activities within the Department are consistent with its mission to protect and manage the Nation's natural resources and cultural heritage; to make available scientific and other information about those resources; to honor trust responsibilities to Tribes; and to supply energy for the future.

This report describes the actions the Department took in FY 2015 to advance technology transfer. These range from developing and helping commercialize new technologies to reduce the discharge of invasive non-indigenous species in cargo ballast waters into U.S. waters to testing and demonstrating earthquake early warning systems to developing new chlorine-resistant desalination membranes to enhance water supplies. It also describes activities to meet the objectives of the Department's Technology Transfer Plan, submitted to the Office of Management and Budget in FY 2012, to advance its technology transfer activities. These activities demonstrate the innovation, expertise and dedication of the Department's employees, including its many scientists and engineers. The report addresses actions being taken to stimulate the development and dissemination of new technologies using prize competitions authorized by the America COMPETES Reauthorization Act of 2010 and other authorities. Finally, the report includes a Data Appendix which provides cumulative data tables for the Department for FYs 2011–2015, as requested by the Office of Management and Budget, and the National Institute of Standards and Technology. These tables include updates to previous years' data, where appropriate.

II. Advancing Technology Transfer in the Department of the Interior

The FY 2015 enacted budget for the Department of the Interior included $935.9 million for research and development. Much of the funding was for applied research ($754.4 million), while basic research and basic development received $53.3 million and $128.1 million, respectively. The programs supported through these funds generate large amounts of knowledge, information, and technology, which help the Department meet its mission objectives and are transferred to resource managers, stakeholders, and the general public.

The Department's bureaus have varying levels of involvement with scientific and technical research and innovation, and technology transfer. In FY 2015, as in previous years, the majority of technology transfer activities reported by the Department under the Federal Technology Transfer Act of 1986 (FTTA) were undertaken by the U.S. Geological Survey (USGS) because it is the largest research and development (R&D) organization within the Department, both in terms of budget and personnel, and, therefore, generally has greater involvement with technology transfer. Typically, USGS accounts for over 70 percent of the Department's R&D budget.

The Department's scientists, engineers and other technical personnel advance the state of knowledge related to the Department's resources, and ensure that this information is accessible to resource managers, private industry, and the general public. The vast majority of the Department'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 2015, USGS and U.S. Fish and Wildlife Service (FWS) personnel authored or co-authored over 8,900 reports, books, fact sheets, and other publications, including over 3,500 scientific publications. The other bureaus, while also active in publishing and distributing scientific, technical and engineering results, however, do not systematically track these products, so their contributions are not included in these counts.

Bureaus also use other conventional approaches to share scientific and technical resources and expertise with each other, universities and other entities to address resource management issues. For example, six bureaus are active participants in the network of seventeen Cooperative Ecosystem Studies Units (CESUs), a collaboration among 373 partners, including 15 Federal agencies and over 350 non-Federal partners (including universities, Tribes and tribal organizations, State agencies, museums, aquariums, arboretums, and conservation organizations). Each CESU is hosted by a university.

Bureaus that are active in research and development, 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 the Department's bureaus and private sector industries to pool their expertise and resources to jointly create and advance technologies that could help fulfill agency missions while helping U.S. industries innovate and commercialize technologies that can strengthen our national economy and create jobs. This report focuses primarily on the aspects of technology transfer related to the FTTA.

FY 2015 Accomplishments

In FY 2015, the Department continued to build on actions initiated in FY 2011 and the successful implementation of the Departmental Plan on Technology Transfer submitted to OMB in FY 2012 to institutionalize technology transfer programs within the Department. These actions also enable all bureaus to more effectively and efficiently implement the FTTA and related legislation while maintaining focus on their missions. These actions included:

- Increased coordination and cooperation amongst Department bureaus through presentations where bureaus with greater experience with instruments made available through the Federal Technology Transfer Act shared their knowledge with bureaus with less experience. These also illustrated the benefits of using these instruments to augment appropriated resources made available to bureaus to pursue their mission.
- Increased accessibility to resources to advance technology transfer through improvements to the Department's technology transfer website. This site, which is updated continually, provides information on relevant bureau programs and activities; opportunities for other agencies, and private and non-profit institutions to cooperate with the Department's

scientists, engineers and technical personnel; links to information on best practices related to technology transfer for novice and experienced practitioners; and other training related information.

- Development of Departmental policy and procedural guidance for offering and administering prize competitions, following intense interest within bureaus to use prize competition authority under the America COMPETES Reauthorization Act of 2010 to advance innovations to fulfill mission goals.

During FY 2015, the Department's scientific, technical and engineering personnel continued to engage in a broad range of cooperative activities to develop and disseminate innovative technologies, including:

- Publishing over 8,900 reports, books, papers, fact sheets, and other publications, including over 3,500 in scientific publications.
- Collaborating on 826 Cooperative Research & Development Agreements (CRADAs), of which 586 were new that fiscal year. These are substantial increases over last year's numbers of 601 and 423, respectively. In addition, the Department was engaged in at least 318 other collaborative R&D relationships, versus 292 in FY 2014.
- Greatly expanding the number of non-traditional CRADAs, i.e., material use and facility use agreements, which they engaged in under the FTTA from 566 in FY 2014 to 787 in FY 2015.
- Disclosure of seven (7) new inventions. In addition, eight (8) patents were filed and three (3) patents were received.
- Managing twenty (20) active licenses for inventions and other intellectual property earning over $105,000.

Finally, following publication of the Departmental policy and procedural guidance on prize competitions in April 2015, several bureaus have begun exploring and implementing the use of such competitions to advance technologies to address mission needs. Specifically:

- Reclamation's Water Prize Competition Center, established in FY 2015, is an interagency effort to develop new, or improve existing, technologies to restore ecosystems, improve infrastructure sustainability, and water availability. The first competition, launched in FY 2015, was to develop, test and demonstrate new methods to remotely track fish. Reclamation is developing additional competitions for FY 2016, and beyond.
- Reclamation's prize competition-related activities during FY 2015 garnished several awards at the 5-year anniversary of the start of Challenge.gov, the General Service Administration (GSA) interagency platform for offering and tracking federally-sponsored prize competitions. These awards, co-sponsored by the Office of Science & Technology Policy and GSA, include *Newcomer of the Year Award* for its pioneering efforts in developing and implementing the Water Prize Competition Center, and the *Best in Technology Award* for contributing its technical expertise and the testing facility to the USAID-Reclamation Desal Prize competition seeking a scalable, sustainable, and affordable desalination technology for use in rural areas in both developing and

developed countries, including in Native American communities. As a result of the competition, two teams were selected for their top performing brackish water desalination technologies. MIT and Jain Irrigation Systems was awarded first place for their photovoltaic-powered electrodialysis reversal (EDR) system and the University of Texas at El Paso (UTEP) Center for Inland Desalination Systems finished in second with their Zero Discharge Desalination (ZDD) technology. Finally, a Reclamation desalination research expert, Saied Delagah, won the *Unsung Hero Award* for his outstanding, behind the scenes coordination of the technical efforts that enabled the international Desal Prize.

- USGS is partnering with other Federal agencies on the Climate Resilience Data Challenge (partners: NASA, NOAA, and EPA). This challenge is part of the Climate Data Initiative, a broad effort to leverage the federal government's extensive, freely-available climate-relevant data resources to spur innovation and private-sector entrepreneurship to advance awareness of and preparedness for the impacts of climate change. USGS is focused on providing ideas to improve Climate Resilience to address adverse impacts of climate change, such as coastal flooding, sea level rise, food security, and public water utilities. It is also cooperating with Reclamation's Water Prize Competition Center's efforts, as well California AgTech Roundtable's Aps for Ag hackathon.
- BLM is working on raising funds for a prize challenge that would help address the challenge of using fertility control vaccines to manage healthy wild horse and burro populations on public lands. Currently available fertility control technologies are limited in their effectiveness due in part to the logistical challenges of consistently finding, tracking and treating the animals. A solution to this challenge is critical because wild horse and burro herds have a rapid growth rate if left unchecked, annual adoptions of excess animals are at a near-record low, and the cost to care for unadopted excess animals in BLM-funded off-range corrals and pastures is unsustainable in the long-term.

III. Overview of Technology Transfer Activities

Table 1 indicates that The Department's bureaus use, or are contemplating using, a diverse range 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	Reclam-ation	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		
Technical Assistance Agreements (TAAs)	X					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		
Web and other mechanisms	X	X	X	X	X	X	X	X

IV. Technology Transfer Agreements

Table 2 provides a summary of new and active technology transfer agreements undertaken within the Department in FY 2015. There were a total of 826 active CRADAs in FY 2015, of which 586 were newly executed. By contrast, in FY 2014, there were a total of 601

Table 2: Collaborative Relationships for Research & Development (FY 2015)

	USGS	Reclam-ation	BSEE	FWS	Total
● **CRADAs**, total active in the FY(1)	814	8		4	826
- New, executed in the FY	585	1		0	586
▪ Traditional CRADAs,(2) total active in the FY	31	3		4	38
- New, executed in the FY	12	0		0	12
▪ Non-traditional CRADAs,(3) total active in FY	783	4		0	787
- New, executed in the FY	573	1		0	574
● **Other collaborative R&D relationships**[4]					
▪ (Collaborative Agreements), total active in the FY	315	1	2	n/a	318
- New, executed in the FY	120	0	1	n/a	121

CRADA = Cooperative Research and Development Agreement
(1) "Active" = legally in force at any time during the FY. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC § 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 (TAA) and Facility Use/Service Agreement (FUSA) fit 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.

Table 3 summarizes invention and patenting activity within the Department during FY 2015 broken out by bureau. This activity was limited to USGS and Reclamation. The table indicates that seven new inventions were disclosed, eight new patent applications were filed and three new patents were issued. In addition, since the publication of the last (FY 2014) Annual Report, FWS has identified a new patent application that was submitted that year.

Table 3: Invention Disclosure and Patenting (FY 2015)

	USGS	Reclam-ation	Total
● New inventions disclosed in the FY(1)	7	0	7
● Patent applications filed in the FY(2)	7	1	8
● Patents issued in the FY	2	1	3

(1) Inventions arising at the bureau.
(2) Tally includes: U.S. patent applications, foreign patent applications filed on cases for which no U.S. application was filed, divisional applications, and continuation-in-part applications. Excludes: provisional, continuation, duplicate foreign, and Patent Cooperation Treaty (PCT) applications.

Specifically, USGS filed patent applications for a device to monitor subsurface temperatures in land and water; a device to deter bats from colliding with wind turbines; a device to measure

relative land surface elevation tables; a hydrophonic device used to measure sediment transport in river beds; a mixing method to treat ballast water in cargo ships; and a device used to measure water infiltration rates and conductivity of soil. In addition, patents were issued to USGS for an effective system and method of artificially recharging groundwater reservoirs; and a device to assist in the collection of storm water samples in a vertical profile.

Table 4 provides a summary of the number of active licenses managed by the Department's bureaus.

Table 4: Active and Income Bearing Licenses (FY 2015)

	USGS	Reclam-ation	Total
● **All licenses**, number, total active in the FY	15	5	20
▫ New, executed in the FY	3	0	3
● **Income bearing licenses**	15	3	18

Additional data, broken out by bureau and covering FY 2011–FY 2015, are contained in the Data Appendix to this report. These show that total income in FY 2015 from all licenses amounted to over $105,000 (from 18 income bearing licenses), a substantial increase over the $58,000 from 16 licenses in the previous fiscal year.

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

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

Mission	Technology Transfer
United States Geological Survey (USGS). The mission of the 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.	The 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. The USGS makes this information and knowledge readily available to decision makers and the public. Thus, one of the 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 (see Table 1).
U.S. Fish & Wildlife Service (FWS). The mission of the U.S. Fish & Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.	FWS's Research and Development (R&D) is primarily focused on providing the basis for effective conservation in order to meet its mission. The agency's primary research nexus with the private sector centers on the Fish and Aquatic Conservation Program. 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. Today there are seven such centers working with industry and government to improve aquaculture opportunities.
Office of Surface Mining Reclamation and Enforcement (OSMRE). OSMRE helps States develop and implement their own approved surface coal mining programs.	OSMRE advances it 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.
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. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.	Under the National Park Service benefits-sharing policy and procedural guidance (available at http://www.nps.gov/applications/npspolicy/DOrders.cfm), benefits sharing occurs when NPS receives monetary or non-monetary 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. The benefits-sharing policy and guidance address technology transfer and employee inventions. Authorities under the FTTA are essential to the NPS benefits-sharing program.

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

Mission	Technology Transfer
Bureau of Safety and Environmental Enforcement (BSEE). The BSEE works to promote safety, protect the environment, and conserve resources offshore through vigorous regulatory oversight and enforcement.	The BSEE R&D program operates through the Emerging Technologies Branch (ETB) and the Oil Spill Response Research (OSRR) Branch. BSEE research is associated with operational safety, pollution prevention, and oil spill cleanup techniques and technologies.
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.	Reclamation has the lead Federal responsibility for water management and hydropower in the 17 Western States. Its research program is highly applied towards development of solutions that benefit its operations and infrastructure reliability. The research programs use technology transfer fundamentals to help speed field deployment of new innovations.
Bureau of Ocean Energy Management (BOEM). The Bureau of Ocean Energy Management manages the exploration and development of the Nation's offshore resources. It seeks to appropriately balance economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.	BOEM's Environmental Studies Program (ESP) develops, conducts and oversees scientific research specifically to inform policy decisions regarding development of Outer Continental Shelf (OCS) energy and mineral resources. Research covers physical oceanography, atmospheric sciences, biology, protected species, social sciences, economics, submerged cultural resources and environmental fates and effects.
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 the BLM manage public land resources for a variety of uses, such as energy development, livestock grazing, recreation, and timber harvesting, while protecting natural, cultural, and historical resources.	BLM's science and technical focus has been on place-based applications to improve the management of public lands in accordance with FLPMA's multiple use mandate. In addition to its traditional technological transfer activities, BLM is exploring additional technology transfer opportunities under 15 U.S.C. 3710 and U.S.C. 205 and 207 that could be employed to help advance its multiple-use mandate and which can be used in the landscape approach as the BLM transitions to ecoregional-area land management.
Office of Environmental Policy and Compliance (OEPC). Within the Office of the Secretary, OEPC provides leadership on a national and regional level for environmental policies and compliance and serves as the Department's unifying and lead voice for a wide range of environmental issues. OEPC ensures environmental stewardship and sustainability through compliance with the National Environmental Policy Act (NEPA), executive orders, regulations, and reporting requirements; manages the Department's funding program for long-term cleanups of hazardous materials; and oversees the Department's activities to protect and recover natural and cultural resources and historic properties for emergency incidents and all hazards disasters.	OEPC is responsible for leading and coordinating the Department's involvement in Federal activities to restore and recover natural, cultural and historical resources affected by major disasters. It ensures that a cadre of trained individuals is ready and available in short order in the wake of a national disaster to fulfill their roles to undertake recovery and response activities as part of interagency and inter-governmental teams. Developing and maintaining this capability requires training and substantial transfer of knowledge and expertise to members of this cadre. This is a critical part of developing and maintaining readily-accessible human capital to restore and recover damaged natural, cultural and historic resources, or otherwise mitigate such damage in the event of a major disaster.

Subsequent sections briefly describe each bureau's technology transfer program and a sample of their activities in FY 2015. The tabular data requested by OMB Circular A-11 are reported in the Data Appendix, to the extent data are available.

V. U.S. Geological Survey

The United States Geological Survey (USGS) is a scientific bureau within the Department of the Interior 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. Under its science strategy outlined in "Facing Tomorrow's Challenges—U.S. Geological Survey Science in the Decade 2007-2017," USGS focuses on the following interdisciplinary mission areas: Ecosystems; Climate and Land Use Change; Energy, Minerals, and Environmental Health; Natural Hazards; Water Resources; Core Science Systems; Administration and Enterprise Information; and Facilities. These mission areas combine expertise from several Earth Science disciplines (e.g. hydrology, geochemistry, biology) to address relevant issues of concern to people and other living things on the planet. Organization around these mission areas allows the USGS to better address the needs of its customers and partners.

Delivery of science information is a primary purpose of the bureau. Technology transfer activities with the public and private sectors, including academia and non-profits, are, therefore, integral to fulfilling this purpose. They typically support the collection and transference of scientific data (knowledge dissemination). In FY 2015 U.S. Geological Survey personnel, for example, authored or co-authored over 8,534 reports, books, fact sheets, and other publications and information products, including over 2,204 scientific journal articles, 923 USGS Series scientific publications, and 4,112 abstracts. The USGS also cooperates with its public and private collaborators to help them maintain necessary services, better understand the environmental consequences of their commercial and non-commercial activities, and develop new products and services. The USGS has 35 major laboratories and several hundred field offices located around the country.

Within the USGS, technology transfer that extends beyond traditional publications, meetings and conferences and is related to the Stevenson-Wydler Innovation Act and the FTTA is managed through the Office of Policy and Analysis (OPA). OPA staff service USGS Science Centers and offices throughout the country.

In 2015, OPA, on behalf of the USGS, continued negotiating and drafting Cooperative Research and Development Agreements (CRADAs), Technical Assistance Agreements, Facility Use Agreements, Material Transfer Agreements, and Patent Licenses. This office also manages the USGS intellectual property and inventions program; marketing USGS technology opportunities and facilitating partnerships with industry, non-profits, academic institutions, Tribal nations, and State agencies. OPA also provides training to USGS personnel on technology transfer and intellectual property matters.

In 2015, USGS had 814 active traditional and non-traditional CRADAs, the majority of which (783) were technical assistance and facility use agreements. These were substantially more than in FY 2014, during which it had 587 active CRADAs, including 560 user agreements. In addition, USGS executed 315 other collaborative agreements, managed a total of fifteen (15) active patent licenses. In addition, it filed seven (7) patent applications, received two (2) patents, and executed three (3) new patent licenses.

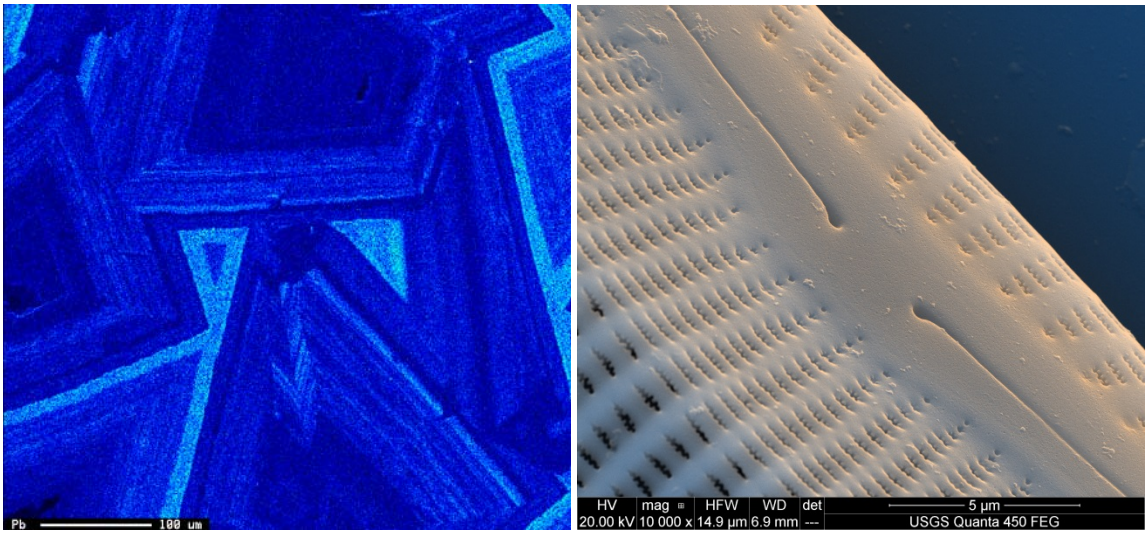
USGS science and research contributes to a broad range of collaborative projects in the private and academic sector. The USGS has increased to twenty eight (28) the number of specialty analytical laboratory services providing unique capabilities to U.S., foreign, and academic partners that can be made available through the USGS' Facility Use program. Examples include:

- The Tephrochronology Project and Laboratory, which conducts unique analyses, compilations and interpretation of volcanic ash layers in the western United States. [Tephrochronology is the study of volcanic ash deposits, combining petrology, geochemistry, and isotopic dating methods.] The project's database includes temporal and spatial distribution of the volcanic ash layers and provides an understanding of the geological evolution over time of the western and Pacific margin region in the U.S.

- The Optically Stimulated Luminescence Dating Laboratory, which has developed and characterized phosphor technology to measure radiation exposure to personnel, objects, and to the environment. This lab performs sample preparation, data generation and interpretation of the analyses.

- The Reston Stable Isotope Laboratory has the unique capability in the United States of preparing and calibrating stable isotopic reference materials for the light elements, including hydrogen, carbon, nitrogen, oxygen, and sulfur. There are several unique instruments in this laboratory. These include a DuPont double-collection, isotope-ratio mass spectrometer; a VG 602 hydrogen double-collection isotope-ratio mass spectrometer; and a semi-automated silver-tube sealing apparatus [described by Qi et al in Rapid Communication in Mass Spectrometry, "Novel silver-tubing method for quantitative introduction of water into high-temperature conversion systems for stable hydrogen and oxygen isotopic measurements", v. 24, p. 1821-1827 (2010)].

- The Denver Microbeam Laboratory has an electron microprobe (EPM) and two scanning electron microscopes (SEM) that can be used to analyze geologic samples and other types of samples. These instruments provide topographic information (using secondary electrons), average atomic number (using backscattered electrons), and defect imaging (using cathodoluminescence) through a range of magnifications (50x to 500,000x). In addition, they can perform quantitative chemical analysis of elements (ranging from tens of ppm up to 100 percent) with better than 1 percent relative precision and 2 percent relative accuracy. Structural analysis of material is also possible using electron backscattered diffraction. Researcher-driven EPMA and SEM of geologic samples is rarely available in the private sector. Most private sector work is performed on biological samples, semiconductors, or gunshot residue and lacks the expertise to analyze geological materials. In addition, the USGS allows the owner of the samples that are being analyzed to operate the instruments and direct the analysis.



Left: The excellent energy resolution and low limits of detection of the electron microprobe make it the ideal instrument to map trace elements in pyrite. This x-ray intensity map displays the relative concentrations of Pb in pyrite from the Lepanto Gold Mine, Philippines. Such studies, in combination with other research techniques, allow economic geologists to reconstruct the ore deposit, model ore grade, and predict the presence of concealed deposits. [Photo credit: Heather Lowers, USGS]. Right: Scanning electron microscopy is essential for observation and measurement of the silica cell walls of diatoms. Here, the external structure of the areolae of the diatom *Encyonema nicafei* is shown in detail. This organism was formally described as a species new to science using images from the USGS facility. [Photo credit: Heather Lowers, USGS]

The following are examples of current USGS technology transfer activities.

Ballast Nozzle Mixing Methods. The USGS invented a novel nozzle-mixing method to reduce the discharge of invasive non-indigenous species into U.S. waters during the release of ballast waters from cargo ships. It entered into an exclusive license agreement with Glosten, Inc., to commercialize and make the nozzle mixing methods publicly available as part of Glosten's proprietary Ballast Responder.

Cargo ships that transport goods around the world can carry nonindigenous species in the ballast water that is used to stabilize and balance the vessel. The release of the ballast water from the ships is a major transport mechanism for the nonindigenous aquatic organisms. When the ships enter port, the ballast is released which may introduce nonindigenous species to local waters. These species can have a dramatic negative effect on marine, estuarine, and freshwater ecosystems in the United States and abroad. These effects can range from altering the structure and dynamics of the ecosystem to killing native species. Therefore, it is important to reduce, if not eliminate, nonindigenous species that may be in the ballast water prior to discharging it in any U.S. waters. This can be accomplished through mixing a biocide in the ballast water. Complicating this process is the fact that cargo ships have a wide variety of ballast tank configurations. The USGS has invented a system, which paired with Glosten's products, circulates the ballast water with a biocide without removing the ballast water from the ballast tank. This novel method overcomes the challenges of mixing within different ballast tank configurations and is a cost effective solution to combating the introduction of exotic aquatic species.

USGS's Dr. Barnaby Watten on the deck of American Steamship Company's *Indiana Harbor* testing passive nozzle mixing methods and gathering base line data. Dr. Watten is utilizing a diaphragm pump in order to pump water from one end of the ballast tank to the other in order to enhance the ballast mixing. [Photo Credit: Noah Adams, USGS]

Improved Device to Measure Ground Temperature. USGS and Alpha Mach, Inc. have entered into an exclusive license agreement to commercialize and make publicly available the temperature probe co-invented by both parties to continuously measure temperature in soils and riverbed sediments at multiple depths. This allows the rate and direction of seepage to be estimated. This device has many practical applications to those interested in collecting temperature data for hydrological and ecological investigations. The new temperature probe was designed to overcome the challenges of current methods, using microchip thermistors and internal data storage, with a focus on employing heat as a tracer in surface water investigations.

Test of Earthquake Early Warning Notifications. USGS and Global Security Systems, LLC (GSS) have established a collaboration to test the use of the latter's ALERT FM system to broadcast earthquake early warnings generated by the USGS ShakeAlert System. The USGS ShakeAlert System in California consists of sensors placed strategically throughout the state that detect seismic vibrations. If these vibrations exceed a pre-determined level, that would trigger an alert, and send out warnings. These warnings could be distributed across outdoor sirens, ALERT FM receivers, smartphone apps, and other notification pathways such as radio and TV broadcasts.

ALERT FM is unique since it operates a dedicated emergency notification system that is satellite-based and is not reliant on potentially vulnerable Internet connectivity. It is already being used in many southern states for tornados and hurricane notification. ALERT FM uses the digital data subcarrier of local FM radio stations, including Univision station in southern

California and public radio station KQED in northern California, to distribute critical alerts in as little as 6 seconds.

An objective of the partnership is to have ShakeAlert earthquake early warning alerts posted to GSS alert software and broadcast to a set of GSS receivers. In addition, the USGS and GSS will collaborate on system design and best practices for alerting different sectors, including emergency response personnel, utilities, and other industries. Early warning of earthquakes will allow businesses to take actions to protect their employees, customers, and critical infrastructure from strong shaking. Even a few seconds of warning is enough notice to shutdown vulnerable processes, move people from unsafe places, and for people to drop, take cover and hold on.

Information would be received on portable or fixed receivers that can be programmed for specific groups, counties, or areas. ALERT FM receivers automatically tune to and lock on to the strongest FM signal in the area. As the USGS ShakeAlert System begins issuing public alerts for the West Coast of the US, ALERT FM receivers would be available for purchase by residents and businesses.

USGS has partnered with Global Security Systems because it is a systems integrator, service provider and manufacturer of the ALERT FM, Alert Studio and GSSNet, a satellite data delivery system that has developed a commercially available end-to-end notification platform based on FM radio broadcasts fed by satellite for distributing mass notifications. GSS has a nationwide satellite delivery system to originate and uplink Common Alert Protocol (CAP) based emergency audio and text alerts. GSS Alert FM receivers, cell phones equipped with a radio chip and software, and other consumer devices receive the alert messages. The GSSNet satellite data delivery system for emergency alerts currently is currently in operation on over 500 radio stations in 17 states and Canada.

Using Environmental DNA to Detect Aquatic Invasive Species. Aquatic invasive species are a significant concern, because they can cause environmental and economic damage. Preventing their spread is imperative to successful integrated pest management efforts, and the detection of environmental DNA (eDNA) has become an important surveillance method to detect the presence of Asian carps (bighead carp — *Hypophthalmichthys nobilis* and silver carp — *Hypophthalmichthys molitrix*) and other aquatic invasive species. However, most current methods to detect Asian carp eDNA (and DNA of other species) require specialized laboratories and equipment. The USGS recently verified a new technology for detecting Asian carp in water samples. This technology uses a portable hand-held detection device that detects environmental DNA (eDNA) of Asian carps (bighead carp and silver carp) in water samples. Expert and novice users verified that the new technology could accurately and rapidly detect Asian carp eDNA in water samples taken from fish transport tanks containing about 10,000 minnows and 0, 1, or 10 silver carp. The process has been simplified so that experience in genetics or molecular techniques is not needed to detect the DNA of Asian carp in environmental samples. The process took less than an hour to collect, process and detect the DNA of silver carp in water samples taken from the carp-containing tanks.

Developing portable, rapid and reliable methods and kits such as this one will improve the detection of invasive species and pathogens and will improve the ability of resource managers to

make timely decisions to prevent, contain, and control invasive species and pathogens. Future efforts will continue the evaluation of the method and kit under field conditions, including fish shipments that might contain invasive carps, and to develop procedures and information needed to allow conservation officers and law enforcement agencies to use the kit to prevent illegal transport of Asian carps and other species. This 5 year project is utilizing various agreement types over the project period to formalize the collaborative work.

Challenge Related Activities

In addition to the more conventional technology transfer activities illustrated by the above examples, in FY 2015, USGS participated in several prize competitions and related activities in conjunction with other agencies within and outside the Department. In each of these, the USGS role typically consisted of providing technical and scientific expertise, including judging submissions, familiarizing participants with and providing access to USGS data, helping develop the challenge design, helping identify best challenge practices, and supplementing, where necessary and appropriate, prize purses. Following is a brief summary of these challenges, related activities and significant outcomes to date.

Climate Resilience Data Challenge. This Climate Data Initiative is a broad effort sponsored by NASA, in partnership with USGS, NOAA and EPA, to leverage the federal government's extensive, freely-available climate-relevant data resources to spur innovation and private-sector entrepreneurship in order to advance awareness of and preparedness for the impacts of climate change. This challenge had multiple phases: Idea Generation, Design, and Prototype development. There were three "Idea Generation" challenges, with competitors being tasked with providing ideas to help society become more resilient to climate impacts (e.g., coastal flooding, sea level rise, food security, public water utilities etc.) using three categories of data: (a) only NASA Climate Data, (b) only US Federal Government Climate Data, and (c) any data, whether currently available or not.

This challenge, which closed in April 2015, resulted in mobile applications related to permafrost prediction that could be used by Alaskans and others to rate infrastructure risk; identification of large harmful algae blooms in the Great Lakes region; and an agricultural application related to crop yields based on various climate conditions that could be used by farmers.

Water Prize Competition Center. The USGS is cooperating with the Bureau of Reclamation's Water Prize Competition Center, which was launched in early 2015, to identify, coordinate, and run multiple challenges centered around water availability, ecosystem restoration, and infrastructure sustainability. The Columbia River Research Laboratory, within the USGS Western Fisheries Research Center, has supported Reclamation's efforts to establish prize competition processes, and launch the initial prize competition seeking New Concepts to Remotely Track Fish. Subject matter experts from Reclamation and the USGS Columbia River Research Laboratory co-led the prize competition design and judging for this initial challenge and are actively working as part of the design and judging teams on other aquatic ecosystem restoration prize competitions.

USGS scientific and technical personnel are also participating in the water availability theme area and are currently generating potential prize competition ideas including a Science Data and Collection Reporting App, Water Budget Calculator App, and a Multi-Scale Objective Drought Monitoring and Prediction Tool. Additional details on the activities of the Water Prize Competition Center can be found in Section IX.

Apps for Ag. This is a project of the pro-bono California AgTech Roundtable and supported by several regional agricultural technology hubs. The Roundtable held a successful "hackathon" at the Farm of the Future operated by West Hills College in Coalinga, CA in 2014. At this hackathon, teams of coders competed to create cell phone apps to meet the stated needs of farmers. About 60 people participated. The AgTech team is organizing a second *Apps for Ag* with the UC Davis World Food Center in early FY 2016. The ad hoc organizing panel is also working with Cabrillo College in Monterey County on a third *Apps for Ag* in the spring.

Roundtable members include USDA, CDFA, California Department of Technology, California Public Utilities Commission, California Farm Bureau Federation, California Association of Pest Control Advisers, San Joaquin Valley Partnership, Valley Vision, Western Growers Association and other organizations. USGS will participate in judging, and providing data, technical expertise, and onsite participation.

VI. U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (FWS or the Service) is dedicated to the conservation, protection, and enhancement of fish, wildlife and plants, and their habitats. The FWS is the only agency in the Federal Government whose primary responsibility is management of fish and wildlife resources for the American public. The agency manages the 150 million acres of land and water in the National Wildlife Refuge System which receives over 45 million visitors each year. The FWS also operates 70 National Fish Hatcheries which, in conjunction with its Fish Health Centers and Fish Technology Centers (see below), restore native aquatic populations, mitigate for fisheries lost as a result of Federal water projects, and support recreational fisheries throughout the United States.

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

The technology transfer function of the FWS is shared among several FWS programs/divisions including the Division of Science Applications, the Division of Policy, Performance and Management Programs (PPM) for patent questions, and the Office of the Solicitor. The vast 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.

In addition, FWS employees are actively involved in the larger scientific community, including participating in scientific societies, scientific meetings and conferences, and generating and publishing scientific research. Sharing scientific and information via public outreach and partnerships is a high priority for the FWS. For example, the Service is a partner to all units within the 17 Cooperative Ecosystem Studies Units (CESU) Network, allowing the Service to be involved in interdisciplinary and multi-agency research projects with the host university and other non-federal partners. In 2015, the Service pursued dozens of projects through the CESU network including surveying and monitoring efforts, climate change vulnerability assessments, streamflow projections, and many others.

The FWS 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 journals are in the public domain and are completely electronic. Overall, in FY 2015, FWS personnel published approximately 400 articles in peer reviewed science journals. Many of those articles are available online via open access journals, while others are available through paid subscription because of publishers' terms of copyright.

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 conservation of fish, wildlife, and plant natural resources.

Patents: In 2015, PPM continued to help the National Wildlife Refuge System pursue a patent filed for one of its program employees. The patent would be for a device that may help fight invasive plant species on both public and private lands. PPM worked with the Bureau of Reclamation to establish an Interagency Agreement with USDA's Agricultural Research Service (ARS) to obtain patent law expertise. ARS filed the patent in January of 2014. In September of 2015, the U.S. Patent and Trademark Office indicated that they anticipate reviewing the patent in 22 months. If the patent is issued, it would add to the four obtained by FWS since 1998. These include a patent for calcein detection devices developed at the FWS' Northeast Fishery Center in Lamar, PA, for detecting non-invasively-marked hatchery-reared Atlantic salmon for up to three years post-marking which has been licensed exclusively to Western Chemical (Ferndale, Washington) for a period of eight years. Other inventions include a rocker/agitator for transportation and storage of fish sperm (e.g., in captive breeding programs of imperiled species), a fistula device to gather eggs from inside a fish, and a method for agglomerating fine powders for larval aquatic feed.

CRADAs: In 2015, the FWS established a new Collaborative Research and Development Agreement (CRADA) between the Aquatic Animal Drug Approval Partnership (AADAP) Program and AquaTechnics, Inc. in Sequim, Washington, which works to manage and prevent diseases in both farmed and natural animal populations, to identify drugs, chemicals, and/or therapeutants that can be used in aquaculture and/or fishery management programs.

The FWS also worked with USGS, BOEM, and the Department to develop a new CRADA as a mechanism for partnering with other bureaus within DOI, specifically, BOEM and USGS, and an

international non-profit entity, to enable DOI bureaus to formally participate in a cross continent wildlife tracking system.

The system employs nanotag tracking technology that will substantially increase the ability to understand spatial and temporal movement patterns of small-bodied wildlife (e.g., birds and bats). The number of projects using this technology is rapidly increasing within FWS, other agencies, and non-governmental groups. The increasing number of nanotag receiving stations operated by different projects can detect all tags on this common frequency within the detection range while distinguishing between the individual tags. This opens up opportunities for large-scale collaboration and data sharing among projects and investigators that tag wildlife, erect receiving stations, and collect data.

This CRADA would fill a critical need for coordinating these nanotag projects. The intent of the CRADA is to develop a consistent Department-wide agreement with the entity that complies with federal policy on data access and availability, and ensures the arrangements with BSC are fair, equitable, and adequately account for the equipment and services provided by the various partners. If finalized, this CRADA would add to the Service's four active CRADAs through the fisheries program (see below).

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

National Conservation Training Center. The FWS's National Digital Library, run by the National Conservation Training Center (NCTC) in Shepherdstown, West Virginia, is a searchable collection of selected documents, images, historical artifacts, audio clips, publications, and video, most of which are in the public domain. The FWS also makes internal publications, reports, and information available to the public through the FWS website. Collections of current and legacy publications are also 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 2015, NCTC and the FWS hosted over 100 science technology and education webinars on topics covering climate change, conservation genetics, conservation biology, habitat restoration, invasive species, environmental education, youth leadership and supervision, youth outdoor skills and other scientific/technical topics related directly to managing the nation's fish, wildlife and plant resources.

Fisheries and Aquatic Conservation Division. The agency's primary research nexus with the private sector centers on programs and facilities within the Division of Fisheries and Aquatic Conservation (FAC). This division 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 Program. These centers and programs provide assistance and support to conservation partners of the FWS, including Federal, State, tribal, and non-government organizations that cover a broad range of disciplines including biostatistics, population ecology, genetics, nutrition, and fish health and pathology.

FWS Aquatic Animal Drug Approval Program. The Aquatic Animal Drug Approval Program (AADAP) within the FAC Division currently has four CRADAs in place, including a relatively new CRADA with AquaTechnics, Inc. The three other existing agreements are with Merck Animal Health (Summit, NJ), Aquatic Life Sciences (Ferndale, WA), and Frontier Scientific (Logan, UT). These agreements permit the parties to identify research opportunities that support development of new aquatic animal drugs, broaden the U.S. technology base, and support accomplishment of FWS scientific mission objectives. For example, in 2015, AADAP developed research study protocols to define the objectives, design, procedures and methods used to conduct clinical efficacy studies on a new sedative for use in aquaculture for the purpose of sedating fish prior to transporting, grading, and sorting them. The protocols have been accepted by FDA. Data generated under these protocols help inform New Animal Drug Approvals, which will provide new advances and tools for Federal, State, tribal, and private fish culture facilities.

Fish Technology Centers. Fish Technology Centers (FTCs) were established in 1965 to develop and improve fish culture technology and 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 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-review journals, and management recommendations are communicated within the Service and to our partners through conservation science partnerships. Following are descriptions of the various FTC laboratories and examples of advances shared through publications and reports in 2015:

Chinook salmon sac fry shortly after hatch. Photo credit: Rob Holm, FWS.

- **Nutrition and Diet Development Laboratories.** These facilities allow for the manufacture of experimental larval, fingerling, and broodstock fish feeds and the testing of many 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. Recent work includes development of alternative fish feeds to reduce reliance on fish meal and fish oil, in partnership with public and industry partners. Due to limited supply and increasing cost of fish meal and fish oil, alternative ingredients are needed to

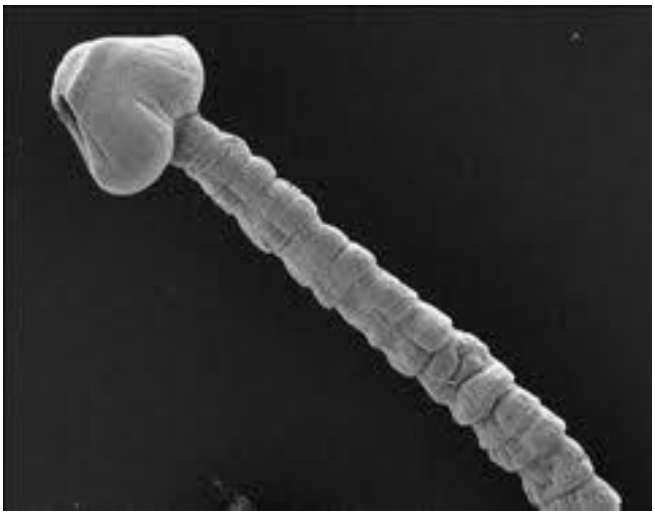
replace these common feed ingredients. Alternative ingredients must be evaluated in feeding trials before they can be used in commercial fish feeds. For example, in 2015 Abernathy Fish Technology Center continued to work with partners to examine the effects of using less fish oil in the diet on gene expression as it relates to growth. The objective of this project is to determine what levels of alternative protein and lipid can be included in fish feed without reducing growth and health of fish, and may help contribute to more cost effective commercial production of fish meal.

- **Conservation Genetics Laboratories.** These laboratories support conservation and management related needs of the FWS and its partners, including, but not limited to: (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. For example, in 2015 the Abernathy Fish Technology Center used genetic markers to compare late returning coho to the hatchery stock and to adjacent wild populations of coho salmon. Understanding the impacts of hatchery operation on adjacent wild populations is critical for the conservation of the species, and has implications for commercial fish production as well.

- **Conservation Physiology and Ecology Laboratories.** These laboratories focus on understanding the physiological requirements and tolerances of threatened and endangered species. Less-invasive or non-invasive 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, state, universities, and NGOs for a variety of analyses including the determination of fish sex and stage of maturity as well as blood chemistry analysis, histology, proximate analysis, and radioimmunoassays. Recent accomplishments include developing methods to prevent the spread of invasive species such as quagga mussels while having a minimal impact on native fish species. In addition, laboratories are looking at potential impacts of climate change on fish growth, which could be significant for aquaculture facilities and how fish are grown commercially.

- **Fish Passage Research and Engineering.** In 2015 the FWS National Fish Passage Program (NFPP) supported research into areas on fish ecology, behavior, and life-history requirements relative to selected environmental factors by using open-channel flumes, swim tunnels and artificial streams, where researchers can simulate varied stream conditions for addressing a wide variety of questions for partners conducting fish passage restoration work. NFPP also supported on the ground collaboration and information exchange with local townships and cities on engineering and designing fish friendly road stream crossing structures that are also resilient to flooding events.

Fish Health Centers. The FWS's Fish Health Centers play an integral role in applied science and technical transfer. Their scientists are leaders both nationally and internationally in the diagnosis of wildlife diseases and in the science of aquatic animal health, 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. For example, in 2015 Dexter FHC in New Mexico began a study assessing the sensitivity of various techniques of non-lethal screening for Asian Tapeworm in humpback chub. Development of non-lethal sampling methods to monitor aquatic animal health should minimize impacts on more limited stocks of imperiled species under care in federal hatcheries or in wild populations, and could benefit commercial operations by facilitating movement of bait fish as well.



The Asian tapeworm, Bothriocephalus acheilognathi, parasitizes freshwater fish, particularly cyprinids (which includes carps and true minnows). It has a fleshy, arrow-head or heart shaped head region (scolex) and two slit-like openings which are short and deep. It has no neck; instead, body segments begin directly behind the scolex. The Asian tapeworm,native to east Asia, has been detected in the Great lakes region. Photo: Dr. Boris Kuperman and Dr. Victoria Matey.

Aquatic Invasive Species: The FWS Aquatic Invasive Species program works to prevent transfer and introductions of exotic, introduced, non-native, and other potentially harmful species and to develop early detection and rapid response capabilities. For example:

- The FWS is working 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 expected to significantly benefit both FWS programs and partners by allowing earlier detections of invasive species. For example:
    - Working through the Great Lakes Restoration Initiative (GLRI) and the University of Notre Dame to develop a surveillance program for invasive species at risk of invading the Great Lakes (e.g., several species of Asian carp);
    - Working with University of California Davis to develop eDNA markers for use in the early detection of southern watersnake (*Nerodia fasciata*);
    - In Alaska, working with Joint Base Elmendorf-Richardson and the Corp of Engineers to develop an eDNA assay for waterweed (*Elodea spp.*), and with other partners to develop eDNA markers for invasive northern pike (*Esox lucius*).

- FAC has developed three rapid screening tools to help determine a species' risk of invasion. Knowledge of both low- and high-risk species will help industry, states, and consumers make responsible choices about which species to acquire and use. In addition, these tools will help state agencies make decisions for potentially invasive species and work with industry to manage risky species in their jurisdictions. For example, in January, 2015, Michigan enacted Public Act 537, establishing new protections to minimize the risk of invasive species and requiring the use of the Service's risk assessment protocol.
- To help prevent further spread of aquatic invasive species by recreational boats, the FWS has funded a proposal from the American Boat and Yacht Council to develop a Technical Information Report that would give manufacturers of boats and associated equipment guidelines and best practices to reduce the likelihood of spreading AIS and assist in the "clean, drain and dry" (including decontamination) process.

Crushed Ivory Design Challenge Prize. FWS is conducting a challenge to identify creative ideas on how best to use illegal ivory that was seized and crushed by authorities under the Ivory Crush program to prevent it from being marketed in order to raise public awareness of wildlife trafficking and help reduce demand for elephant ivory and other illegal wildlife products. The challenge, offered under the FWS's general authority to conserve wildlife species, was announced in FY 2014, and closed in FY 2015. However, as of this writing, winners, if any, have not been announced.

VII. Office of Surface Mining Reclamation and Enforcement

The Office of Surface Mining Reclamation and Enforcement (OSMRE) is responsible for ensuring, through a nationwide regulatory program, that coal mining is conducted in a manner that protects communities and the environment during mining, 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 training to its State and Tribal partners to enhance their ability to maintain effective programs.

While OSMRE has no formal research and development program, 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 State and Tribal partners continue to administer their surface mining programs efficiently and effectively.

The principles 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.

The OSMRE accomplishes these principles via the Technical Innovation and Professional Services (TIPS) program, the National Technical Training Program (NTTP) and the National Technology Transfer Team, as elaborated below.

Technical Innovation and Professional Services (TIPS). The 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 TIPS provides rely on off-the-shelf scientific and engineering computer hardware and software. This technical assistance has grown from a few software applications available on a single specially-designed shared workstation, to a suite of software on each user's desktop computer.

TIPS is a national program that continues to research emerging technologies and their application to the Surface Mining Control and Reclamation Act of 1977 (SMCRA). A fundamental premise of TIPS is that it enables every official responsible for the implementation and enforcement of SMCRA to use the same technological tools, thereby promoting consistent enforcement of SMCRA nationwide. This also means that personnel enforcing SMCRA can easily exchange data with one another, and since the tools that TIPS provides are predominantly the same as those used by coal mining companies and reclamation contractors, data is easily exchanged between mining and SMCRA officials.

The following are examples of activities undertaken by the TIPS program in FY 2015.

GeoMine Web Application: GeoMine is designed to be an interactive web-based digital map of coal mining and reclamation activities in the United States. During FY 2015, the GeoMine Team was engaged in internal system testing and database development in anticipation of DOICloud platform hosting in FY 2016. GeoMine uses a web-based viewer (GeoMine Viewer) developed by OSMRE in collaboration with the Fish and Wildlife Service (FWS), Environmental Protection Agency (EPA), Army Corps of Engineers (ACE), and coal mining regulatory authorities in Kentucky, Tennessee, Virginia and West Virginia. GeoMine supports decision-making associated with surface coal mining activities by improving accessibility to data, improving the timely delivery of authoritative information, and enhancing understanding and visualization of geospatial data at various scales. It would also help mines comply with the requirements of SMCRA, the Clean Water Act (CWA) and the Endangered Species Act (ESA). When fully deployed, the application will display geospatial data that is already publicly available from each contributing coal-producing State and Tribe nationwide. This would increase transparency and allow the public to better understand the impact of both coal mining and reclamation activities. The OSMRE also continued digitizing mine boundary maps in Kentucky and West Virginia through various Americorps programs, including the Environmental Stewards Program, as well as college students from OSMRE's Mid-Continent and Western Regions. The GeoMine Viewer should be ready for public launch in 2016.

Remote Sensing Pilot Project: The OSMRE released the Remote Sensing Pilot Project Final Report in April 2015. The OSMRE Remote Sensing Specialists in the TIPS program had been working on this pilot project since 2009 to "determine the best satellite image data, products, and services that will support effective and efficient SMCRA solutions for the regulatory program." The project explored the processes and requirements involved in acquiring image data, products

and services from the National Geospatial-Intelligence Agency (NGA) Office of Commercial Partnerships through the USGS. The President's 2003 Commercial Remote Sensing Space Policy and 2010 National Space Policy, tasked the NGA with sharing satellite imagery with Federal agencies. In 2009, the OSMRE also entered into an official partnership with the NGA through the USGS to assist the goals of this pilot project.

OSMRE will continue to work with the NGA to further improve products and services for the use of satellite imagery in SMCRA applications. In the interim, TIPS has established an annual imagery purchase process to provide images for mines where OSMRE is the regulatory authority and will assist States on a case-by-case basis.

ArcGIS Image Server: A result of the Remote Sensing Pilot Project was that in FY 2015, the OSMRE deployed the ArcGIS Image Extension for Server (ArcGIS Image Server) for internal testing and loading of satellite images. In FY 2015, OSMRE used the ArcGIS Image Server to deliver over 4 Terabytes of imagery into the hands of TIPS SMCRA program customers in an efficient and effective manner. OSMRE users are able to connect to the Image Server, set specific search parameters and be able to readily view and download geospatial data pertinent to their individual projects. The TIPS Remote Sensing Team has cataloged a searchable digital library of raw and processed satellite imagery and derived products. OSMRE will provide these products through the ArcGIS Image Server and they will be accessible to multiple users throughout OSMRE, State, and Tribal offices.

As part of a multi-year ongoing project, the OSMRE Charleston and Lexington Field Offices and the TIPS Technology Transfer Team also conducted aerial inspections of several mine sites in West Virginia and Kentucky using a small Unmanned Aerial System (UAS), the RQ-16 T-Hawk Micro Air Vehicle (T-Hawk), to help determine whether UASs might be used effectively, efficiently, and at a reasonable cost, to enhance OSMRE's mandated oversight duties. The OSMRE was able to inspect areas covered under multiple coal mining permits over a two week period using a high definition video camera mounted on the T-Hawk. These areas covered approximately 235 acres and several miles of mine boundaries. The data captured was used to create 3D models of mining structures, perform volume calculations of approved spoil areas, locate tree planting areas, assess blasting sites (pre- and post-blast) and evaluate permit perimeters to determine if there are disturbances off the permitted site.

A perimeter pond at a surface coal mine in Bell County, Kentucky, as seen from above with RQ-16A T-Hawk. The outlet does not appear to discharge into a natural or designed channel as required. This information would prompt an onsite inspection. Photo was taken for OSMRE by the T-Hawk, remotely piloted by Lance Brady, BLM.

University Partnerships - Minority Higher Education Program: The OSMRE continues to work on building mutually beneficial partnerships with minority serving colleges and universities under its Minority Higher Education Program (MHEP). This includes collaborating with its MHEP partners on training and education programs and providing guidance and direction to ensure that the intended results are achieved. In addition to traditional training within the SMCRA community, the TIPS program continued its collaborative partnership with Adams State University (ASU), a Hispanic Serving Institution in Alamosa, Colorado, through a cooperative agreement with ASU, recognizing that cooperation on resources and knowledge, as well as the advancement of the Clean Energy Economy through initiatives would benefit the government, ASU, its students, and the public. The agreement guides the parties in pursuit of common objectives to enhance education, job opportunities and access to "real world" experience.

TIPS Training Program. This is a collaborative effort among OSMRE, States, and Tribes that provides specialized training to use specialized hardware and software tools related to mining and reclamation. 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. TIPS training is unique in that OSMRE tailors the training exclusively to mining and reclamation uses. Importantly, most of the tools it uses and provides training for are off-the-shelf applications. The OSMRE delivers TIPS courses on-site at the customers' requests, and in dedicated training centers in OSMRE Regional Offices. TIPS conducted twenty-four instructor-led classes in FY 2015 with 314 students completing class sessions and another four online training courses for 41 students. The OSMRE conducted four of the training classes at on-site locations to meet the specific training needs of particular offices or groups of students, and enable broader participation throughout the SMCRA community. In FY 2015, the TIPS training program received a customer satisfaction rating of 98 percent, exceeding the annual Government Performance and Results Act goal by 5 percent.

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 identification of training needs through course development and presentation is a cooperative effort between State, Tribal, and OSMRE offices. The NTTP utilized 123 subject matter expert instructors (mostly volunteers) from State, Tribal, and OSMRE offices in FY 2015 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. These instructors participate in course instruction, development, and content revisions. In FY 2015, NTTP trained 667 students from State, Tribal and OSMRE programs. It offered 34 training sessions 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. The course subjects are, where appropriate, tailored to conditions and characteristics specific to each mining region, and offered in or near those regions. Course subjects include a wide variety of technical areas including design of abandoned mine land restoration, proper inspection tools and techniques, soils and revegetation, identification and handling of acid/toxic forming materials, water quality

assessment, legal aspects of enforcement procedures, and preparation of evidence and testimony. In FY 2015, the program achieved an overall effectiveness rating of 97 percent, based on student and supervisor responses regarding the value of the training in their current positions.

National Technology Transfer Team. The OSMRE National Technology Transfer Team brings together members of OSMRE, State, and Tribal SMCRA programs as well as representatives from the Interstate Mining Compact Commission, the Western Interstate Energy Board, and the National Association of Abandoned Mine Land Programs in order to coordinate understanding of mining related issues across the country. Through regular meetings, the parties involved identify, discuss and try to find solutions to common issues that arise through their programs' daily implementation of SMCRA. The team also hosts and participates in technical programs such as workshops, forums, and symposia, in order to collaborate with partners outside the SMCRA community. This includes the Applied Science Program**,** whose goal is to develop and demonstrate improved technologies to address environmental issues related to the mining of coal and the reclamation of the land after mining. The program has accomplished this by funding studies by universities, non-profit 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.

When funding is available for Applied Science projects, the NTTT solicits Requests for Proposals (RFPs) to advance environmentally responsible mining and reclamation. The NTTT evaluates and ranks these proposals, and provides its recommendations regarding the RFPs to the OSMRE Executive Council and Director. OSMRE funds selected Applied Science projects through cooperative agreements with the relevant institutions. The Applied Science Program had 16 ongoing projects at the beginning of FY 2015, of which 9 were completed during that fiscal year. Seven new Technical Investigations were funded during FY 2015 with anticipated completion dates in FY 2017. Final reports for these projects are available at http://www.osmre.gov/programs/tdt/appliedscience/projects.shtm.

The NTTT also supports public outreach, through the Youth Initiative Program via participation in such activities as Chemistry Week, Engineer's Week, and the Ohio River Watershed Celebration activities. The main target audiences for these events are elementary students, high school students, and upcoming young professionals.

In August 2015, in conjunction with the National Park Service, OSMRE held a Technology Transfer event on the Flight 93 memorial grounds to showcase two low-cost, but highly effective, treatment technologies capable of near total removal of total iron and manganese from contaminated waters. One treatment system used a wetland system to consistently reduce total iron concentration from 50 milligrams per liter (mg/L) to less than 1 mg/L at a 1,200 gallon-per-minute flow rate. The second system employed a passive manganese removal bed to reduce the manganese concentration from about 10 mg/L to less than 0.5 mg/L in a 60 gallon-per-minute discharge.

VIII. 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. The vast majority 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, and in cooperation with partners, preserving and interpreting 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.

In order to expand the range of expertise and tools available to it, NPS participates in many collaborative ventures with universities and other governmental and non-governmental organizations, including the CESU Network.

The NPS Cultural Programs include the National Center for Preservation Technology and Training (NCPTT), which was created by Congress to fill a fundamental need for research and technology transfer among Federal, State, and local historic preservation programs. 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.

The NPS also encourages qualified scientists to undertake research on park physical, biological and other resources under the egis 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 policy 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. NPS issued the benefits-sharing policy on December 19, 2013, and the benefits-sharing handbook on September 29, 2014. See http://www.nps.gov/applications/npspolicy/DOrders.cfm.

Nile Mile Hole, Upper Laguna Madre, Padre Island National Seashore. These waters have the highest known rate of accumulation of sediment and aquatic organisms on water quality measuring devices used throughout the national park system. Such biofouling increases instrument maintenance and decreases data quality. Photo credit: NPS/Joe Meiman, 2015.

Device to Facilitate Water Quality Measurement in High Biofouling Environments. Staff at the Gulf Coast Inventory and Monitoring Network, which NPS designated a federal laboratory in 2015, has developed a supplemental equipment design to facilitate water quality measurement in high biofouling environments. The design enables currently available datasondes to extend water quality measurements within calibration acceptance criteria. When used with sondes currently on the market, the invention is designed to greatly increase the length of unmanned or continuous monitoring deployments in biofouling environments and may increase accuracy under turbulent flow conditions. The device modifies the calibration chamber of the sondes and establishes measurement conditions that greatly limit biofouling and may limit the effects of turbulence so that instrument/sensor drift, rather than water quality conditions, drives recalibration frequency requirements. The resulting extended service intervals may reduce operational costs by 50 percent or more. In addition, the device limits sensor exposure to ambient waters thus lowering maintenance costs related to biofouling.

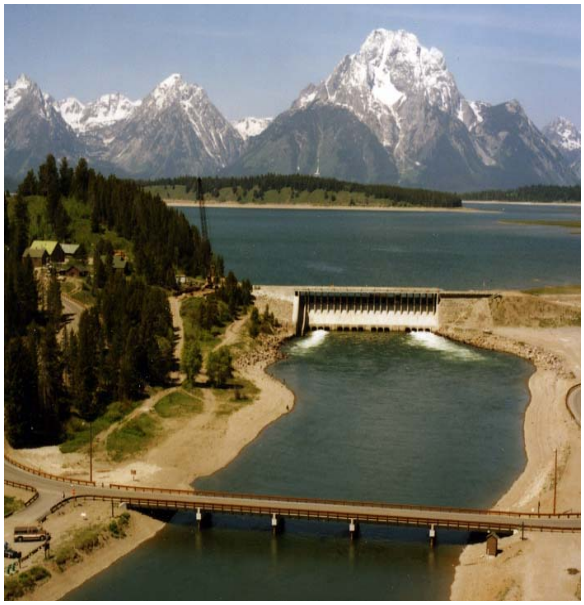
IX. Bureau of Reclamation

The Bureau of Reclamation (Reclamation) is a water management agency whose mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. It is the largest wholesaler of water in the country. It brings water to 31 million people, and to one out of five Western farmers, who produce 60 percent of the Nation's vegetables and 25 percent of its fruit and nut crop. Reclamation is the second largest producer of hydroelectric power in the Western United States. Its 53 power plants annually provide more than 40 billion kilowatt hours of electricity, enough to power 6 million homes, generating $1 billion in revenues.

Reclamation 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 Research and Development Office manages two appropriated R&D programs.

The Science and Technology (S&T) Program is the primary R&D program for Reclamation and funds intramural research that spans the spectrum of water and water related resources research. The Desalination and Water Purification Research (DWPR) Program invests in extramural R&D that advances the capabilities of water treatment technologies to become more broadly used by others in creating new water supplies. Such new water supplies can relieve water stress on Western communities, Tribes, Western river basins supporting Reclamation projects, and the Nation as a whole.

S&T Program goals are to identify and develop cost effective solutions to the technical and scientific problems affecting 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. This applied R&D Program addresses the full range of technical issues confronting Reclamation water and power managers and their project stakeholders. It has contributed many tools and capabilities that are currently used by Reclamation and western water managers. Program products strengthen the scientific basis of Reclamation's decision-making related to policy development, program implementation, and water and power operations.



Jackson Lake Dam, with the Grand Tetons in the background. Photo: Dave Walsh, Bureau of Reclamation.

Program funding is allocated and coordinated across four areas: (1) Research and Development Projects (2) Water and Power Technology Prize Competitions, (3) Technology Transfer, (4) and Dissemination / R&D Infrastructure.

Reclamation Collaborative Activities - S&T Program projects are competitively selected based on the ability to meet priority needs that have broad application across Reclamation and the West. Project-specific research is typically driven by the necessity to improve solutions and processes at a particular Reclamation facility or project, and is done as part of the technical studies and engineering work associated with operating, updating, and maintaining a specific Reclamation facility or project operational responsibility. Program projects address a wide range of science and technical challenges facing Reclamation water and power managers spanning four domains:

- Conservation or expansion of water supplies
- Environmental issues in water delivery and management
- Water and power infrastructure reliability
- Water operations decision support

Needs identification and prioritization under each domain is guided by input from Reclamation end-users and informed by perspectives from partner agencies and stakeholders. In response to these needs, the program invites research projects through internal research solicitation and external research brokering. Internally solicited research funding is awarded to employees bureau-wide, based on proposal relevancy to Reclamation mission and on technical adequacy. Projects address any of the above four domains and typically have strong cost-sharing and collaboration with Reclamation end-users, stakeholders, other agencies, and/or universities. External research is often used to complement internal research to be responsive to agency science priorities that evolve over time and typically cut across the four domains. Such external research is implemented through contracts, cooperative agreements, interagency agreements, and technology transfer agreements. It often involves leveraging external expertise and specialized collaborative capabilities, which enable targeted research to more rapidly address priority science needs.

Reclamation Technology Transfer – Although Reclamation's R&D focuses on water and power issues specific to the arid and variable climates characteristic of the Western U.S., the new solutions, tools, and information developed can have broad applicability regardless of location. 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.

The majority of Reclamation's technology advancements are transferred through public dissemination, while others require 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. It also serves as the Bureau's Office of Research and Technology Applications (ORTA), as required by 15 USC § 3710(b).

The R&D Office utilizes a funded interagency agreement with the USDA Agricultural Research Service (ARS) Office of Technology Transfer to have access to the full range of expert skills needed to implement technology transfer authorities (e.g. experienced technology transfer specialists, patent advisors, license specialists, CRADA specialists) on a project-by-project basis. This arrangement benefits the government since it avoids the need to build similar capabilities within Reclamation or the Department. This agreement served as an example for FWS to retain the services of ARS in its pursuit of a patent application for dealing with invasive plant species on public and private lands.

Reclamation also works to create more awareness across U.S. industries and other non-government organizations about the specialized research resources (people, lands, and facilities) that they can access through technology transfer agreements authorized by 15 USC § 3710a. In

addition to physical research laboratories, Reclamation's R&D assets include engineering and scientific expertise, and extensive water storage, water delivery and hydropower facilities that offer unsurpassed real-world laboratories for field tests, evaluations, and demonstrations of new technologies and processes related to water and hydropower. Although the majority of its R&D activities do not involve development of patents or industry involvement to mature technologies into viable products, the technology transfer activities that Reclamation conducts under the authorities of the Federal technology transfer legislation are an important subset of its technology transfer responsibilities.

Highlights of activities conducted under the Federal Technology Transfer Act during FY 2015 include:

Next Generation Desalination Membranes. An ongoing CRADA with a U.S. manufacturer of desalination membranes produced two related subject inventions. Reclamation was also issued a patent for a new, promising chlorine resistant chemical monomer that could be a key ingredient for developing the next generation membrane that is the focus of this CRADA. The primary CRADA objective is to develop new membranes that meet or exceed the current industry standard for water purification performance characteristics while not deteriorating from chlorine exposure. This is also a long-sought goal of the global desalination community of practice. Chlorine dosing and management is a necessary and costly process to prevent membrane biofouling. Chlorine is also a residual component in many water sources that are treated by desalination membranes. The membrane damage caused by chlorine exposure not only compromises membrane performance but also increases desalination operations, maintenance, and replacements costs. The CRADA combines the research expertise, know-how, facilities, and relevant background intellectual property of both parties in an effort to accelerate achieving the CRADA objectives The CRADA research is making progress toward full scale testing and demonstration of new membranes.

Developing Reclamation Technology Transfer Directives and Standards (D&S). The Research and Development Office drafted Reclamation Directive and Standard for implementing the new Department Manual Chapter for Technology Transfer (761 DM1) issued on May 16, 2014. The D&S establishes processes for Reclamation to maximize the beneficial opportunities provided by the Technology Transfer Act of 1986 to both Reclamation and Non-federal partners to jointly develop new solutions to water and water -related problems. At the end of FY 2015, the draft D&S was completing the internal review and comment process. The public comment process and finalization of the D&S is scheduled for FY 2016.

Improving Water Operation Decision Support Software. Under a CRADA with Colorado State University, Reclamation made improvements to water operation decision support software owned by Colorado State University. The software is used by many Reclamation water operation offices and others in the federal and non-federal water management community. Under the terms of the CRADA, Reclamation received a no cost perpetual license to use the software. Colorado State University will also make the improvements available to their other users.

Testing New Technologies for Hydropower Generation Applications. Reclamation entered into a Material Transfer Agreement (MTA) to receive and test a power system stabilizer and an

automatic voltage regulation system developed by a U.S. manufacture of power generation equipment. Under the MTA, Reclamation will conduct tests, to determine their suitability for hydropower generation applications. Since approximately 85 percent of power is generated by thermal and other non-hydro power generation methods, industry is primarily focused on developing and supplying power generation technologies and equipment that are designed specifically for non-hydro power generation applications. As such, Reclamation commonly tries to determine if such technologies and equipment are suitable, or can be modified, for hydropower generation applications. The MTA will allow the MTA partner to gain insights on the feasibility and requirements to manufacture and market their products to the global hydropower generation community. They will also gain access to Reclamation's technical expertise and laboratory facilities not readily available in the private sector that are able to test and evaluate technologies for hydropower applications.

Prize Competitions to Develop Innovative Solutions to Water-Related Problems

Reclamation's Research and Development Office (through the Science and Technology Program) established the Water Prize Competition Center in FY 2015 to launch nationwide prize competitions under the prize competition authorities provided by the America COMPETES Reauthorization Act of 2010 (15 USC § 3719), an amendment to the Stevenson-Wydler Technology Innovation Act.

The Reclamation Water Prize Competition Center began launching prizes that seek innovative solutions related to the following mission-critical areas.

- *Infrastructure Sustainability.* These prizes would be designed to help increase the efficiency and effectiveness of operations, maintenance and repair of the extensive inventory of water storage, water delivery, and hydropower generation infrastructure managed by Reclamation. They would help meet increasing water demands of the West while protecting the environment and the public's investment in these facilities.

- *Ecosystem Restoration*. These prizes are intended to help recover fish species listed as threatened and endangered, and prevent new listings under the Endangered Species Act. Effective solutions will help Reclamation comply with environmental laws and regulations and sustain healthy aquatic ecosystems, while continuing to meet its water delivery obligations.

- *Water Availability.* These prizes would assist Reclamation to better conserve and manage existing water supplies, create new sources of useable supplies, and forecast and manage water supplies to meet competing water needs under a variable and changing climate.

Reclamation forged coalitions with other federal agencies that have a stake in these mission areas to collaboratively design, launch, and judge the prize competitions. Federal collaborators currently include USGS, NOAA, USACE, FWS, USDA, NASA, EPA, and NIST. The Federal collaboration will enable agencies to leverage Federal capabilities, catalyze interagency working relationships, better define and solve joint problems, avoid duplication, and find solutions that

have a broader impact across the mission of multiple Federal agencies, the stakeholders we collectively serve, and overall public good.

Reclamation launched the initial prize competition in FY 2015 seeking new concepts to remotely track fish. Through this prize competition, the Federal government received a perpetual, no-cost right to use 22 solutions that were submitted by Solvers from across the nation and overseas. The top six submissions include ideas that the panel of expert federal judges believed had strong promise and should be further tested and demonstrated. Other submissions also identified innovative or novel approaches, but were considered more difficult or unlikely to be practical at this time.

The ability to reliably and effectively track fish throughout their life-cycle is central to efforts to recover threatened and endangered fish species. Current methods to track fish rely on capture and handling of fish to implant or attach tags that can be complex, costly, and stressful to the fish. Current tagging technologies also have longevity and detection capability shortcomings, which limit the data interpretations needed to inform fish recovery actions. Discovering new or improved concepts and technologies to track and monitor fish health could provide breakthroughs that significantly improve the effectiveness and reliability of fish recovery programs.

For its efforts on prize competitions during FY 2015, Reclamation and its personnel received 3 awards at the 5-year anniversary of Challenge.gov in early FY 2016. These are:

- *Newcomer of the Year (2015)*: Awarded to Reclamation's Research and Development Office for creating the Water Prize Competition Center and forging interagency coalitions to collaborate on launching water and water related prize competitions.

- *Best in Technology*: Awarded to Reclamation for contributing the technical expertise and demonstration facilities used to conduct the USAID sponsored Desal Prize. USAID interests were to advance small scale desalination technologies to support family farm businesses in developing countries while Reclamation's interests were to advance small scale desalination technologies that could be used by Native American and rural communities in the western U.S.

- *Unsung Hero*: Awarded to Saied Delegah, a Reclamation desalination research expert, for his outstanding, behind the scenes coordination of the technical efforts that made the Desal Prize possible.

During FY 2016, Reclamation plans to launch several challenges in each of the 3 subject matter theme areas. Reclamation also plans to explore ways to combine the authorities provided by Prize Competitions (15 USC § 3719) with Technology Transfer Act of 1986 authorities (15 USC § 3710a) to forge partnerships with non-federal organizations, including the private sector, to accelerate innovation and the lab-to-market process through jointly sponsored prize competitions.

X. 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.

Within BSEE, the Office of Offshore Regulatory Programs (OORP) develops standards and regulations to enhance operational safety and environmental protection for the exploration, development, and production of offshore oil and natural gas on the U.S. Outer Continental Shelf (OCS).

The Oil Spill Preparedness Division (OSPD) is responsible for developing standards and guidelines to ensure that offshore operators are prepared to respond to an offshore oil spill. It also ensures their 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 industry's preparedness for oil spill response. The Division oversees the Oil Spill Response Research program, and works closely with sister agencies such as the U.S. Coast Guard, the National Oceanic and Atmospheric Administration, and Environmental Protection Agency to continually enhance response technologies and capabilities.

OSPD also operates Ohmsett in Leonardo, NJ, which serves as the National Oil Spill Response Research and Renewable Energy Test Facility. Although not classified as a Federal laboratory, Ohmsett is available for use by industry and government. Advances made by research conducted at the Ohmsett facility are vital to the oil spill response industry.

BSEE R&D programs operate through the Emerging Technologies Branch (ETB) and the Oil Spill Response Research (OSRR) Branch. The former supports research associated with operational safety and pollution prevention (including renewable energy). The ETB, established in 2012 to replace the Technology Assessment and Research (TA&R) group, is the agency's focal point on operational safety and pollution prevention research. It also helps ensure that industry operations on the Outer Continental Shelf incorporate the use of Best Available and Safest Technologies (BAST) as required in the 1978 Outer Continental Shelf Lands Act amendments. The OSRR program was established through the Oil Pollution Act of 1990 to research oil spill response technology and operational techniques. Its Ohmsett facility is available to provide independent and objective performance testing of full-scale oil spill response equipment and marine renewable energy devices, and improving technologies through research and development.

BSEE's R&D focus is on offshore operational oil/gas and renewable energy issues. The majority of the bureau's technology advancements are transferred through public dissemination. In addition to making the final reports of research projects publicly available on the BSEE website, BSEE also makes its research results available via conferences, and other fora, e.g., the annual Clean Gulf Conference; the Pacific States-British Columbia Oil Spill Task Force Annual Meeting; and the Coastal Response Research Center's Oil Spill Dispersant Research Forum.

BSEE's primary research synergy is with international government organizations, the oil/gas and renewable energy industries, and oil spill response organizations. It is typically in the area of ensuring that the best available and safest technology is used on the US Outer Continental Shelf. Additional information and research deliverables are available at: http://www.bsee.gov/Technology-and-Research/Technology-Assessment-Programs/index/, and http://www.bsee.gov/Technology-and-Research/Oil-Spill-Response-Research/index/.

BSEE is a member of the International Committee on Regulatory Authority Research and Development (ICRARD), which focuses on transferring knowledge worldwide between governmental entities in the area of health, safety, and environment in the petroleum sector. Although membership is only available to government entities, ICRARD cooperates with industry to coordinate and transfer technology.

BSEE is also a member of the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR). Comprised of 15 Federal agencies, ICCOPR was established as part of the Oil Pollution Act of 1990 to "coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the Federal agencies, in cooperation and coordination with industry, universities, research institutions, state governments, and other nations, as appropriate."

A complete listing of current and completed research can be found at http://www.bsee.gov/Research-and-Training/index/. The following are examples of publicly available research projects completed in FY 2015 which would, among other things, advance technological options and transfer knowledge about best technological practices to industries and among regulators operating on the Outer Continental Shelf.

Acoustic Tool to Measure Oil Slick Thickness at Ohmsett. This project enhanced the data collection capabilities at Ohmsett. It developed and installed an remotely operated vehicle at Ohmsett with an acoustic tool to measure the thickness of oil slicks in the test tank. This increases the capabilities of Ohmsett to rapidly and accurately measure oil slicks in the tank during experiments; increasing the quality of data collected. Prior to development of this tool, oil slick thickness could only be estimated visually, manually, or with user provided equipment.

Innovative Technology Enhancements for Measuring Test Parameters at Ohmsett. This project was another project designed to enhance the data collection capabilities of Ohmsett. It provided the capability to remotely calculate the spatial coverage of oil and ice by adapting technology developed by previous BSEE-funded projects with Ocean Imaging for at-sea oil spill mapping. This new instrument at Ohmsett will increase the accuracy and speed of analyzing tests at Ohmsett, maintaining its role as a state of the art facility.

Development of Surrogate Ice Modules for Simulated Arctic Environment Testing at Ohmsett. This project explored the feasibility of developing surrogate ice modules for use at the Ohmsett test facility. These modules were designed to mimic the weight and buoyancy characteristics of real salt water ice and to be discernable from oil and water when using Ohmsett's new analytical tools. Sample modules were tested during a recent ice test at Ohmsett.

These modules will enhance Ohmsett's ability to replicate Arctic conditions on a more cost-effective and year-around basis.

Research to Support the Prediction of Effectiveness of Dispersant Use in the U.S. Beaufort and Chukchi Seas. This project synthesized existing data, identified gaps in current knowledge, and conducted mid-scale tests to fill the gaps in existing knowledge of dispersant effectiveness under Arctic-like conditions. The authors of the project identified the prevailing environmental conditions in the Beaufort and Chukchi Seas, and estimated where and when dispersants may be an effective oil spill remediation tool. They found that the seasonal presence of a shallow freshwater lens in the Arctic Ocean and near shore areas, the presence of heavy ice coverage, and low temperatures that increase the viscosity of oil could hinder dispersant performance. The results of this study — which will be of use to responders who must make decisions during an oil spill, should one occur — are currently under peer review.

Wellbore Survey Technology: Wellbore surveying technology and services enable not only directional drilling and surveying during normal drilling operations but also play a significant role in collision avoidance and relief well drilling / well intersection operations. During the various "ranging" runs conducted by BP on the Deep Water Horizon relief well it become known that some of the performance properties and capabilities of the down hole survey tools were limited by temperature limits (e.g. 350 – 400 F). As drilling continues in the Gulf of Mexico in deeper, more hostile environments, the technology required to intersect a blowout well may be limited as a result of the tool capabilities. Wellbore surveys provide data which is used to determine the position of a wellbore or to steer a drilling assembly in three-dimensional space. Typically a survey measurement is comprised of 1) the depth of the point along the course of the borehole (measured depth), 2) the inclination at the point, and 3) the azimuth at the point. These three components are used to calculate the position of the wellbore. A survey report is the compilation of a series of positional (northings, eastings, and vertical depth) calculations listed in association with the survey measurement components. An additional measurement, tool face orientation, is often measured and recorded. This measurement reflects the rotational orientation of the drill string and is utilized to steer the drill string in the desired direction. Ranging is another form of wellbore surveying, which is used for steering, is a measurement of the earth's magnetic field and its perturbations. Such measurements can be used to determine proximity and orientation relative to cased wellbores or drill strings thus ranging's application in collision avoidance or well interception.

Freeze up Study of the Alaskan Beaufort and Chukchi Seas: This project was intended to build upon the knowledge and expand the database acquired during the past years and is designed to address five specific objectives: 1) Describe the ice conditions that evolve during the freeze-up and early winter seasons, including the development of the land fast ice zone and early shear zone, 2) Locate and map features of potential importance for offshore exploration and production activities, including ice movement lines, substantial leads (linear openings in the sea ice) and polynyas (areal openings in the sea ice), first-year ridges and rubble fields, and multi-year floes, 3) Locate and map ice pile-ups on natural shorelines and man-made structures, and estimate the dimensions associated with such features, 4) Correlate significant changes in the ice canopy with the corresponding meteorological conditions and 5) Use the data acquired since

2009-10, characterize present-day freeze-up processes and compare them with those documented in the 1980s.

Capping Stack Technology Requirements: This study aims to determine the state-of-the art of capping stack technologies with the potential to increase safety during Outer Continental Shelf drilling, well completion, well workover and production operations. The assessment will determine the differences between capping stacks currently in use by industry in Gulf of Mexico, Alaska, and overseas. This study will also conduct an assessment of the current capping stack standards, compile a list of usable Potential Incident of Noncompliance (PINC) and provide criteria and guidelines for design, manufacture, maintenance, and inspection of capping stacks.

Determination of Fracture/Fatigue-Fracture Behavior of Equipment Constructed with Cladded Weld Materials: The objective of this project was to define a general approach to and advance development of a useful predictive computer-modeling tool for use in analyzing failure modes of cladded materials used in oil and gas drilling and extraction equipment. The study developed a constitutive model defining the fatigue and fracture behavior of cladded pipe under typical deep-water conditions with testing and the model limited to a single material. Cladded material performance reliability is compromised not only by the corrosive environment, but by the additional effects of high pressure and high temperature to which these materials are exposed.

The Climatology and Synthesis of Eddies and Eddy Joint Project (CASE-EJIP). This project seeks to answer questions concerning metocean conditions in the Deepwater (DW) operations in the face of changing climate. The project is the source of all industry DW Gulf current design criteria, and the data it maintains is the foundation for further development of tools to predict Loop encounters and other DW current phenomena. The importance of understanding the Loop / eddies is underscored by the experiences of the past, whereby DW drilling and installation operations have been severely impacted by eddies. The data and experience collected during these events will lead to important updates to the industry's design and forecast tools. In addition to being the industry repository for DW current criteria in the Gulf, since the hurricanes of 2004-2008, CASE-EJIP has led studies on Loop-hurricane interaction, maximum credible hurricanes and co-sponsored industry efforts to develop a synthetic hurricane hazard model for the Gulf that accurately characterizes the influence of Loop water on hurricane intensity and confirm regional variation of the hazard to offshore and coastal infrastructure.

XI. Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) is charged with managing the Nation's offshore resources in a balanced way that promotes efficient and environmentally responsible energy and mineral development through oil and gas leasing, renewable energy development, and marine mineral leasing based upon a commitment to rigorous, science-based environmental review and study.

BOEM manages access to and fair return for the energy and mineral resources of the Outer Continental Shelf (OCS) to help meet the energy demands and mineral needs of the Nation, while also balancing such access with the protection of the human, marine, and coastal environments. As the Nation's offshore energy and mineral resource manager, BOEM administers a comprehensive, progressive cycle of analyses to provide the key information necessary for decisions about whether, where, and when offshore energy and mineral development can or should occur.

Management of the oil and gas resources of the OCS is governed by the OCS Lands Act, which sets forth procedures for leasing, exploration, and development and production of those resources. Section 18 of the OCS Lands Act calls for the preparation of a nationwide offshore oil and gas leasing program, setting forth a five-year schedule of lease sales designed to best meet the Nation's energy needs. BOEM is responsible for implementing the requirements of the OCS Lands Act related to preparing the leasing program.

BOEM's Office of Environmental Programs conducts environmental reviews, including *National Environmental Policy Act* (NEPA) analyses and compliance documents for each major stage of energy development planning. These analyses inform the bureau's decisions on its Five Year Program, and conventional and renewable energy leasing and development activities. Additionally, BOEM's scientists conduct and oversee environmental studies to inform policy decisions relating to the management of energy and marine mineral resources on the OCS through its Environmental Studies Program.

BOEM's three regional offices — New Orleans, Louisiana; Camarillo, California; and Anchorage, Alaska — manage oil and gas resource evaluations, environmental studies and assessments, and leasing activities, including the review of Exploration Plans and Development Operations and Coordination Documents, fair market value determinations, and geological and geophysical permitting.

BOEM Science. The BOEM's Environmental Studies Program (ESP) plans, conducts and oversees world-class scientific research to inform policy decisions regarding leasing and development of 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 physical oceanography, atmospheric sciences, biology, protected species, social sciences and economics, submerged cultural resources and the environmental effects of energy development. BOEM is 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, 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 the dissemination of information, knowledge and technologies to the various regions, and to commercial entities and other stakeholders with interests in the OCS.

Studies that have been undertaken by or through funding from BOEM are available to the public through the Environmental Studies Program Information System (ESPIS), and technical summaries of more than 700 BOEM-sponsored environmental research projects, as well as copies of more than 2,000 research reports, are available for online full text search. To learn more about BOEM's ongoing work to further environmental studies, go to: http://www.boem.gov/studies.

Many large interdisciplinary projects with funding from BOEM have included partnerships with other Federal agencies and academic institutions as well as private companies directed towards offshore ecosystem studies that utilize state-of-the-art technologies such as autonomous underwater vehicles surveys, deep-water human-occupied submersibles and remotely operated vehicles. Many projects have developed innovative imaging technologies and digital analysis techniques for establishing long-term biological monitoring stations in deep water. These partnership studies have leveraged expertise and technologies to meet common management goals.

Following are few examples of BOEM's scientific research and development activities being undertaken in FY 2015, including some that are being undertaken in cooperation with other parties.

Tethys. BOEM is an active partner in developing the Tethys system, Tethys was developed to be a freely available open source temporal-spatial database for metadata related to acoustic recordings. The database is intended to house the metadata from marine mammal detection and localization studies, allowing the user to perform meta analyses or to aggregate data from many experimental efforts.

Tethys was initially developed through the National Oceanographic Partnership Program (NOPP) Broad Agency Announcement for Marine Mammal Detection and Monitoring, which was co-funded by the Office of Naval Research and BOEM. Tethys metadata has been adopted by the NOAA National Centers for Environmental Information in a pilot project to Archive passive acoustic recordings collected to detect marine mammals. Although promising, Tethys will benefit from additional study and development. The system is now undergoing a "phase II" development effort co-funded by BOEM and the Navy's Living Marine Resources Program.

Marine Arctic Ecosystem Study (MARES). BOEM leads another NOPP program, the Marine Arctic Ecosystem Study (MARES), a broad Arctic study initiated in FY 2015 that investigates the interrelationship among the physical, biological, chemical and social science components of the Beaufort Sea ecosystem from Barrow, Alaska, to the Mackenzie River delta in Canadian waters. This integrated ecosystem research initiative is being coordinated and planned by

BOEM in conjunction with several federal and private sector partners: U.S. Arctic Research Commission, U.S. Coast Guard, U.S. Geological Survey, U.S. Integrated Ocean Observing System, Marine Mammal Commission, National Science Foundation, National Oceanic and Atmospheric Administration, Office of Naval Research, and Shell Oil Company.

Researchers are using the latest technology in marine mammal-mounted sensors to measure physical and ocean color properties in difficult to reach areas of the Arctic Ocean. Several seals were tagged this summer, and data are actively being transmitted in real-time using satellite telemetry.

Impact of Offshore Wind Turbines on Coastal Radar. BOEM activities in the emerging realm of offshore renewable energy are focused on the assessment of the best currently available technology to apply to management decisions. One ongoing effort is the "Impact Assessment of Offshore Wind Turbines on High Frequency (HF) Coastal Oceanographic Radar," which examines interference between radio waves broadcast by ocean surface current mapping radars and the rotating blades of offshore wind turbines.

Three-Dimensional Offshore Oil Spill Model. BOEM uses the latest technology for assessing the impact of oil spills. For example, BOEM developed a three-dimensional oil spill model, improving upon a NOAA Trajectory Analysis Planner (TAP) software, to asses impacts of oil spills to subsurface biota.

Archiving Tissue and DNA Samples in BioRepository. BOEM is archiving tissue and DNA samples from its environmental studies, using Smithsonian's new biorepository. This is an expansion of BOEM's previous work in invertebrate archiving that BOEM has had with the Smithsonian Institution's National Museum of Natural History since 1979. The biorepository samples will support future work using the latest DNA analysis techniques, which can inform research on species taxonomy, population genetics, and a variety of other biological topics.

XII. Bureau of Land Management

The Bureau of Land Management's (BLM's) multiple-use and sustained yield mandate, set forth in the Federal Land Policy and Management Act of 1976, directs it to manage America's public land resources for a variety of uses, such as energy 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. The BLM administers more public land – over 245 million surface acres – than any other Federal agency in the United States. Most of this land is located in the 17 Western States and Alaska. The BLM also manages 700 million acres of sub-surface mineral estate throughout the Nation.

The BLM invests $16-18 million/year in research and development. It also makes significant investments in applied research projects. The BLM defines applied research as systematic study, with on-the-ground validation, to gain knowledge or understanding necessary to inform management questions. BLM research projects are intended to provide knowledge necessary to help the BLM address social, economic, biological, political, technical, or physical challenges

affecting its management of the public lands. Projects are focused on addressing specific 'researchable' problems recognized by the BLM. They usually have applicability beyond a particular location and time and are usually directed at development of new methodologies and technologies. Currently, the focus of BLM research and development efforts are towards developing basic foundational research and ensuring scientific integrity (e.g., through peer review, etc.). As explained below, technology transfer occurs as part of these existing efforts, and the BLM is currently evaluating the feasibility and benefits of additional technology transfer opportunities authorized under 15 USC § 3710 and 35 USC § 207 and § 209.

Currently, the BLM's technology transfer efforts include, but are not limited to, information dissemination. For example, the BLM recently issued an in-depth manual explaining how new technology (e.g., geospatial) is to be incorporated into existing procedures, techniques, and training (e.g., the landscape approach) and made available within and outside the BLM, as appropriate.

The BLM is also developing recreational mapping products that will assist with its management and the public's use of the BLM's approximately 30 million-acre National Conservation Lands. These lands include 221 Wilderness Areas, totaling 8.7 million acres; 20 National Monuments, comprising 5.6 million acres; and 21 National Conservation Areas and similar designations, comprising 4.1 million acres. Wilderness Study Areas, National Scenic and Historic Trails, and Wild and Scenic Rivers also are included in the National Conservation Lands. The recreational mapping products BLM is developing will help ensure the public has access to consistent maps and information across all BLM recreational areas. This project includes three specific products: (1) static, printable maps; (2) interactive online maps; and, (3) story maps showcasing unique sites and resources at recreational areas.

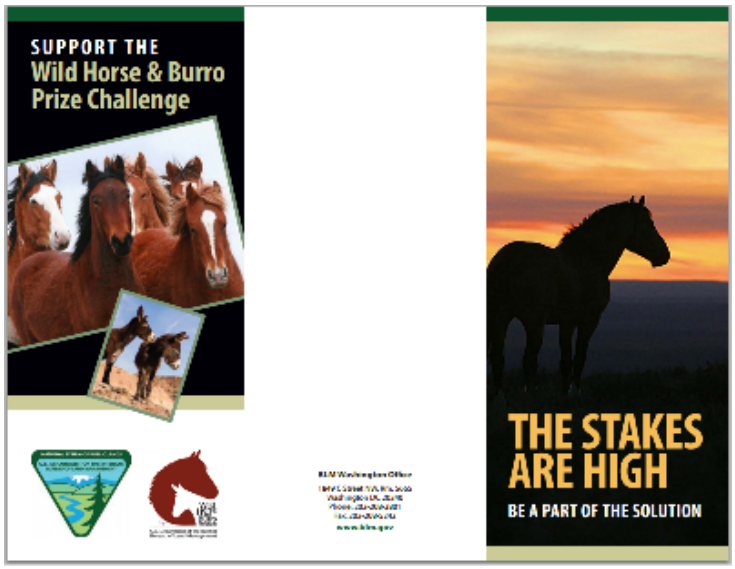
San Rafael River in the San Rafael Swell of central Utah. Photo: BLM

Similarly, in connection with its emphasis on "landscape approaches" to its planning and management obligations, the BLM has established and continues to fund Rapid Ecoregional

Assessments (REAs). The REAs will provide geospatial base data to support future decision making, management, and projects. This base date can be used to move the BLM towards new conceptual models, innovative methods, and new practices that more fully integrate science into its everyday work processes.

Finally, in FY 2015 the BLM's Wild Horse and Burro (WHB) program continued to work on a prize challenge to sustainably manage wild horse and burro populations on public lands. Currently available fertility control technologies are limited in their effectiveness due in part to the logistical challenges of consistently finding, tracking and treating the animals. A solution to this challenge is critical because wild horse and burro herds have a rapid growth rate if left unchecked, annual adoptions of excess animals are at a near-record low, and the cost to care for unadopted excess animals in BLM-funded off-range corrals and pastures is unsustainable in the long-term.

The BLM worked with InnoCentive, a global leader in crowdsourcing innovation problems, to design a competition to devise a solution to this challenge. It is currently working with external non-governmental organizations to develop a fund-raising plan for its prize challenge, and determining next steps for soliciting private funds for the prize, including potentially forming partnerships with external entities. A prize will only be awarded to a solution that is judged to be viable. BLM anticipates that technology transfer will be a component of any solutions identified as part of this effort.



Brochure to help raise funds for the Wild Horse and Burro Prize Challenge. Photo: BLM.

XIII. Office of Environmental Policy and Compliance

The Office of Environmental Policy and Compliance (OEPC), within the Office of the Secretary, provides leadership on a national and regional level for environmental policies and compliance and serves as the Department's unifying — and lead — voice for a wide range of environmental

issues. OEPC ensures environmental stewardship and sustainability through compliance with the National Environmental Policy Act (NEPA), executive orders, regulations, and reporting requirements; manages the Department's funding program for long-term cleanups of hazardous materials; and oversees the Department's activities to protect and recover natural and cultural resources and historic properties for emergency incidents and all hazards disasters.

Environmental Emergency Preparedness. The National Response Framework (NRF) identifies DOI as a primary Federal agency for dealing with damages to natural and cultural resources from all types of disasters and emergencies. The National Disaster Recovery Framework (NDRF) also designates DOI as the coordinating Federal agency for the recovery of natural, cultural and historical resources damaged by national disasters. Within DOI, OEPC has the responsibility to lead and coordinate the Department's involvement in both NRF and NDRF related activities for natural and cultural resources. As such, it has the responsibility of ensuring that it has a cadre of trained individuals ready and available in short order in the wake of a national disaster to fulfill their roles in recovery and response activities as part of interagency and inter-governmental teams. These roles extend from field coordinators and team leaders to subject matter experts in myriad scientific, engineering and technical fields. Developing and maintaining this capability requires training and substantial transfer of knowledge and expertise to members of this cadre. This is a critical part of developing and maintaining readily-accessible human capital to restore and recover damaged natural, cultural and historic resources in the event of a major disaster.

Resource Advisor (READ) Curriculum Development. Following the BP Deepwater Horizon oil spill, the Department was faced with the task of fulfilling its mission of protecting and managing the Nation's natural resources and cultural heritage during the oil spill response operations. The Department deployed Resource Advisors (READs) to assist the Incident Management Teams conducting oil spill response measures to ensure they were as protective of natural and cultural resources as practicable. Typically, Environmental, Natural, or Cultural Resource specialists are tapped to serve as READs, but they have to be trained in a timely manner to protect sensitive resources and mitigate damage from oil spills or other all-hazards disasters that might occur unexpectedly.

The Deepwater Horizon Congressional supplemental provided funding for OEPC to develop a Departmental curriculum to train and prepare bureau employees to serve in the role of READs following an emergency incident or disaster. Working in conjunction with the bureaus, and with the assistance from FWS' National Conservation Training Center and a NPS/CESU agreement with Texas A&M University, OEPC led a multi-disciplinary and multi-bureau workgroup to develop an authoritative training curriculum to prepare Departmental and other employees as READs who can balance resource concerns with incident response priorities.

It continued the development of this curriculum in FY 2015, working towards the completion of three courses incorporating multiple scenarios that will be made available as online training classes. The first of the three courses was launched in 2013. Since the launch, 272 individuals have completed the course through FY 2015.

The innovative curriculum equips individuals with the unique skill sets required of a READ by providing a comprehensive overview of existing natural and cultural resources laws and their application, an understanding of the Incident Command Structure that manages the oil spill response, how the READ is positioned within that structure, and provides knowledge of additional resources available to assist in identifying possible natural and cultural resources that may be threatened, and measures to restore and recover these resources. During the curriculum development, other federal agencies expressed interest in hosting the training on their own departmental training web sites. This would allow for technology to be transferred across the Federal Government, and the maintenance and development of expertise both within and outside the Department. As a web-based curriculum, the READ courses are accessible anytime, anywhere and can ideally be taken quickly during the early stages of an emergency incident or disaster.

Recovery Field Coordinator Training. Recognizing that many disaster impacted communities may have limited capacity to plan and execute a recovery plan in the aftermath of a disaster, the NDRF identifies six Recovery Support Functions (RSF) to assist FEMA help local, State, Tribal, and Insular Area governments with any long-term recovery process following a major disaster. FEMA uses the RSFs to provide planning, expertise, and knowledge of existing federal programs that can be leveraged to assist in the recovery process. One of these RSFs is dedicated to helping protect and restore Natural and Cultural Resources (NCR) impacted by natural disasters, in accordance with the priorities of the local community. OEPC, on behalf of the Department, has the lead for coordinating federal Natural and Cultural Resources (NCR) RSF efforts.

As the Coordinating Agency for the NCR RSF, OEPC's key responsibility, when directed by DHS/FEMA through a Mission Assignment, is to deploy Field Coordinators to lead the support to any local, State, Tribal, and Insular Area governments overwhelmed in a disaster situation. The Field Coordinators work directly with the impacted communities to assess their needs and develop a strategy for natural and cultural resource recovery. In addition, the Field Coordinators direct and facilitate the efforts of any staff from the Bureaus or any one of fifteen partner agencies deployed to provide additional specialized technical expertise. This expertise is provided on a wide range of topics, including beaches, dunes and barrier systems; biological and habitat resources assessments; fishing and recreational uses; tribal concerns; National Register of Historic Places properties and sites; museums; libraries; and archives.

In FY 2015, OEPC developed training materials for the Field Coordinators and other deployed individuals, focused on the multi-jurisdictional and multi-disciplinary nature of recovery. Training materials include desk-top reference documents for use during deployments and a guided six-module training course. A Concept of Operation Plan explains their roles within the greater NDRF. Standard Operating Procedure provides specific details on Field Coordinator responsibilities at the Joint Field Office established by FEMA to help state and local authorities. The Field Coordinator Training course explains key concepts from both documents in a user-friendly format and is slated to be launched as a web-based course on DOI-Learn in FY 2016.

XIII. Conclusion

Over the past year the Department has continued its progress toward institutionalizing technology transfer as a routine part of its science, engineering and other technical activities. Specifically, during FY 2015, its scientists, engineers and technical personnel:

- Published over 8,900 reports, books, papers, fact sheets, and other publications.
- Substantially increased the numbers of Cooperative Research & Development Agreements (CRADAs) that they engaged in from 601 in FY 2014 to 826 in FY 2015.
- Engaged in at least 318 other collaborative R&D relationships, versus 292 in FY 2014.
- Increased the number of non-traditional CRADAs, i.e., technical assistance, material use and facility use agreements, which they executed from 566 in FY 2014 to 787 in FY 2015.
- Disclosed of seven (7) new inventions, filed eight (8) new patents were filed and received three (3) patents.
- Managed twenty (20) active licenses for inventions and other intellectual property that earned over $105,000.

In addition, DOI bureaus are exploring the use of prize competitions as a cost effective method of identifying and developing innovative technologies and approaches to dealing with natural resource issues affecting their mission:

- To help accelerate the use of prize competitions, the Department published policy and procedural guidance on offering and administering prize challenges pursuant to the America COMPETES Reauthorization Act of 2010.
- Reclamation's Water Prize Competition Center (CWPC), established in FY 2015, is leading several interagency efforts to develop new, or improve existing, technologies to restore ecosystems, and improve sustainability of water and power infrastructure, and water availability through improved conservation and management.
- For these, and related efforts, Reclamation and its personnel have received a number of national awards, sponsored by the Office of Science and Technology, for the year 2015. These include *Newcomer of the Year Award* and the *Best in Technology Award*. Also, Saied Delagah, a Reclamation desalination research expert, won the *Unsung Hero Award* for his outstanding, behind the scenes coordination of the technical efforts that enabled the international Desal Prize.
- The CWPC's first competition, launched in FY 2015, was to develop, test and demonstrate new methods to remotely track fish. Additional competitions are being developed for FY 2016, and beyond.
- USGS is partnering with other Federal agencies on the Climate Resilience Data Challenge (partners: NASA, NOAA, and EPA). It is also cooperating with Reclamation's Water Prize Competition Center's efforts, as well California AgTech Roundtable's *Aps for Ag* hackathon.
- BLM is working on raising funds for a prize challenge that would advance conservation of wild horses and burros.

DATA APPENDIX

The following tables provide cumulative data for the Department. Data for individual bureaus are available on line 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 is not collected or it is otherwise unavailable. These tables include updates to previous years' data, where appropriate.

Table 1: Invention Disclosures and Patents

		FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
	Invention Disclosures					
1	Number of new inventions disclosed	5	10	9	6	7
	Patents					
2	Number of patent applications filed	2	3	8	4	8
3	Number of patents received	1	3	4	2	3

Table 2: Income Bearing Licenses

		FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
	Income Bearing Licenses					
4	Number of income bearing licenses	22	22	16	14	18
5	Exclusive licenses	3	12	4	5	7
6	Partially exclusive licenses	0	0	0	0	0
7	Non-exclusive licenses	19	10	12	9	11
	Elapsed Amount of Time for Granting Licenses					
8	Average (months)					
9	Minimum (months)					
10	Maximum (months)					

Note: Blank cell indicates that the data is not available.

Table 3: Licensing Income

		FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
	Total income (all licenses active in FY)	114,963	75,975	96,250	58,248	105,580
	Total income distributed	110,678	71,450	91,813	55,690	97,198
	% of total income distributed to inventors					
	% of total income distributed to other					
	Total income from patent licenses	114,963	75,975	96,250	58,248	105,580
	Total income distributed	110,678	71,450	91,813	55,690	97,198
	% of total income distributed to inventors					
	% of total income distributed to other					
	Earned Royalty Income					
11	Earned Royalty Income from top 1% of licenses					
12	Earned Royalty Income from top 5% of licenses					
13	Earned Royalty Income from top 20% of licenses					
14	Minimum Earned Royalty Income					
15	Maximum Earned Royalty Income					
16	Median Earned Royalty Income					
	Disposition of Earned Royalty Income					
17	Total amount of Earned Royalty Income received	103,963	64,651	96,250	58,248	105,580
	Total amount of ERI distributed	110,678	71,450	91,813	55,690	97,198
18	Percent of Earned Royalty Income distributed to inventors					
19	Percent of Earned Royalty Income distributed to the agency or laboratory					
20	Licenses terminated for cause					

Note: Blank cell indicates that the data is not available.

Table 3A: License Activity

	Metric	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
	Licenses, Total Active	25	26	20	18	20
	New Licenses	2	1	3	0	3
	Invention Licenses, Total Active	23	24	20	16	18
	New Invention Licenses	2	1	3	0	3
	Income Bearing Licenses, Total Active	22	22	16	15	18
	Income Bearing Exclusive Licenses	3	12	4	5	7

Table 4: CRADAs

		FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
	CRADAs					
21	Number of active CRADAs	351	379	476	601	826
22	Number of newly executed CRADAs	295	284	376	423	586
23	Active CRADAs with small business involvement					
24	Number of small businesses involved in active CRADAs					
	Traditional CRADAs					
25	Active traditional CRADAs	22	28	21	35	38
26	Newly executed traditional CRADAs	13	5	2	11	12
	Non-traditional CRADAs					
27	Active non-traditional CRADAs	327	351	455	566	787
28	Newly executed non-traditional CRADAs	282	279	378	411	574
	Other collaborative R&D relationships					
	(Collaborative Agreements), total active in the FY	209	283	322	292	318
	New, executed in the FY	155	165	137	112	121

Note: Blank cell indicates that the data is not available.

Frequently-Used Acronyms

AADAP	Aquatic Animal Drug Approval Program
ARS	Agricultural Research Service (within USDA)
BAST	Best Available and Safest Technologies
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
BSEE	Bureau of Safety and Environmental Enforcement
CESU	Cooperative Ecosystem Studies Units
CRADA	Cooperative Research & Development Agreements
CWA	Clean Water Act
DHS	Department of Homeland Security
eDNA	environmental DNA
EPA	Environmental Protection Agency
EPM	Electron Microprobe
ESA	Endangered Species Act
ETB	Emerging Technologies Branch
FAC	Division of Fisheries and Aquatic Conservation
FEMA	Federal Emergency Management Agency
FTC	Fish Technology Center
FTTA	Federal Technology Transfer Act of 1986
FUSA	Facility Use/Service Agreement
FWS	Fish and Wildlife Service
GSA	General Service Administration
GSS	Global Security Systems
MHEP	Minority Higher Education Program
MTA	Material Transfer Agreement
NASA	National Aeronautics & Space Administration
NCPTT	National Center for Preservation Technology and Training
NCR	Natural and Cultural Resources
NCTC	National Conservation Training Center

NDRF	National Disaster Recovery Framework
NEPA	National Environmental Policy Act
NFPP	National Fish Passage Program
NGA	National Geospatial-Intelligence Agency
NGO	Non-governmental Organization
NIST	National Institute of Standards & Technology
NOAA	National Oceanic & Atmospheric Administration
NPS	National Park Service
NRF	National Response Framework
NTTP	National Technical Training Program
NTTT	National Technology Transfer Team
OCS	Outer Continental Shelf
OEPC	Office of Environmental Policy and Compliance
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
R&D	Research & Development
READ	Resource Advisor
RSF	Recovery Support Function
SEM	scanning electron microscope
SMCRA	Surface Mining Control and Reclamation Act of 1977
TAA	Technical Assistance Agreement
TIPS	Technical Innovation and Professional Services
UAS	Unmanned Aerial System (or drone)
USACE	US Army Corps of Engineers
USAID	US Agency for International Development
USDA	US Department of Agriculture
USGS	United States Geological Survey