Chapter 6 INNOVATION, INFORMATION, AND TECHNOLOGY TRANSFER

INTRODUCTION

The 2012 Economic Report of the President (ERP) discusses the role of innovation, the provision of information, and research and development as a means of facilitating economic growth. Technological change, or innovation, can be loosely defined as the introduction of a new or improved product, service, or process; it is the primary source of long-run increases in productivity and human welfare (Grossman and Helpman 1991). Over time, rising productivity drives growth in the output that an economy can produce (ERP, February 2012). The ERP discusses the fact that research and development is a critical driver of innovation:

In a nutshell

- Scientific information and technology transfer provide critical inputs to improved decision making in both the private and public sectors.
- Quantifying the economic value of the end-uses of publicly provided data and information, and incorporating these values into benefit-cost analyses can provide a useful mechanism to demonstrate the return on the public's investment.
- Economic analysis methods have been developed that can be applied to address challenges that arise when monetizing the value of public goods such as data and information sources.

> *"… Public support for research and development remains critically important, particularly in basic research, which aims to expand scientific knowledge and thus does not generally have immediate commercial applications. Private firms can thus find it especially difficult to capture the benefits that stem from this research, and the positive spillover effects of basic research can be especially large" (ERP, 2012).*

Interior's bureaus are engaged in a variety of activities designed to provide basic research, provide information (including both scientific and technical information), and transfer technology to decision makers in the public and private sectors. The information produced by Interior is a critical input that helps support private markets, the production processes of private entities, and many public sector decisions. For example, oil, gas, and mineral markets are underpinned by scientific and technical information on resource availability; water use and allocation decisions rely on precipitation and runoff predictions; and preparedness for natural hazards relies on information about the locations and probability of such events occurring. The information supplied in these examples has an economic value that is at least partly incorporated in the market prices of traded goods and services. In some cases,

What is Technology Transfer? *The concept of "technology transfer" from Federal laboratories is to transfer the ideas, inventions, and technologies conceived or developed with taxpayer dollars out of the laboratory and into the hands of potential users.*

the economic value of information is associated with reducing the uncertainty facing market participants or decision makers. In other cases the value of information is associated with the impetus it provides for technological change.

This chapter discusses some of the different types of information produced by DOI, and the economic concepts associated with this information. For the purposes of this chapter, "information" includes information developed by the bureaus through research or systematic data collection, and activities that facilitate the transfer of information to the private sector.

Each Interior bureau conducts research and data collection to support its individual mission. However, many of these activities are undertaken within the U.S. Geological Survey (USGS), since it is the Department's primary science organization. These activities include:

- Energy and mineral assessments;
- Natural hazards;
- Land use change;
- Understanding of ecosystems;
- Climate change; and
- Water resources.

USES OF INFORMATION

Information resulting from government research and development activities is often available at little or no cost to the user, providing an inexpensive input to decision making. In general, information and data sources generated through DOI research are used in both the private and public sectors for a variety of end-uses that generate significant societal benefits. They are used both directly and indirectly as an input to production processes or decision making by federal, state and local governments, private markets, and the general public. For instance, The National Weather Service, U.S. Army Corps of Engineers, the Federal Emergency Management Agency and, through them, the broader public rely on input from continuous records of streamflow information provided by the USGS streamgaging network for timely and accurate flood forecasts and warnings, flood management, and disaster mitigation. The same streamflow information is directly used by boaters, swimmers, and fishermen in their decisions to pursue their chosen activities.

An important stage in the process of innovation is commercialization of new technologies. In some cases, government research and development activities might follow a path from basic research, to applied research, to the development of specific technologies that can be transferred to the private sector, resulting in commercial applications. Such activities may be undertaken collaboratively between DOI and external entities such as industry, universities, trade associations, and state and local governments. Tools such as Cooperative Research and Development Agreements (CRADAs) help facilitate partnerships between the Federal government and non-Federal entities, as well as the efficient transfer of federally conceived or developed technology into the private sector.[32]

[32] Some of the benefits provided by CRADAs include: enabling both partners to leverage their research budgets and optimize resources; providing a means for sharing technical expertise, ideas, and information in a protected environment; permitting federal scientists to work closely with their non-federal counterparts; offering non-federal

DOI also uses its own research to help inform a wide range of management decisions in the interest of the general public. For instance, NPS regularly monitors a range of vital ecosystem indicators such as soil structure, water quality, water quantity, wetland and grassland vegetation, among many others, in an effort to improve management of natural resources within the National Park system. The BLM likewise uses scientific methods to monitor rangeland conditions. Information collected directly from the public, usually through surveys, is also used for DOI management purposes. For example, Interior bureaus responsible for managing lands and providing recreational opportunities directly to the public often conduct surveys to gather a range of information from visitors, community members, and the general public used for planning and improved management of these lands.

Landsat Image Maps Aid Fire Recovery Efforts: The Remote Sensing Applications Center (RSAC), operated by the U.S. Department of Agriculture Forest Service, and other federal agencies that specialize in fire recovery use Landsat 5 and 7 satellite data to observe vegetation, water and soil changes after a fire. Fire response teams use these data to fight the fire, protect threatened and resources, including wildlife and water bodies.

"Before we started using Landsat data …,Burned Area Emergency Response teams had to conduct aerial and ground-based surveys, sit down with a topographic map and sketch out areas of high burn severity," said Brad Quayle, of the RSAC, Salt Lake City, Utah. "With our USGS partners, we've now mapped over 28 million acres and 900 fires since 2001 using Landsat satellite data." Melissa Quijada, NASA Goddard Space Flight Center; see http://www.nasa.gov/mission_pages/fires/main/post-fire2011.html).

QUANTIFYING THE VALUE OF DOI INFORMATION – CONCEPTS, CHALLENGES, AND EXAMPLES FROM THE LITERATURE

Concepts and Challenges

Information is a valuable economic resource. It improves decision making by reducing the uncertainty of outcomes. Publically provided scientific data and information sources generate significant societal benefits, and quantifying the return on the public's investment in the development of scientific information and transfer of federal technology has become increasingly important. In concept, the value of information can be evaluated using standard economic techniques such as benefit-cost analysis. However, evaluating the net economic benefits of the scientific information provided by DOI presents some challenges, one of which is related to the "public good" nature of the data and information provided.[33]

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partners access to a wide range of expertise in many disciplines; allowing the partners to agree to share intellectual property emerging from the effort; and permitting the Federal Government to protect information emerging from the CRADA from disclosure for up to 5 years, if this is desirable.

[33] *Public goods*, as defined by economists, are goods which have the characteristics of *non-rivalry* and *non-excludability*. Goods with these characteristics are often, but not always, provided by the public sector. *Non-rivalry* implies that, in general, the additional cost of one more person using this type of good is typically zero. For example, if one individual goes to the USGS National Streamflow Information Program website and downloads data on streamflows in a particular river to determine whether they should kayak that day, this does not diminish the availability of this same information to other users at no direct cost. *Non-excludability* implies that individuals cannot be prevented from using the good. In direct contrast, private goods are both *rival* and *excludable*, and are provided through private markets, allowing forces of supply and demand to set a market-clearing price in the absence of market failures.

An additional challenge stems from the fact that the information generated through DOI research is used in a variety of national (and sometimes international) uses, providing economic benefits that could be monetized in different ways. Further, this information is often shared freely among users, making quantification of its total value to society challenging. One of the key components to developing estimates of values is obtaining information from users on how they are using the data. Few such studies have been conducted to date. In addition, much of the information provided by Interior bureaus also has few or no substitutes, so it may not be possible to use secondary sources to quantify its value. Despite these challenges, significant advancements have been made in quantifying the economic value of public goods, in particular the value of information sources.

Examples from the Literature

Many economic studies have estimated the value of various types of information to individual decision makers. The majority of these studies have focused on estimating the value of weather forecasts used by producers to increase agricultural productivity. The construct used to analyze these problems has historically been oriented around a decision-analytic cost-loss framework, where a decision maker chooses between two actions: protecting an activity at a known cost or doing nothing and facing the risk of a loss due to some event. Information helps the decision maker more accurately assess the risk of this event occurring.[34] Additional studies have attempted to estimate the social, rather than individual, market value of information sources. For instance, Adams et al., (1995) estimate the economic value of improved El Niño-Southern Oscillation (ENSO) forecasts to the entire U.S. agricultural sector.[35] Considerable advancements using dynamic integrated models to address the economic value of information in relation to global climate change have also been made over the years (Nordhaus, 1994; 1997).

> *"If information is only as valuable and useful as it is easy to obtain, the USGS Real-time Streamflow World Wide Web page is the ultimate source of information for river anglers"* (Dave Motes, Mark Kovach Fishing Services; article available at: http://recreation.usgs.gov/riversmallies.html.)

Within Interior, the U.S. Geological Survey has carried out a number of studies quantifying the economic benefits associated with the uses of scientific and technical data and information that it provides. Beginning in the 1990s, a number of studies have estimated the value of geologic maps (Bernknopf et al., 1993; Halsing et al., 2004; Bernknopf et al., 2007); earth science information (Bernknopf et al., 2001); and satellite imagery (Miller et al., 2011). These studies all provide estimates of the economic value for a sample of the end uses which publically provided data and information sources are put towards. However, for reasons mentioned previously, these estimates are neither comprehensive nor certain.

Studies implementing an alternative cost approach to quantify the economic value of data and information provided by the National Oceanic and Atmospheric Administration (NOAA) have been conducted in

[34] Often a Bayesian framework is applied, where some prior probability of an event is specified and then updated as new information arises. The decision maker is assumed to choose the action that maximizes their expected return (utility) or minimizes expected costs.

[35] Johnson and Holt (1997) provide a comprehensive summary of some early value of information approaches and studies specific to weather and climate forecasts.

recent years (NOAA, 2002; Centrec Consulting Group, LLC, 2003; 2005).[36] Additional studies have used an avoided cost approach to value improvements in data provided by NOAA (NOAA, 2002; 2004). In addition, a handful of studies have focused on estimation of the value of information in relation to improvements in hazards forecasting specifically (National Weather Service, 2002; Centrec Consulting Group, 2007). An issue commonly raised in these studies is how to capture the full range of benefits to society from these improvements (Carsell et al., 2004; National Weather Service, 2002; Letson et al., 2007).

Non-market valuation techniques have also been applied to monetize the societal value of publically provided data and information sources. Examples include households' values for current and improved weather forecasting services (Lazo and Chestnut, 2002; Lazo et al., 2010); the benefits of supercomputers used in research to contribute to improved weather forecasting (Lazo et al., 2003); the economic benefits of the information provided by NOAA's Physical Oceanographic Real-Time System (Kite-Powell, 2005; 2007; 2010); as well as the value of Landsat moderate resolution imagery (Miller et al., 2010).

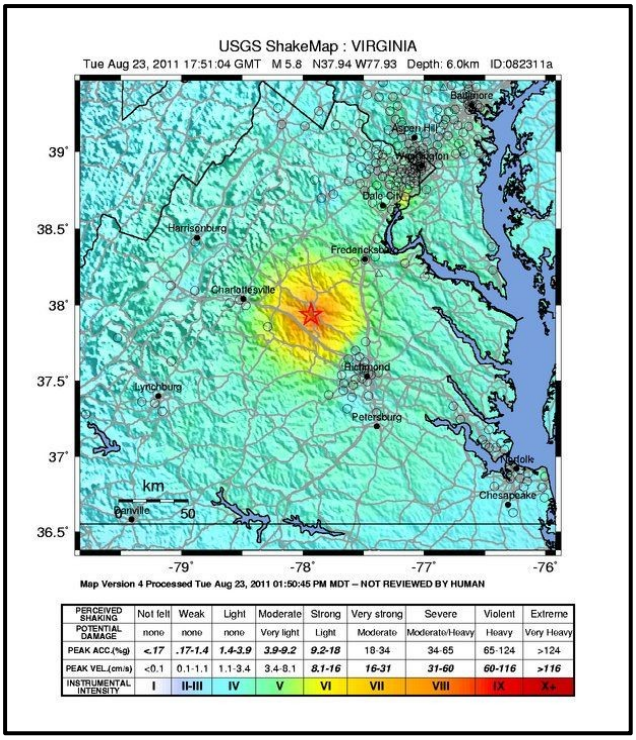
[36] Under this approach, the price a given company or industry pays to obtain needed data from NOAA (often a highly subsidized price) can be compared to the costs that would be required for that company or industry to perform the functions on their own to obtain those same data internally, the difference being the value of the data in that use.

EXAMPLES OF DOI INFORMATION AND DATA COLLECTION WHICH PROVIDE SOCIETAL BENEFITS

Interior bureaus produce a wide range of information through research and data collection that benefit the general public. The following are a few examples. Given the wide range of such activities, however, this chapter only scratches the surface of the real and potential benefits flowing from such activities. The descriptions provided here are qualitative because currently there is insufficient information to quantify their value in monetary terms.

U.S. Geological Survey

The USGS operates many programs which provide easily accessible historical and real-time scientific data to national and international users on a wide array of topics. These data contribute to an increased understanding of natural resources and hazards which improves the accuracy of hazards forecasting, societal resilience to natural hazards, land-use planning, and decision making, all of which has considerable economic value.



Shake map, Virginia's 8/23/11 5.8 Magnitude Earthquake.

For instance, the bureau's Earthquake Hazards Program provides near real-time maps of ground motion and shaking intensity following significant earthquakes. These maps are used by both public and private entities for post-earthquake response and recovery, preparedness, and disaster planning. Hazard maps, which identify areas of the country that are most likely to experience strong shaking in the future due to earthquakes, are used to establish seismic building codes, insurance rate structures, and risk assessments.

The bureau's Volcano Hazards Program conducts continuous, real-time monitoring of volcanoes in the United States. This program provides information regarding volcanic unrest and potential eruptions for public officials and communities. This information facilitates disaster preparedness and response which helps reduce loss of life and property resulting from volcanic activity. Information is also provided to the Federal Aviation Association in order to reroute flights and reduce the risk of future ash encounters, which can cause large economic losses in the aviation sector through aircraft damages, cargo delays, and passenger flight delays and cancellations.

USGS' Land Remote Sensing Program is the Nation's archive for the world's largest collection of civilian remotely sensed data covering the Earth's land masses. Real-time data and information, including millions of satellite images and aerial photographs, can be searched and accessed online by any individual with internet access. Imagery obtained through Landsat satellites, which are jointly managed by USGS and the National Aeronautics and Space Administration (NASA), are used in a broad range of applications by both public and private sectors. For example, Figure 6-1 shows a satellite image of

Arizona's Wallow North Fire in 2011. The image's false colors are used to help firefighters and emergency response teams identify various aspects of the fire

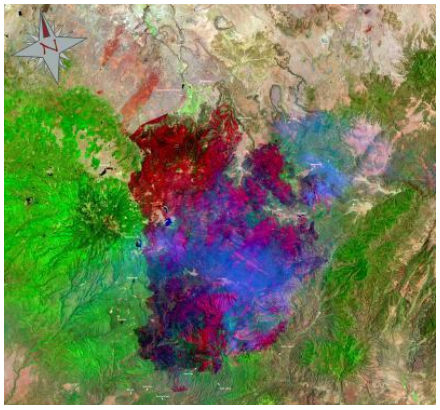


Figure 6-1. Landsat 5 Satellite Image of the Wallow North Fire in East Central Arizona (6/15/11).

(NASA/USGS, Mike Taylor).

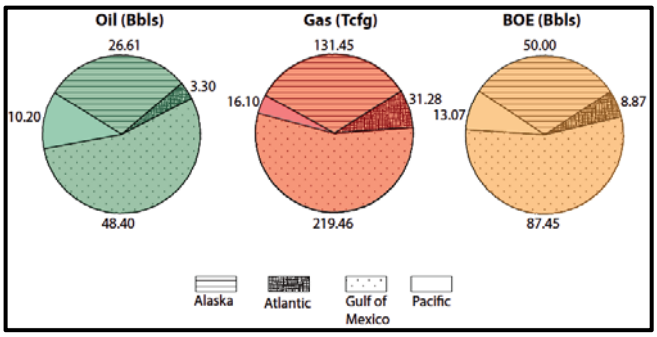
Miller et al., (2011), in a survey of nearly 1,400 current U.S. users of moderate resolution Landsat imagery, identified applications ranging from agricultural forecasting and biodiversity conservation to law enforcement and real estate assessments and taxation. The contingent valuation method was applied to determine what respondents would be willing to pay for substitute imagery equivalent to the current Landsat product they use. The researchers found that respondents would pay on average about $750 per scene (plus-or-minus $250). The results, however, are not generalizable to the population of imagery users due to the sampling approach taken (Miller et al., 2011). In its next phase, this research effort will include international imagery users and attempt to provide estimates that can be generalized to the population of users.

Another easily accessible source of information is real-time data on daily streamflow conditions throughout the United States, provided through the USGS National Streamflow Information Program. Provision of these data is made possible by the bureau's streamgage network, which has measured river streamflow since 1889. Streamflow data are used for such valuable end uses as:

- Water resource appraisal and allocations;
- Assessments of interstate agreements, compacts, and court decrees;
- Engineering design (reservoirs, bridges, roads, culverts, treatment plants);
- Operations (reservoirs, power production, navigation);
- Identifying changes in streamflows due to changes in land use, water use, and climate;
- Flood planning and warning;
- Streamflow forecasting;
- Support of water quality sampling; and
- Characterizing and evaluating instream conditions (for habitat assessments, instream flow requirements, and recreation).

Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement

The Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) manage natural gas, oil and other mineral resources on the outer continental shelf (OCS). These resources provide a significant amount of the U.S.'s energy supply. BOEM periodically conducts an oil and gas assessment of the OCS to determine the amount of undiscovered technically recoverable resources, as well as the quantity of undiscovered economically recoverable resources. The 2011 assessment (Bureau of Ocean Energy Management, 2011) estimated a mean of 88.6 billion barrels of undiscovered technically recoverable oil and 398.4 trillion cubic feet of undiscovered technically recoverable natural gas in the Federal OCS of the United States. This information underlies leasing and management decisions on the OCS and serves as an important input to energy markets. Many entities, including corporations, offshore operators, exploration companies, and energy markets, use these estimates for long-term planning, evaluation of investment options, and design of exploration strategies.



Mean Undiscovered Technically Recoverable Resources, by Type and Region, 2011 Assessment

BOEM oversees environmentally sound development of offshore energy and mineral resources. The bureau uses data and information provided by its Environmental Studies Program as one resource to achieve this goal. Initiated in 1973, this program plans, conducts, and oversees scientific research related to ocean resources. This research is used to inform policy and management decisions regarding development of offshore energy and mineral resources, such as the

Box 6-1. BOEM Arctic Research

A recent cooperative agreement signed by BOEM with the University of Texas and a team of leading Arctic researchers, begins a five year comprehensive study of the Hanna Shoal ecosystem in the Chukchi Sea off Alaska's northwest coast, an important and productive biological ecosystem which supports a high concentration of marine life. The study will document ocean circulation, ice conditions, and organisms such as zooplankton. Bowhead whales depend on zooplankton for food and are valuable culturally to the native Inupiat people of the Arctic coast as part of their subsistence diet. The resulting information on physical and biological processes will be used by industry and BOEM in decisions regarding energy development in this region, and will be included in future National Environmental Policy Act analyses.

"Industry is ready to begin exploratory drilling, but they want as much information as possible to avoid having any obvious or measureable impacts on the local ecosystem. Knowing the location of biologically sensitive areas is very valuable to the permit holders. The information we gather will allow BOEMRE to make better decisions on how best to recover oil and gas from in the Chukchi Sea at minimum risk to the Arctic ecosystem."

Dr. Kenneth Dunton, project Principal Investigator, professor of marine science, The University of Texas at Austin. (Source: Lee Clippard, http://web5.cns.utexas.edu/news/2011/10/chukchi-sea.)

determination and scheduling of oil and gas lease sales on the OCS. This information enables BOEM to better balance any trade-offs between energy development and environmental protection of marine and coastal resources. Through this program, BOEM has also become a leader in the provision of scientific knowledge on the nation's marine and coastal environment.

BSEE supports research associated with operational safety and pollution prevention through its Technology Assessment and Research (TA&R) program, and is also the principal Federal agency funding offshore oil spill response research. The TA&R program helps determine the best available and safest technology for offshore conventional and renewable energy operations, while the Oil Spill Response Research program maintains a comprehensive, long-term research program to improve oil spill response technologies, including in Arctic environments. BSEE also operates Ohmsett - the National Oil Spill Response & Renewable Energy Test Facility, one of the world's largest wave tanks, which helps to test and evaluate full-scale equipment for the detection, containment, and cleanup of oil spills.

Bureau of Reclamation

The Bureau of Reclamation's Science and Technology Program is the bureau's primary Research and Development arm, responsible for evaluating and funding research projects to further Reclamation's mission of helping the American West fulfill its growing demands for water, while protecting the environment and the public's investment. To address technical and scientific challenges facing the provision of water and power to the 17 Western States, the bureau's Research and Development Office over the past seven years has funded 800 research projects focused on innovative solutions to these challenges. Current research projects include such topics as:

- Conserving or expanding water supplies;
- Advanced water treatment technologies;
- Environmental issues in water delivery and management;
- Water and power infrastructure reliability;
- Water operations decision support;
- Ongoing research on climate change and variability; and
- Early detection of zebra and quagga mussels.

Specific examples of data provided by Reclamation include near-real time water and environmental data collected by a network of hydrologic and meteorologic monitoring stations operated and maintained by the bureau's Pacific Northwest Region. This network, collectively referred to as Hydromet, is used to manage Reclamation's water operations in this region. Hydromet data, when integrated with other available information, are used to estimate the status of river and reservoir water supplies. A subset of Hydromet includes a satellite-based network of agricultural weather stations, referred to as Agrimet. These data are used for crop water use modeling and other agricultural applications.

Box 6-2. Using Technology to Address a Damaging Invasive Species

Zebra and quagga mussels are invasive, freshwater mollusks that attach to structures and surfaces in or close to water. They first appeared in the Eastern United States in 1988 and have since spread to Western waters. They can clog pipes, screens, fire control systems, and cooling water systems, which can reduce the capacity and efficiency of power plants and water pumping and treatment facilities. These invasive mussels are a growing concern for owners and operators of water infrastructure because getting rid of and protecting against them can entail significant costs.

Zebra and Quagga Mussels

Reclamation is the second largest producer of hydropower in the United States. It operates 58 hydroelectric power plants that annually produce about 40 billion kilowatt-hours of electrical energy with revenues of over $1 billion. It delivers 10 trillion gallons of water to more than 31 million people each year, and manages, with partners, recreation sites that have an estimated 50 million visits annually. Consequently, it has a large stake in addressing, in an environmentally sound manner, the zebra and quagga mussel problem efficiently and effectively.

One solution being investigated by Reclamation is the use of Pseudomonas fluorescens (Pf), a common bacterium found in soil and water. Dead cells of a specific strain of Pf have been found to disrupt the digestive tract of zebra and quagga mussels, killing the adult mussels within hours of ingestion. It therefore has the potential to purge established mussel colonies as well as prevent new colonies from being established. Pf is highly selective; at applied rates it does not harm native bivalves, fish, or other aquatic organisms. Unlike mechanical treatments, Pf treatments should not require facilities to shut down ongoing operations and can be applied to pipes with small diameters. Moreover, Pf has been found to work faster and with less environmentally hazardous effects or byproducts than traditional biocide treatments.

Reclamation is working with Marrone Bio Innovations, Inc. (MBI) under a Cooperative Research and Development Agreement (CRADA) to tailor Pf as an environmentally safe treatment to protect water facilities water facilities located in the west. Field trials and testing have been conducted at Davis Dam, Nevada. A solution to the zebra and quagga mussel problem will benefit Reclamation as well as other owners/operators of water facilities in the West and elsewhere. It also will benefit owners of boats, docks, and other structures that in or near water. This product may be commercially available as early as 2012.

Office of Surface Mining Reclamation and Enforcement

The Office of Surface Mining Reclamation and Enforcement (OSM) is responsible for balancing continued domestic coal production with the protection of society and the environment. The bureau collaborates with states and tribes to ensure that coal mining operations are carried out in a safe and reliable manner, and that the lands on which these operations take place are restored to their beneficial uses once mining is completed. In addition, OSM reclaims abandoned mine lands and oversees and assists state programs in restoring lands and water degraded by mining operations that occurred prior to the bureau's establishment. OSM frequently uses scientific information to achieve these objectives and thus actively works with academic institutions, as well as state and federal agencies, to promote scientific research related to reclamation of mining lands and overall environmental protection.

OSM funds numerous applied research projects under its National Technology Transfer Team Applied Science Program. The goal of this research is to develop and improve technologies used to address environmental impacts of current and past coal mining, including the reclamation of land after mining occurs. Examples of current research efforts and partnerships include working with:

- Researchers at Pennsylvania State University and the University of Oklahoma to improve passive treatment technologies for mine drainage.

- Virginia Tech's Water Resources Research Center to monitor and assess the response of aquatic life to total dissolved solids (TDS) in order to better understand TDS levels in Central Appalachian headwater streams where coal mining occurs.

- U.S. Department of Agriculture to improve the design of reclamation plans through researching effective strategies to control annual brome grasses on mine lands. This information will assist OSM in designing effective reclamation plans.

- Clark Atlanta University to investigate the effects of high conductivity mining effluents on benthic organisms in Alabama coal mining streams.

Bureau of Land Management

The Bureau of Land Management (BLM) is a multiple-use land management agency within Interior, responsible for administering approximately 248 million surface acres. Activities on these lands include recreation, energy development, mining, logging, livestock grazing, and management of wild horses and burros. To balance these varied uses, BLM's decisions draw upon scientific data and information sources.

For instance, as a result of the 1971 Wild Free-Roaming Horses and Burros Act, the bureau is responsible for managing the majority of wild horses and burros on public lands. This has resulted in a large portfolio of research and databases used to inform management decisions within the bureau's Wild Horse and Burro Program and balance conflicting opinions regarding how these animals should be managed. In an effort to protect rangelands from deterioration due to overpopulation and ensure that horses and burros are kept at populations consistent with the land's capacity, the BLM must maintain herds at Appropriate Management Levels. These levels are established through monitoring and evaluation of extensive rangeland data on factors such as vegetation, soils, water, wildlife, and wildfire. To meet these management levels, the BLM conducts ongoing research related to the effectiveness and practicality of contraceptive agents, sex-ratio management, and other management techniques used to maintain minimally reproducing, self-sustaining herds. The bureau also collects data to determine the genetic diversity of herds in order to determine whether management actions need to be taken to address genetic concerns. To further facilitate successful management of wild horses on public lands, the BLM maintains the Wild Horse Identification and Management System. This visual database is used by federal wild horse managers, federal adoption program managers, individual horse owners, academic researchers, and federal and state land managers to identify wild horses and track information on them.

Wild Horses – In early 2011, an estimated 38,500 wild horses and burros roamed BLM-managed rangelands.

Reliable, science based population estimates are critical to virtually all aspects of wild horse and burro management decisions. In an effort to improve herd counts, which are conducted every four years, the BLM has partnered with the USGS and Colorado State University to test various aerial survey techniques and improve their wild horse and burro census. Accurate and defensible population estimates provide considerable benefits to both federal wild horse managers as well as external interest groups. These include improved management of wild horses and burros on public lands, determination of the number of animals that can remain on public lands, as well as a more accurate allocation of grazing units provided to ranchers. To ensure that best science is used in all aspects of its wild horse and burro management, in early 2011 the bureau requested an independent review of its scientific studies and overall Wild Horse and Burro Management Program by the National Academy of Sciences/National Research Council. The results will be used by the BLM to determine the best way to use scientific research within this program and identify areas where more research is needed. These findings will also be made available to the public.

In addition to using its own scientific research to improve management, the BLM also incorporates information obtained from the public into resource management decisions. For example, by conducting visitor use surveys and research through its National Recreation Office, the bureau gathers information from the public regarding their experiences and satisfaction with BLM recreation sites, including opinions on amenities, services, and staff. Surveys also allow visitors the opportunity to provide input as to how BLM lands can be enhanced and better managed. This information is used by the bureau to improve management of the lands it administers, providing a direct benefit to visitors of BLM recreation sites.

Box 6-3. A BLM Socio-economic Survey

The Upper Las Vegas Wash Conservation Transfer Area (Wash) is a highly sensitive area located in the northern Las Vegas Valley. The Bureau of Land Management was tasked with researching how alternative scenarios of development would impact sensitive resources (e.g., wildlife, plants, cultural resources, soils) around the Wash. BLM contracted with Utah State University to design and implement a survey to better understand residents' attitudes toward the Wash and protection of its resources.

The survey was designed to help understand how social and economic conditions in nearby neighborhoods are linked to the landscape and environment that surrounds the Wash. Survey questions centered on what people thought of the Wash and how they made use of the area. Survey results indicated that both visual accessibility and spatial proximity were related to use of the Wash area for outdoor activities, familiarity, and attachment to the Wash environment. However, visual accessibility and spatial proximity were not important predictors in the likelihood that residents would engage in 'sanctioning' behavior if they observed environmentally damaging activities in the Wash.

The results suggested that educational programs about the ecological sensitivity of the Wash, combined with management actions that provide residents with opportunities to experience the area in positive ways that foster environmental attachment, may increase protective orientations toward the Wash.

Source: Utah State University. June 2011. Upper Las Vegas Wash Conservation Transfer Area: A System to Develop Alternative Scenarios, Final Report.

National Park Service

The National Park Service (NPS) plays a critical stewardship role, charged with preserving the natural resources on the lands it manages to provide for the enjoyment and education of current and future generations. Much of the scientific information collected by NPS is done within its Inventory and Monitoring (I&M) Program, established in 1992. This program conducts natural resource inventories and monitors the status and trends of various park resources. The National Park Service's I&M Program collects a wide range of natural resource data from the nation's parks. The primary goals of the I&M Program are to:

NPS Inventory and Monitoring Program Staff

- Inventory the natural resources under NPS stewardship to determine their nature and status;
- Monitor park ecosystems to better understand their dynamic nature and condition and to provide reference points for comparisons with other, altered environments;
- Establish natural resource inventory and monitoring as a standard practice throughout the National Park system that transcends traditional program, activity, and funding boundaries;
- Integrate natural resource inventory and monitoring information into NPS planning, management, and decision making; and to
- Share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives.

12 "Baseline" Natural Resource Inventories:

- ✓ Natural Resource Bibliography
- ✓ Base Cartography Data
- ✓ Air Quality Data
- ✓ Air Quality Related Values
- ✓ Climate Inventory
- ✓ Geologic Resources Inventory
- ✓ Soil Resources Inventory
- ✓ Water Body Location and Classification
- ✓ Baseline Water Quality Data
- ✓ Vegetation Inventory
- ✓ Species Lists
- ✓ Species Occurrence and Distribution

Through this program, a set of 12 baseline natural resource inventories are conducted throughout the National Park system to document the location and condition of park resources. This establishes comprehensive baseline data used to inform park management and decision making, design long-term monitoring plans for key resources, and facilitate comparison of current park conditions with natural or desired conditions within the National Park system. Information obtained through the bureau's long-term ecological monitoring program is also used for research, education, and promoting the public understanding of park resources.

Organization of the large quantities of resulting data is accomplished through data management plans for each of 32 I&M networks. The individual data sets are then transformed into useful and readily available information through analysis, synthesis, and modeling. I&M network staff deliver the information to managers, planners, policy makers, scientists, and other key audiences.

NPS I&M networks

The NPS also uses data and information obtained through surveys of the public to inform park management and planning. Many of these surveys, conducted through the Visitor Services Project, employ questionnaires to gather data on visitor characteristics and opinions regarding a particular NPS unit. This information is used by park managers and planners to improve visitor services and overall park management. In addition, the National Park Service in partnership with the University of Wyoming recently completed its second comprehensive survey of the American public. The questionnaire obtained information from over 4,000 households on public attitudes and behaviors regarding various aspects of National Park Service programs and services, as well as demographic characteristics of visitors and non-visitors to national parks.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (FWS) is charged with conserving the nation's fish, wildlife, plants and their habitat. FWS plays a large role in generating and collecting scientific data and information used to meet this objective. For example, the FWS's Migratory Bird Data Center (a partnership with the USGS) houses extensive data sets and information on various bird populations and habitats in an effort to support conservation activities. Data sets collected through bird inventories, surveys, and monitoring programs are used to assess the status and trends of North American bird populations and facilitate planning and evaluation of bird conservation strategies and overall natural resource management. Long-standing surveys such as the Waterfowl Breeding Population and Habitat Survey date back to the 1950s and represent a successful partnership in data collection efforts between the FWS and the Canadian Wildlife Service. This survey provides population and trend information for various North American duck species and provides critical information used in the establishment of hunting regulations, as well as in waterfowl conservation. Hunter activity and harvest data are also available at this data center.

The FWS also houses a variety of geospatial data sets. For example, The National Wetlands Inventory, established in 1974, is a series of topical maps depicting wetland and deepwater habitat throughout much of the United States. These maps provide information to decision makers and the general public regarding the status, characteristics, and functions of wetlands and other key aquatic habitats. This information is used in resource management decisions at all levels of government, for purposes such as habitat management, acquisition of important wetland areas, fisheries restoration, floodplain planning, and endangered species recovery plans. Additional key uses beneficial to the general public include watershed and drinking water supply planning, municipal building and transportation corridor siting, oil spill contingency planning, and land appraisals. This information is also used by private organizations, as well as academic institutions in research and education. Analyzing trends in the status of the nation's wetlands is critical in ensuring that the ecological, social, and economic benefits provided by these valuable ecosystems are maintained.

Duck hunters will find plenty to cheer about in the annual breeding population and habitat survey. Conducted each May by the U.S. Fish and Wildlife Service and the Canadian Wildlife Service, this year's survey reveals the second-highest pond count and a record 45.6 million ducks, the most since the survey was started in 1955 (Chris Hustad, Editor, DuckHuntingChat.com, July 1st, 2011)

As the Interior bureau responsible for administering the Endangered Species Act, the FWS is also responsible for designating critical habitat necessary for the conservation of a threatened or endangered species. Metadata, spatial data, and an interactive map providing boundaries of areas across the United States where final critical habitats exist are provided through the bureau's Critical Habitat Portal webpage. This information is used to inform the public of the importance of these areas to

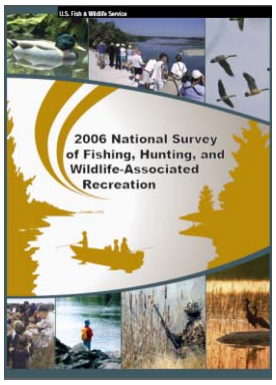
The Critical Habitat Mapper.

the conservation of a species, as well as for planning and land management.

Similar to the NPS, the FWS has an extensive program of inventorying and monitoring of the nation's natural resources. In a partnership with the USGS, the FWS has identified 21 geographic landscapes, each comprising an area within which a Landscape Conservation Cooperative (LCC) operates. An LCC is a network of partnerships between federal, state, and local government, tribes, universities, nongovernmental organizations, landowners, and other stakeholders. Each network shares and uses scientific information to proactively address land use pressures and resource threats accelerated by climate change, such as habitat fragmentation, invasive species, and water scarcity. The value of this information is in its use to help inform resource management decisions.

In addition, the bureau collects a variety of information from the public used in both state and federal decision making. For example, the FWS and USGS recently conducted a visitor survey on a sample of 53 National Wildlife Refuges throughout the country. Refuge visitors were queried on various aspects of their visit, providing the FWS with information that can be used to improve refuge management and visitor services.

Box 6-4. FWS National Survey of Fishing, Hunting and Wildlife-Associated Recreation



The National Survey of Fishing, Hunting and Wildlife-Associated Recreation provides invaluable data about demographic trends in hunting, fishing and outdoor recreation, while also informing the public about the economic benefits provided by these activities. The survey is one of the Nation's most important wildlife-related recreational databases. It is the only source of comprehensive information on participation and expenditures that is comparable on a state-by-state basis, and is widely used by the outdoor recreation industry. The national survey provides state fish and game agencies with information and assistance that they would have had difficulty obtaining on their own and at a much lower cost.

Federal Decision Making: FWS's Adaptive Management and Regulation of Waterfowl Harvests used the National Survey to report the number of people who engaged in migratory bird hunting, how often they went hunting, and how much money they spent participating in this activity. This information was used in decision making with impacts extending to the national level. FWS's North American Waterfowl Management Plan used information from the national survey to report the number of waterfowl hunters and how much money they spent. The impacts are nationwide and the information was crucial in decision making, such as the creation of special seasons on more abundant species, the setting of harvest and species-specific limits.

State Decision Making (State Wildlife Action Plan): The Arizona Game and Fish Department used the survey to help guide and implement a statewide watchable wildlife project, which will be part of a Wildlife Viewing Action Plan. "This is a step to include users and stakeholders in evaluating the plan," says Watchable Wildlife Coordinator Joe Yarchin. "We're looking for input on any broad objectives or strategies we might have missed, including alternatives. We want feedback on whether this is hitting the mark or has some gaps that need to be addressed." The National Survey was the data source used to show that there is strong public interest in watching wildlife (over 1.3 million visitors and $838 million in spending annually, 2006). Without the National Survey the Arizona Game and Fish Department would not have been able to report how many people watch wildlife in their state and how much they spend on the activity. Several other states have similar uses for the National Survey data.

Sources: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/AHM/ahm2.html; http://www.fws.gov/birdhabitat/NAWMP/index.shtm; http://azgfd.net/artman/publish/NewsMedia/Game-and-Fish-seeks-input-on-Wildlife-Viewing-Action-Plan.shtml

FUTURE DIRECTIONS

Scientific information provides a critical input to improved decision making in both the private and public sectors. It also helps identify problems and fashion solutions, a process that can be speeded up through technology transfer. The examples presented in this chapter illustrate applications of some of the scientific research, information, and technology transfer activities undertaken by DOI.

Advances in economic analysis have led to the development of methods that that can be applied to address the challenges associated with monetizing the value of 'public goods' such as data and scientific information. Applying these methods is challenging, but additional empirical research can help quantify the value of information and technology transfer and can help to demonstrate a return on the public's investment.

A critical step in quantifying the value of scientific information is a deeper understanding of how the information is actually used. Various approaches to strengthen this understanding could be considered, including establishing the ability to track how online data are used, say, by including optional feedback forms where users could voluntarily describe their uses of the data. This type of information could be used to better understand why the information has value and to help estimate these values.

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