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Fort Collins Science Center
Fiscal Year 2010 Science Accomplishments

Open-File Report 2011–1114

U.S. Department of the Interior
U.S. Geological Survey

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Compiled by Juliette T. Wilson

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U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia 2011

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Suggested citation:
Wilson, J.T., compiler, 2011, Fort Collins Science Center fiscal year 2010 science accomplishments:
U.S. Geological Survey Open-File Report 2011–1114, 62 p.

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Field crew at the Sky Pond sampling site in the Loch Vale watershed, Rocky Mountain National Park, Colorado. Photo by Melannie Hartman, Colorado State University.

The 2010 Loch Vale (Rocky Mountain National Park) Team. Project lead Jill Baron is third from right in the second row. This USGS research project, conducted in partnership with Colorado State University since 1981, has provided ecological research opportunities for approximately 30 undergraduate and 25 graduate students over the years and continues to do so to the present. Photo by Eve-Lyn Hinckley, Colorado State University.

Fort Collins Science Center
Fiscal Year 2010 Science Accomplishments

Compiled by Juliette T. Wilson[1]

Science for Natural Resources Management

America's natural systems and landscapes are impacted by increasing land-use pressures and widespread resource threats amplified by a rapidly changing climate. These changes are occurring at an unprecedented pace and scale. As a result, public land and natural resource managers in the United States are confronted with increasingly complex decisions that have important ramifications for ecological systems and humans. The U.S. Geological Survey (USGS) of the Department of the Interior (DOI) and other DOI agencies have recently implemented several programs to coordinate research, development, and technical assistance to support these natural resource managers. For example, through the U.S. Fish and Wildlife Service, DOI has implemented *Landscape Conservation Cooperatives* (LCCs; http://www.fws.gov/science/SHC/lcc.html), wherein various partners work together to ensure the sustainability of America's natural resources by leveraging resources and strategically targeting scientific research.

The DOI also operates a *National Climate Change and Wildlife Science Center* (NCCWSC; http://nccwsc.usgs.gov/index.shtml) at USGS headquarters. The Center was established by Congress in 2008 to deliver scientific and technical information to help natural resource managers cope with a changing climate. Under [DOI] *Secretarial Order No. 3289* (http://130.11.48.178/nccwsc/main/files/2010/03/SecOrder3289.pdf), the USGS is expanding the scope and geographic reach of this climate-science effort by establishing eight regional Climate Science Centers (CSCs), one of which will be located at Colorado State University in Fort Collins. The CSCs will provide scientific information and tools that Federal resource managers and other interested parties can apply to anticipate, monitor, and adapt to climate changes and associated ecological responses at local to regional scales.

The scientists and technical professionals at the USGS Fort Collins Science Center (FORT) apply their diverse ecological, socioeconomic, and technological expertise to investigate complicated ecological problems. FORT continues to work closely with DOI agency scientists, the academic community, other USGS science centers, the NCCWSC, the North Central Climate Science Center, several of the Landscape Conservation Cooperatives, and many other partners. FORT incorporates the expertise of these partners by providing a full complement of "the right people" to provide critical information needed to help answer complex natural-resource management questions.

In Fiscal Year 2010 (FY10), FORT's scientific and technical professionals conducted ongoing and new research vital to the science needs and management goals of DOI, other Federal and State agencies, and non-governmental organizations. Several science projects expanded in FY10 and new

[1] Cherokee Services Group, under contract to the U.S. Geological Survey Fort Collins Science Center, 2150 Centre Avenue, Building C, Fort Collins, CO, 80526-8118.

research has been undertaken to meet these evolving needs and goals in the areas of biological information management and delivery (informatics), climate change, fisheries, invasive species, science support, security and technology, status and trends of biological resources (including human dimensions), terrestrial and freshwater ecosystems, and wildlife resources. These scientific efforts continue to support the USGS "Mission Areas" identified in the *USGS Science Strategy* (http://www.usgs.gov/science_strategy), as well as the science plans of several LCCs. Table 1 in Appendix I shows how FORT accomplishments in 2010 relate to specific USGS programs and science Mission Areas.

This report describes selected FORT science accomplishments and partners for FY10. The publications and other products generated in FY10 are listed, as well as staff accomplishments, activities, appointments, committee assignments, and invited presentations.

FORT scientists inventoried reptiles and small mammals on the uninhabited island of Pagan, Commonwealth of the Northern Mariana Islands. The Department of Defense has proposed to use this island for military training and exercises, and USGS personnel were part of a multi-agency effort to document the island's biodiversity so as to better understand the potential impacts of military activity. Photo by Robert Reed, USGS.

Pagan Island can only be accessed by boat or small aircraft; here, the research team unloads survey equipment from a plane. The runway was greatly shortened in the 1980s by lava flows (seen behind the plane) from the island's active volcano. See page 11 for details about this work. Photo by Robert Reed, USGS.

2010 Science Accomplishments

Highlights of FORT project accomplishments are described below under the specific USGS science program with which each task is most closely associated, although there is considerable overlap. The work of FORT's six branches (Aquatic Systems, new in 2010; Ecosystem Dynamics; Information Science; Invasive Species Science; Policy Analysis and Science Assistance; and Trust Species and Habitats) often involves major partnerships with other agencies and cooperation throughout the USGS disciplines (Biological Resources, Geography, Geology, Geospatial Information, Water). These are noted using the following symbols:

 = major collaborative venture

 = integrated science projects involving other USGS disciplines

= new science direction

Biological Informatics

Science activities in this category support implementation of technologies and tools to integrate, analyze, visualize, and apply biological information to natural resource issues and to provide research that supports the advancement of biological informatics capabilities. Work includes increasing the availability and usefulness of biological data and information and applying standards to enhance its discovery and retrieval.

Modeling with High Throughput Computing. The USGS Science Strategy and the FORT Strategic Plan identify computer modeling as a core requirement to meet the science needs of the Nation. Until now, modeling efforts at FORT have been limited by traditional personal computer (PC) resources. In response, the Geographic Information System (GIS) and Remote Sensing Team and the Computer Operations Team have successfully tested the applicability of Condor (University of Wisconsin, Madison) high throughput computing (HTC) software. Condor is a job-management software that allows processes to be distributed concurrently on a networked system of computers. One benefit is the utilization of existing computer resources that would normally be idle. A second benefit is that highly complex and lengthy jobs, some of which would not even be possible without HTC, are completed in a fraction of the time needed to execute the programs on a single PC. For example, a FORT science job that failed after running for months on a single PC was completed in several days using Condor. In FY10, 40 personal computers (and their cores) at FORT were added as part of the Condor "pool," allowing Condor to tap into the computing resources of these systems when they are not in use. In FY11, this pool will be expanded to more than 250 cores. Not only will modeling jobs finish more quickly, but many more iterations of a job can be run in a relatively short time period. This will allow scientists to process many more model iterations with the potential of gaining additional insight into the issue being studied. The Resource for Advanced Modeling at FORT is now using Condor to execute Maximum Entropy (MaxEnt) models. Condor has also been successfully tested with two-dimensional (2-D) river modeling programs, R statistical programs, and both raster and vector GIS processing.

GIS Data Library and Search Tool. GIS has become a major component of research projects at FORT, but availability of quality data is always an issue. In support of research at FORT, the GIS and Remote Sensing Team (Team) has assembled a valuable set of high-quality GIS data that have wide thematic applicability and spatial extent. These data are accessible to all FORT staff via a Geospatial Data Library (GDL) folder on a universally accessible network drive. The data are arranged in an intuitive hierarchal system and have metadata that are compliant with Federal Geographic Data Committee/Biological Data Profile standards. The Team also has developed a Geospatial Data Library Guide, a methodology for staff to recommend new data for the library, and a methodology for assessing the recommended data to determine if it is suitable for inclusion in the library. To facilitate use of GIS data, the Team developed a data search tool that is quick and easy to use and provides access to the GDL and image services. The user can locate data by searching the metadata using keywords, searching by geospatial location, or accessing the GDL folder and sub-folders directly. The user then can view complete metadata for each data theme and obtain information on how to access the data. There are also instructions for accessing and using external map services (for data viewing but not processing) and both FORT's and external image servers (for data viewing and processing). Using the GDL and geospatial data search tool, FORT scientists can enhance their research by quickly and easily accessing this large reservoir of quality geospatial data. High-quality data and metadata will be available without each scientist having to spend time searching for, downloading, evaluating, editing and (or) processing, and developing metadata. The GDL also reduces the likelihood that individual users will download and store multiple copies of the same data, resulting in more efficient use of FORT's network storage capacity.

Climate and Land-Use Change

Scientific research, monitoring, remote sensing, modeling, synthesis, and forecasting in this category address the effects of climate and land-use change on the Nation's resources. The resulting research and products provide a scientific foundation upon which policymakers, natural resource managers, and the public make informed decisions about the management of natural resources.

Climate Change and Riparian Cottonwood Forests in North Dakota. Changes in river flow resulting from climate change are a major threat to Federal lands across the United States. Monitoring and predicting flow changes and effects on vegetation is a central strategy of the USGS response. The riparian forest of the Little Missouri River in Theodore Roosevelt National Park is dominated by plains cottonwood trees, whose rings record past variation in river flow and climate. In FY10, scientists from FORT, the USGS Water Discipline, the University of Arizona, the University of Arkansas, and the National Park Service collected cores from 500 randomly selected trees on the flood plain of the Little Missouri River. Preliminary ring counts show that these trees are as much as 360 years old, the oldest known plains cottonwood trees in the world. The scientists will relate cottonwood growth and establishment to historic streamflow and climate along the Little Missouri River. They then will combine these relations with the full 360-year tree-ring record to reconstruct precipitation and streamflow since the Little Ice Age. Finally, they will apply these relations to downscaled climate projections to assess changes in cottonwood establishment and growth resulting from human-induced climate change.

Enterprise Information

This work involves creating elements of the USGS integrated information environment and providing support to bureau-level information activities.

Oil Budget Calculator for Flow Rate Technical Group. As scientists scrambled to assess the damage wrought by the 2010 BP Gulf of Mexico oil spill, the USGS was tasked with helping to determine how much oil actually remained in the Gulf as a result of the spill. FORT's Web Applications Team (Team) worked with USGS management to develop a Web-based data collection, modeling, and visualization tool that partner Federal agencies could work with in a secure environment. The Team designed a workflow that allowed the U.S. Coast Guard to input a number of on-the-ground measurements, the National Oceanic and Atmospheric Administration (NOAA) to input data processing variables and model parameters, and the Flow Rate Technical Group (a multi-agency group) to see the inputs and model results in real time. The Team worked with National Institute of Standards and Technology statisticians to run Coast Guard and NOAA inputs through an embedded Monte Carlo simulation and produce charts, graphs, and tables expressing the likelihood of oil distribution scenarios (the amount dispersed, evaporated, biodegraded, skimmed, collected, and available for collection). The work allowed the Flow Rate Technical Group to constantly monitor scenarios and assess remediation efforts.

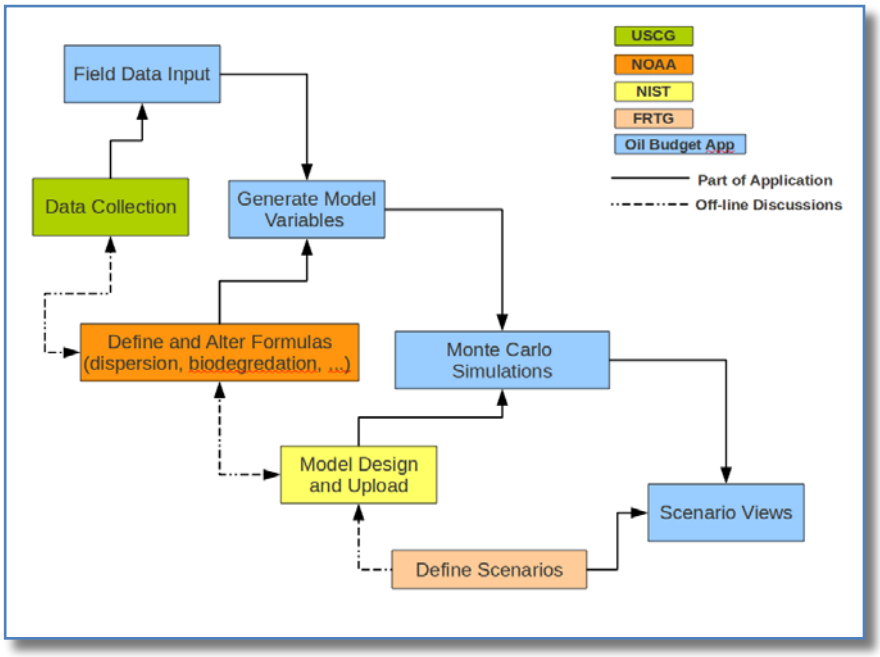
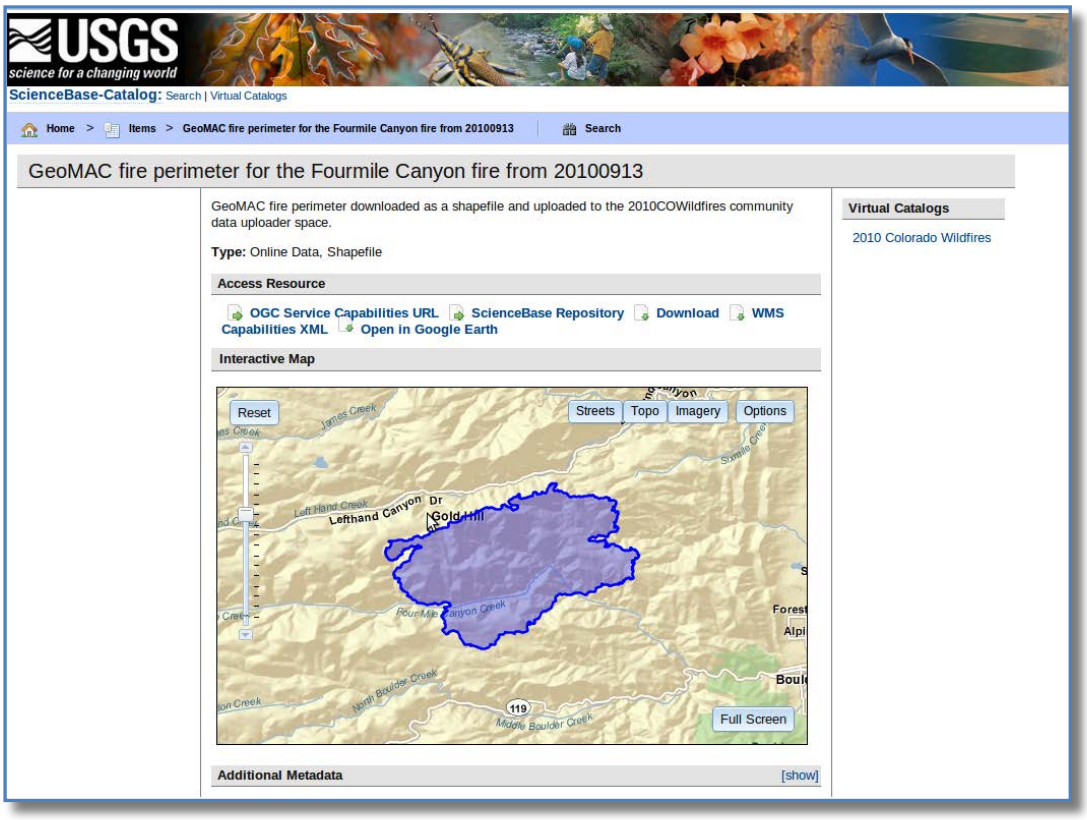


Chart showing the workflow for the Oil Budget application. This application allows the U.S. Coast Guard (USCG; green) to input field-collected data, the National Oceanographic and Atmospheric Agency (NOAA; orange) to adjust formulas that process the field data, the National Institute of Standards (NIST; yellow) to initiate and alter statistical models that use the NOAA formulas and Coast Guard field data, and the Flow Rate Technical Group (FRTG; light orange) to view the model outputs and field data as statistical summaries, charts, graphs, and tables (blue). USGS image.

USGS Centralized AntiMalware and Host-Based Intrusion Prevention. FORT's Computer Operations Team Lead continued to serve on the USGS Information Technology (IT) Security Operations Team (ITSOT), providing technical assistance and developing anti-malware and host-based intrusion prevention (HIPS) solutions and processes for the USGS. Work in FY10 focused on implementing a USGS Centralized Endpoint Protection Solution that allows the USGS to centralize reporting and policy control of all USGS systems in relation to malware and HIPS. In 2009, FORT staff piloted and locally deployed the solution, which was then configured and rolled out to the entire USGS in 2010. As of October 2010, the solution manages all USGS systems. In addition to implementing this

system, FORT staff assisted the USGS and DOI in detecting, analyzing, and resolving malware issues (viruses, trojans, and the like), including variants undetectable by many antivirus products, and is working to help DOI standardize and centralize anti-malware and HIPS management across the entire Department.

ScienceBase Data Repository and Catalog. The USGS Community for Data Integration (CDI) worked throughout FY10 to make data products more accessible to USGS scientists, partner agencies, and the public by sponsoring the Data Integration Development Project to support this enhanced access. As part of this effort, CDI tasked the FORT Web Applications Team with developing the ScienceBase Data Repository and Catalog, which provides a repository and archive for USGS data products, a distribution portal for these products, and a way for users to find USGS datasets. Providing much more than just a downloadable dataset, ScienceBase allows scientists to upload or register their datasets, then work through a metadata wizard to document and define who can access these data. Once documented and secured, the system automatically generates Web services, maps, charts, graphs, and a number of other data visualizations. The system supports a variety of data formats, from GIS datasets to model packages (code, workflow, and outputs). The system also provides support for the USGS Fundamental Science Practices review procedure, encapsulated in a relatively simple Web user interface.



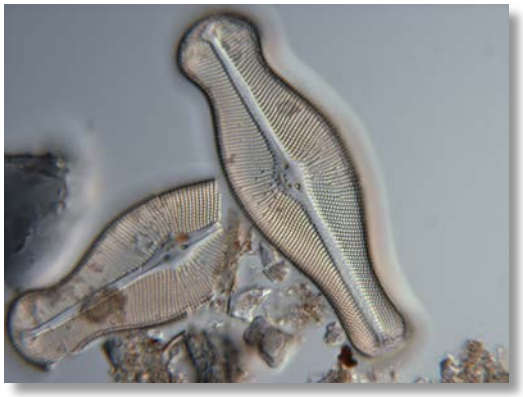
ScienceBase screenshot showing GeoMAC fire perimeter. USGS image.

Fisheries: Aquatic and Endangered Resources

Activities related to fish and aquatic resources involve research and technical assistance that promote understanding of relations among aquatic species and habitats to conserve or restore community structure and function—especially for at-risk species. Products include research and technology tools that support problem solving, decisionmaking, and development and evaluation of adaptive management strategies for restoration and maintenance of aquatic resources.

Launch of the *Diatoms of the United States* Web Site. The U.S. Environmental Protection Agency (USEPA) advises State agencies to use multiple assemblages (periphyton, macroinvertebrates, and fish) in the biological assessment of streams and wadeable rivers. However, taxonomy across different laboratories is not consistent in Federal and State programs. Although datasets may be internally consistent within an individual project, a process to reconcile State datasets with USEPA and other datasets is currently lacking. As a result, States have invested significant resources in their periphyton programs, only to find that their results are not comparable. Consequently, after-the-fact efforts to reconcile datasets are ineffective and costly. FORT served as lead organizer for bringing together Federal agencies, academic scientists, and ecologists to develop a solution. In collaboration with the USEPA, USGS National Water-Quality Assessment Program, and University of Colorado, FORT developed a Web resource that integrates taxonomic and ecological diatom data using existing data from United States surveys of streams and rivers. *Diatoms of the United States* (http://westerndiatoms.colorado.edu), launched in June 2010, provides taxonomic consistency and accuracy. This site serves as a valuable species identification tool for use by water managers, taxonomists, students, and the general public. USGS, USEPA, and State managers are working to incorporate this Web-based tool into task agreements.

Investigation of the Invasive Diatom *Didymosphenia geminata*. Extensive blooms of the diatom *Didymosphenia geminata*, or "didymo," have been occurring in streams and rivers of North America and other regions of the world. In order to respond to these "nuisance blooms" and resulting public and media pressure, water managers need to know if the blooms are natural events or are in response to recent environmental change and spread of invasive genotypes. In order to address the issue, a FORT scientist/diatom specialist investigated interdisciplinary aspects of the problem with collaborators in the National Park Service, U.S. Army Corps of Engineers, Kootenai Tribe, University of Texas, South Dakota School of Mines & Technology, and University of Colorado. In FY10, FORT addressed the population genetics of individual diatoms from across the United States, the historical abundance of species in lake-sediment cores, and the relationship between bloom formation and iron and phosphorus dynamics. FORT also responded to requests for identification and documentation of occurrences. FORT provided guidance for scientists and water managers across the United States, as well as for scientists and managers in Chile and Argentina. The South American invasion was identified in 2010 and reported in *Science* in 2011. The impact of the invasion has received national media attention.



Specimen of the diatom *Didymosphenia geminata* from Rio Espolon, Chile, collected early in 2010 from an extensive bloom on the river. The image has been processed to show the silica cell wall, removing the organic cell contents and the stalk material. Photo by Sarah Spaulding, USGS.

FORT scientist Terry Waddle (holding a GPS survey rod) trains volunteers how to collect bathymetry data on the Upper Delaware River, New York. Photo by Chris Holmquist-Johnson, USGS.

Sensitivity Analysis of Aquatic Habitat Modeling Techniques. Scientists at the FORT Aquatic Systems Branch have used a combination of 2-D hydraulic simulations and GIS applications to develop discharge-specific habitat maps of rivers since about 1997. This group has invested in transferring these techniques to the user community over the past decade, and the techniques are now widely applied by agencies and the private sector. However, relatively little effort has been expended in determining the accuracy of the models used to generate the habitat–discharge functions and habitat maps developed using this process. In 2010 FORT received USGS funding for a sensitivity study of its aquatic habitat modeling techniques. This ongoing study is designed to assess the sensitivity of hydraulic models related to (1) data accuracy and sampling methods using technologically advanced sampling gear, (2) density of data required for models, and (3) post-processing data manipulation. Ultimate users of these study results will be the entire aquatic assessment community that is heavily reliant on physical habitat simulation (PHABSIM) models developed in the 1980s. Among those users are member States of the Instream Flow Council, the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and consulting firms employed to meet the needs of resource-management agencies.

Aquatic Species Habitat Assessment Using Hydrodynamic Models in California and New York. Changes in river flow resulting from climate change and other human stressors may negatively impact habitat for aquatic species on public lands across the United States. Quantifying and predicting flow changes and effects on habitat and species is a central goal of the USGS response. In 2010, FORT scientists partnered with the USGS Northern Appalachian Research Laboratory, the National Park Service (NPS; Yosemite National Park and the Upper Delaware Scenic and Recreational River), and the University of California–San Diego to address flow-related changes to endangered mussels and other macroinvertebrate species. One project focused on the effects of extreme flow events on habitat for the endangered dwarf wedge mussel (DWM) in the Upper Delaware River Basin. FORT provided data from 2005 and conducted new field surveys in 2010 to develop 2-D hydrodynamic models that capture the effects of extreme flows on mussel habitat. Initial evaluation of the survey data reveals that river reaches that experienced substantial scour during a major flood in 2006 no longer support DWM populations.

FORT researchers Leanne Hanson, Ken Bovee (retired) and Terry Waddle finish collecting bathymetry data on the Upper Delaware River in New York. USGS photo.

Similar research in Yosemite National Park focused on how infrastructure development and water use to support park visitation affects stream habitats and macroinvertebrate communities. The results will be used by the U.S. Fish and Wildlife Service in endangered species consultations and by the NPS for preparation of Environmental Impact Statements.

Invasive Species

Research on invasive species involves (1) collection, synthesis, and provision of invasive species information; (2) early detection and rapid assessment of new invaders or incipient populations; (3) monitoring and forecasting changes in populations and distributions of established invaders; (4) developing and testing prevention, control, and management strategies; and (5) determining invasive species impacts and habitat susceptibility to invasion.

Control and Prevention of Brown Treesnake Invasions. The brown treesnake (*Boiga irregularis*) is a highly destructive species that has extirpated many native birds on Guam, as well as bats and lizards. Visual searching is one technique currently used to detect and control these snakes, especially incipient populations. The cost of an eradication program depends upon the least capturable individual. Heterogeneity (analysis of capture variability) in visual detection probabilities sets the cost for control efforts, particularly control programs directed at eradicating an incipient or nearly extirpated population. Visual searches and trapping efforts inside the closed population of brown treesnakes on Guam continue to provide data for many projects. In FY10, FORT researchers began analyzing trial results to determine absolute and relative effectiveness of bait tubes on all sizes of snakes inside the closed population, including one trial in a prey-dense environment, as might be encountered in an accidental introduction. Analyses of visual detection probabilities inside and outside the closed population continued, and investigators also tested the short-term effects of food suppression on trap success. Results published in 2009 of food preferences in juvenile brown treesnakes led to further research in scent attractants, which is ongoing. At the end of FY10, FORT scientists were nearing publication of trial data analyses determining effectiveness of detector dogs in finding the snakes in a low-canopy forest. Island-wide searches for brown treesnakes were initiated to determine spatial variability, size distributions, and characteristics of this species to better inform landscape-level management plans and future suppression strategies. FORT biologists continue to assist the USFWS and U.S. Department of Defense (DOD) in barrier construction plans around the Habitat Management Unit, a 66–hectare area on Guam. Cooperators include the DOI Office of Insular Affairs, USFWS, DOD, Guam Division of Aquatic and Wildlife Resources, U.S. Department of Agriculture (USDA) Wildlife Services, Hawaii's Department of Agriculture and Department of Forestry and Wildlife, and Commonwealth of the Northern Mariana Islands Department of Fish and Wildlife.

Control of Invasive Giant Constrictor Snakes in Florida. Invasive giant constrictor snakes have become established in the greater Everglades ecosystem and are expanding their range in southern Florida. These giant snakes (up to 20 feet and 250 pounds) are efficient predators of warm-blooded species ranging from wrens to deer and

USGS researchers Scott Goetz (far left) and Bob Reed (second from left) and others hold a captured northern African python, one of five caught on the hunt. USGS photo.

represent a novel threat to which native species are poorly adapted. In FY10, development of capture tools continued for Burmese pythons (*Python molurus*) in areas with high python densities outside Everglades National Park. The results will be applied to detecting and capturing pythons as they invade Key Largo, in support of conservation efforts for federally endangered mammals. In FY10, FORT scientists completed publication of a risk assessment of nine species of giant constrictors as potential invaders for use in formulating policy to prevent further invasions. They also assisted in identifying and delineating population control efforts and helped provide resources for genetic identification of samples (such as shed skins) to determine the extent of a newly discovered population of northern African pythons (*Python sebae*). In FY10, the research team completed a trapping trial, adding a new trap type and new monitoring tool for determining success via python capture rates. Cooperating agencies include the USFWS Endangered Species Program and National Wildlife Refuge System, National Park Service, South Florida Water Management District, Florida Department of Environmental Protection, University of Florida, and Florida Wildlife Commission.

Control of Invasive Watersnakes in California. Invasive eastern watersnakes (*Nerodia* species) have become established in at least four locations in California. Without intervention, these snakes will likely expand their range and colonize other regions in the western United States, as they are dietary generalists and prefer temperate climates. These invasive watersnakes may compete for available prey with native species listed under the Endangered Species Act (ESA), transfer parasites to native herpetological populations, and consume ESA-listed amphibians and fishes. In 2009, FORT scientists with expertise in controlling invasive reptiles were asked by cooperating agencies to initiate a new science direction focused on developing techniques to detect, capture, and control populations of invasive watersnakes in California and elsewhere. In FY10, FORT investigators continued development of capture tools in areas with high invasive watersnake densities in and around Lake Machado, a public lake in Harbor City in northwestern Los Angeles. They also conducted significant trapping efforts (over 5,000 trap nights) and removed several hundred snakes. FORT is collaborating with scientists at the University of California–Davis to determine diet and reproductive characteristics of these invasive snakes. Results will be applied to detecting and capturing watersnakes, in support of conservation efforts of State and federally listed taxa. Results will also inform management of additional populations of introduced watersnakes in California (at least three other populations, each representing a different species, are established in the State). Cooperators include the USFWS Invasive Species and Ecological Services programs, California Fish and Game Department, University of Toronto, Los Angeles County Parks and Recreation Department, ECORP Consulting, and Environmental Planning Group.

Preparing for the water snake hunt. Photo by Robert Reed, USGS.

The quarry, an invasive (to California) eastern watersnake. Photo by Robert Reed, USGS.

Biological Invasion of Riparian Ecosystems: Saltcedar and Russian Olive State-of-the-Science. The Salt Cedar and Russian Olive Control Demonstration Act of 2006 (Public Law 109–320) directs the DOI to submit a report to Congress that includes an assessment of several issues surrounding these two non-native trees, now dominant components of the vegetation along many rivers in the western United States. This report, "Saltcedar and Russian Olive Control Demonstration Act Science Assessment," was developed during FY09 and published in 2010 as *USGS Scientific Investigations Report 2009–5247* (http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22895). The report was produced through a collaborative effort led by the USGS and U.S. Bureau of Reclamation with contributions from USDA, university researchers, and others. FORT scientists contributed in a lead editorial role and co-authored five of eight chapters. In FY10, in conjunction with the official publication and release of the report, FORT provided several briefings for Congressional subcommittees and DOI officials in person and in numerous teleconferences. In addition, briefings were provided to representatives from the Colorado River Basin States and the Western Governors Association. Finally, information on this report was shared with a larger audience through the publication of an associated USGS Fact Sheet (*FS2009-3110*; http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22851) and through several interviews with print, online, and radio media.

Reptile and Non-Volant Small Mammal Surveys of Pagan Island. Brown treesnakes (*Boiga irregularis*) have been largely responsible for the loss of many native birds and lizards on the island of Guam. These snakes can survive transportation from Guam in air and sea cargo, placing the entire Pacific region at risk of invasion by this means. With the upcoming military build-up in Micronesia and a proposal by the U.S. Marine Corps to use the island of Pagan as a training base, the risk of snake invasion on Pagan is likely to increase. In order to determine a baseline of current herpetological species on Pagan to prepare for potential brown treesnake interdiction efforts, a FORT research team conducted surveys on the island in 2010. These included reptile visual surveys, trapping, mark-recapture, and absolute counts to determine the distribution and density of these potential prey. Surveys of small terrestrial mammals also were conducted to determine baseline abundance of potential prey. In the process, the research team located previously unknown local populations of reptile species on Pagan and collected rat DNA in light of evidence of a new species found on nearby islands. Results of these surveys illustrate management challenges on Pagan and reveal potential environmental impacts associated with the military buildup in Micronesia. The team worked in coordination with the USFWS, U.S. Navy, and the Commonwealth of Northern Mariana Islands Department of Lands and Natural Resources.

USGS scientists and volunteers complete a vegetation removal plot as part of reptile and rodent surveys on the island of Pagan. Photo by Robert Reed, USGS.

Delivering Invasive Species Research Results to DOI and Other Land Managers. Early detection and rapid assessment of invasive species is critical to containing harmful invaders. Even a cursory survey of national parks, wildlife refuges, and other natural areas in the United States clearly shows that they are under siege by many harmful species of plants, animals, and diseases. Land management agencies are mandated to inventory and monitor the components and processes in natural areas to protect native species and ecosystems. FORT scientists are helping to address these management needs through an integrated system involving (1) coordination of invasive species databases, (2) advanced habitat modeling research, and (3) decision support tools developed in close collaboration with focused user groups. The primary effort for invasive species database information is the Global Invasive Species Information Network (GISIN). Sponsored by the National Biological Information Infrastructure (NBII), GISIN represents an international effort to share invasive species information at a global level. Research on advanced habitat modeling is done through our partnership with Colorado State University. This work led to a dozen peer-reviewed papers in 2010, including papers on risk assessment of invasive species at national scales, the benefits of ensemble mapping of invasive species, and incorporating time-series data in forecasting models. This research was complemented by a FORT Seminar Series presentation on "Large Scale Habitat Modeling." Finally, the data systems and habitat modeling research were delivered to DOI and other land managers through FORT's "Resource for Advanced Modeling" (RAM), a facility where scientists worked with a variety of groups and a mix of priority species, making several advances in modeling while sharing this valuable resource with partners. Key examples include (1) working with NASA to demonstrate the northern advance of Africanized Honey Bees in the United States, (2) involving citizen-scientist groups (for example, for weed mapping in Wisconsin and Colorado) to make better use of citizen-scientist data, (3) improving decision-support approaches (for example, for invasive buffelgrass tracking in Arizona), and (4) working with land managers from Alaska on high-priority invasive plant species.

Status and Trends of Biological Resources

Status and trends research identifies ongoing or impending changes to species, habitats, and ecosystems. Key goals include developing and evaluating inventory and monitoring protocols, analytic tools, and other technologies to measure biological status and trends; collecting, archiving, and sharing critical, high-quality monitoring data in cooperation with partners; and providing analyses and reports that synthesize this information for the scientific community, resource managers, policy makers, and the public.

NEW **Population Assessment of the Mariana Fruit Bat.** The Mariana fruit bat (*Pteropus mariannus mariannus*) occurs on the 15-island archipelago of the Commonwealth of the Northern Mariana Islands (CNMI) and Guam. Because of direct impacts from over-harvesting for human consumption and introduction of the brown treesnake on Guam—as well as indirect impacts and habitat loss from agriculture, typhoons, and feral ungulates—populations of the Mariana fruit bat have declined, leading to its current listing as "threatened" under the Endangered Species Act. At present, most known populations of the Mariana fruit bat inhabit the

Mariana fruit bats on the island of Asuncion, CNMI. Photo by Paul Lisua, courtesy Ernest Valdez, USGS. Used with permission.

northern islands. Given the remote locations of these northern islands, many have not been surveyed as frequently as the southern islands, or surveys have been limited to only a single or a few islands at a time. The DOD has proposed expanding military operations and training to the northern islands, but before this can occur, by law an evaluation of the environmental impacts must be made. As part of a multiple-taxa assessment of the northern Mariana Islands, funded by the DOD and subcontracted through USFWS, FORT conducted an assessment of the Mariana fruit bat by conducting location counts on eight of the northern islands. An administrative report was delivered to USFWS providing information on population status and locations of roosts, as well as natural history information about sensitivity to disturbance, differences among islands in evening activity time, reproduction and feeding behavior, and competition for limited food resources. Cooperating agencies include the USFWS, CNMI Department of Land and Natural Resources' Division of Fish and Wildlife, and the CNMI Northern Island Mayor's Office.

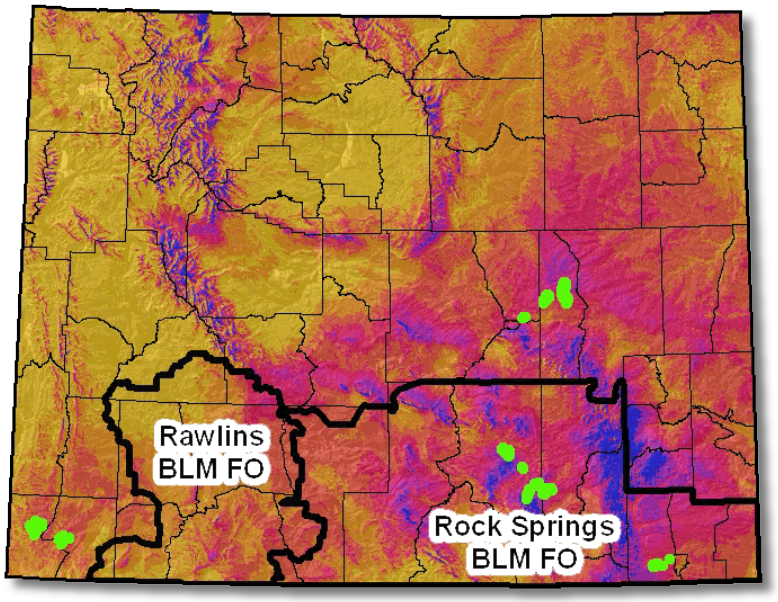
Study of the Users, Uses, and Value of Landsat Imagery. The currently operating Landsat satellites provide high-quality, multi-spectral, moderate-resolution imagery of urban, rural, and remote lands for all areas of the world. The imagery has been applied in a variety of areas, such as global climate research, agriculture, and environmental management. However, there is little understanding of how private businesses, nonprofit organizations, tribes, and State and local governments actually use and value the availability of federally sponsored, moderate-resolution land imaging. In FY10, FORT social scientists reported the results of an extensive FY09 survey of the users, uses, and value of Landsat imagery. Presentations of the results were given at USGS headquarters to the Associate Director of Geography and the Program Coordinator of the Land Remote Sensing Program. Results also were presented at the USGS Earth Resources and Observation Science Center (EROS) and two meetings of the Landsat Science Team, a group of remote-sensing experts that makes recommendations about the Landsat program, including future Landsat satellites. The results are being used by the USGS Land Remote Sensing Program to inform delivery of the products and services related to Landsat imagery and to understand how and why the imagery is important to users in decisionmaking.

Implications of Climate Change on Wetland-Dependent and Grassland Birds. Rapid rates of climate change in concert with land-use conversion pose unprecedented challenges to wetland and avian conservation across the North American prairies. Understanding the relations between climate, ecosystem processes, land and water management, and bird communities is critical for land managers tasked with the conservation of wetland-dependent birds and wildlife. FORT initiated two studies in cooperation with newly formed Landscape Conservation Cooperatives (LCCs; Plains and Prairie Pothole LCC and Great Plains LCC) that address the implications of climate change on wetland-dependent birds and grassland birds. In FY10, investigators began the process of downscaling climate data using dynamic approaches, conducted field work, and began to develop a series of models that will forecast the effects of climate change on (1) water quantity, water quality, and biological outcomes on selected National Wildlife Refuges in the prairie pothole region; (2) the phenology and growth of native and invasive wetland plants; (3) the distribution of breeding

Migrating stilt sandpipers at a wetland in North Dakota. Photo by Beth Dillon, USGS.

and wetland-dependent migrant birds; (4) migrant bird responses to changes in composition and phenology of resources and wetland habitats; and (5) breeding grassland bird productivity. When the projects are completed, the findings will be used to formulate strategies for coping with climate change in prairie environments. Cooperating agencies include the USFWS, Playa Lakes Joint Venture, and Prairie Pothole Joint Venture.

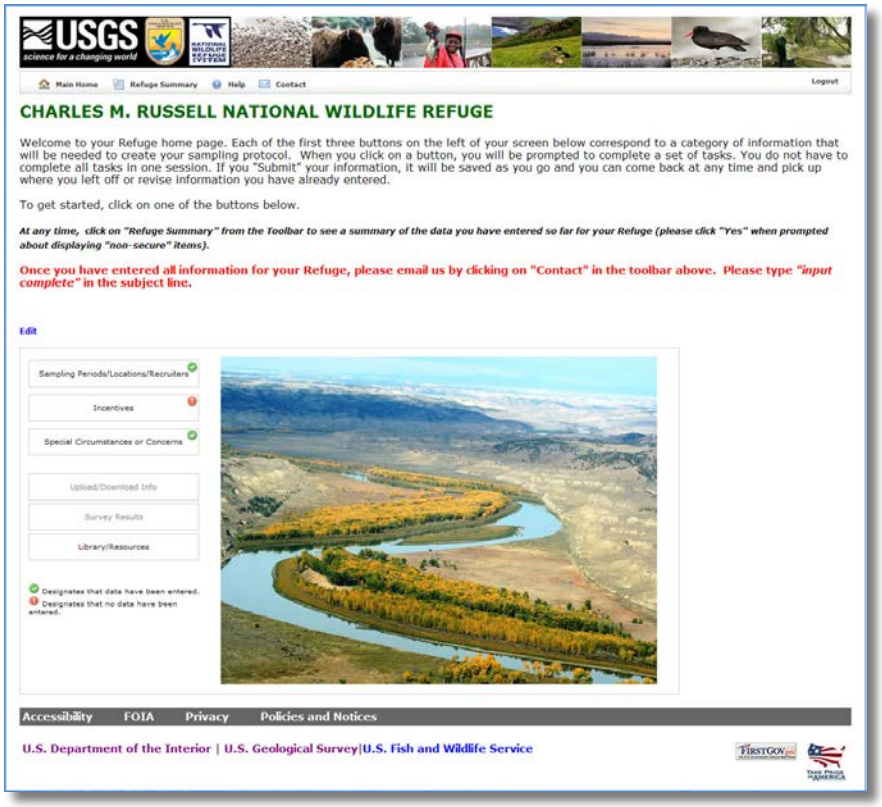
NEW **Spatial Mapping and Attribution of Wyoming Wind Turbines.** As the Nation strives to reduce its dependence on foreign oil, domestic energy production has increased dramatically, especially renewable energy sources such as wind. From 2007 to 2009, wind energy development increased 341 percent in Wyoming, and it continues on that trajectory today. To understand the effects of wind energy development on wildlife and habitats, which are largely undocumented, natural resource managers need to know the locations of wind energy development sites. However, the locations of these sites are currently tracked only by individual energy development companies and have not been available to the public. FORT has changed this by providing the first statewide GIS database of all the wind turbine sites in Wyoming. FORT GIS specialists developed the Wyoming wind turbine data set as part of a science project to develop spatially explicit seasonal distribution models for sage-grouse in Wyoming. The Bureau of Land Management (BLM), USFWS, Wyoming Game and Fish Department, and others are using the wind turbine data to evaluate the effects of wind energy sites in Wyoming on the seasonal use of habitat by greater sage-grouse. Additionally, these data will be incorporated into planning tools for the Wyoming Landscape Conservation Initiative and other wildlife- and habitat-related projects underway at FORT. Specifically, FORT investigators will use the data to quantify direct disturbances of the landscape related to wind energy as well as indirect effects on wildlife and vegetation. Scientists can use the wind turbine locations to discern whether wind energy development affects wildlife use and quantify the magnitude and relative impact of any such effects. In addition to the Wyoming data set, FORT is developing similar data sets for Colorado and New Mexico in association with a USGS regional project on energy and the environment in the Rocky Mountain area.



Map showing concentrated areas of wind turbines (green). USGS image.

Socioeconomic Considerations for National Wildlife Refuge Management and Planning. National Wildlife Refuge (NWR) managers and planners need clear and objective guidance on the use of socioeconomic information in their resource and visitor services management and planning. Refuge comprehensive conservation plans must contain an analysis of the particular refuge's social and economic conditions and also evaluate the social and economic effects of likely management scenarios. These factors are to be used in planning decisions and to help guide management actions. Refuges also need sound baseline data on visitors and visitation, including trip characteristics, visitor experience, and visitor expenditures, to more effectively manage refuge services and facilities and improve

communications with the public. Social scientists and economists at FORT have endeavored to meet those needs by conducting social and economic assessments for different refuges that support long-term planning and provide baseline visitor data. Research in FY10 involved regional economic impact analyses of current and proposed management activities for two refuges, Charles M. Russell NWR and Prime Hook NWR. Additionally, FORT conducted a National Wildlife Refuge Visitor Survey of 52 refuges across the country. Though the survey will be ongoing through FY11, the response rate in FY10 was 70 percent with over 1,000 completed surveys—half of which were completed online. This survey will provide valuable baseline information on visitor experience and perceptions related to services, activities, and facilities; visitor spending in the local community related to refuge visits; visitor understanding of the refuge mission; and visitor understanding of climate change in a refuge-specific context.

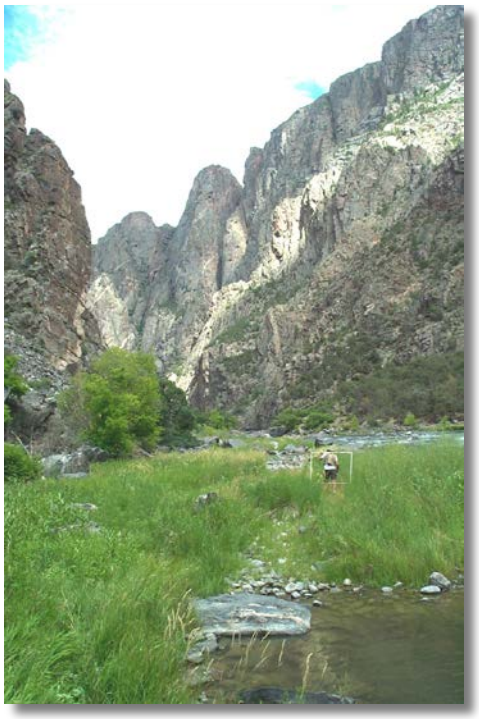


Example refuge home page in the Refuge Information Site for the National Visitor Survey application. USGS image.

Terrestrial, Freshwater, and Marine Ecosystems

Ecosystem investigations aim to quantify and understand factors that influence variation in key ecosystem components over time and space. Emphasis is on developing indices of ecosystem sensitivity to environmental change and vulnerability to potential stressors, and producing tools to predict ecosystem responses to change.

Streamflow in Black Canyon of the Gunnison. Modification of streamflow and its effects on valued resources in Black Canyon of the Gunnison National Park is a regionally and nationally important issue involving multiple Federal agencies and missions (Bureau of Reclamation and National Park Service), multiple interests (agricultural, hydropower, natural resource conservation), and Federal and State courts. This site has also served as a 20-year test case for riparian ecologists at FORT who are developing new methods for relating streamflow to riparian vegetation—producing several journal papers, a decision-support system, and data used in court cases that resulted in a final decree for a Federal Reserved Water Right after more than 30 years of litigation. During FY2010, a benchmark transition occurred as this long-term work reached a final phase of management decisions, with responsibility for continued measurement transferred to the NPS monitoring program and a final synthesis report issued by FORT scientists. In addition to assisting NPS in implementing a targeted monitoring program and applying a decision-support system to their Natural Resource Condition Assessment, FORT and NPS investigators will conduct a final repeat sampling of vegetation, producing a 20-year data set for validation of a predictive model formulated in 1990.



Moving to the next riparian vegetation sampling plot in Black Canyon of the Gunnison National Park in Colorado. Photo by Greg Auble, USGS.

Assessing the Consequences of Energy Development in Western Lands. Increased demand for energy is driving rapid development of oil and gas (including shale gas and coal bed methane), uranium, geothermal, wind, and solar sources of energy throughout the western United States. Much of the development is occurring on public lands, including those under Federal and State jurisdictions. In Colorado and New Mexico, these public lands compose about 40 percent of the land area. Both of these States benefit from revenues generated by energy development, but natural resource managers and other decisionmakers must balance the benefits with their potential effects on historic, scenic, recreational, and ecological resources. Although past studies have assessed some effects of energy development, the information has not yet been synthesized to make it useful to decisionmakers and resource managers. To address

Wind turbines at a site in eastern Colorado. Photo by Natasha Carr, USGS.

this need, FORT is leading an interdisciplinary team of USGS scientists to develop a multi-step analytical process, or framework, for estimating the outcomes and cumulative impacts of energy development in Colorado and New Mexico. This work entails (1) assessing agency information needs, (2) compiling information from USGS assessments of non-renewable energy resources as a basis for estimating potential development of energy resources, and (3) assimilating baseline data on current energy development—both renewable and non-renewable—for projecting characteristic "footprints" and life cycles for use of each energy type in similar areas with the potential for energy development. All the spatial information will be made available to end users in the form of an online, interactive energy atlas. In FY10, the research team assembled data layers and metadata for the energy atlas, digitized wind turbine locations and attributes, developed two draft USGS data series reports (one for each State), and held workshops to begin developing the framework and analytical tools. Combined, the framework, analytical tools, and energy atlas will be highly valuable to decisionmakers and resource managers in their endeavors to anticipate energy-development scenarios in Colorado and New Mexico, evaluate the associated consequences, and develop appropriate mitigation strategies.

Raven (A) Small Unmanned Aircraft System (sUAS) Capabilities Established. The DOI and other Federal and State agencies have long relied on fixed-wing aerial surveys to monitor wildlife populations. However, technological alternatives are needed in order to (1) reduce costs, (2) reduce the number of manned flights and provide options for future survey efforts, and (3) reduce agency carbon footprints via reduction in fuel use. One possible alternative is the use of unmanned aircraft such as the Raven (A). The 4.2-lb Raven (A) sUAS has a wingspan of 55 inches and carries either an electro-optical (natural color) or infrared video camera that can be used to study flora and fauna alike. In 2010, FORT selected a scientist to complete the coursework and training required to become a certified Raven (A) pilot. In collaboration with the USGS and the USFWS Division of Migratory Birds, the pilot received funding under the USGS Quick Response Program to explore using an sUAS to assess the abundance and distribution of sandhill cranes (*Grus canidensis*) in the Central Flyway. Subsequently, the first Certificate of Authorization (COA) to use the Raven (A) sUAS for scientific research was approved by the Federal Aviation Administration. Additional projects that focus on exploring Raven (A) system capabilities and applications are being developed in collaboration with the Wyoming Landscape Conservation Initiative and Colorado Division of Wildlife. Potential research applications of the Raven (A) sUAS technology include fire science, wildlife management, and aquatic studies, as well as habitat, vegetation, glacier, and volcano mapping and monitoring.

Leanne Hanson (USGS) preparing to hand-launch the Raven (A) small unmanned aircraft system during pilot training at Dugway Proving Grounds in Utah. USGS photo.

Integrated Assessment for the Wyoming Landscape Conservation Initiative. The Wyoming Landscape Conservation Initiative (WLCI) is a long-term, science-based effort to ensure that southwestern Wyoming's wildlife and habitats are sustained in the face of increasing land-use pressures, including energy-extraction activities. This multi-partner initiative includes the USGS, BLM, USFWS,

U.S. Forest Service, Wyoming Game and Fish Department, and Wyoming Department of Agriculture. During FY 2008–2010, a major facet of the WLCI has been to develop a Baseline Synthesis and Comprehensive Assessment of the Southwest Wyoming study area. To that end, FORT and other USGS scientists have (1) compiled and analyzed existing datasets, (2) developed conceptual and spatial models that describe the WLCI region's ecosystems, (3) developed techniques and indices and selected indicators for long-term monitoring of the region's ecosystems, (4) assessed changes in land use and land cover as well as the vulnerability of Wyoming's Species of Conservation Concern to those changes, (5) assessed existing energy and mineral resources and their potential for additional development, (6) evaluated the socioeconomic impacts of energy development, and (7) downscaled climate data for use in simulating effects of climate change on the WLCI landscape.

In FY2010, FORT and other USGS scientists began developing an Integrated Assessment (IA) to compile all the Baseline Synthesis and Comprehensive Assessment components into a multiple-disciplinary assessment of the cumulative effects of human-mediated stressors (agents of change) on the WLCI region's natural resources and ecosystem processes. Initial IA tasks completed include obtaining geospatial datasets relevant to the WLCI region, drafting and exercising a framework for conducting the IA by using geospatial data to define resource values and how they are affected by agents of change, and developing a working draft of a synthesis document titled "*Energy, Climate, and Ecosystems— U.S. Geological Survey Integrated Assessment for Southwest Wyoming*." The final IA products— including the synthesis document and the IA framework for conducting future assessments, models, and geospatial information—will provide WLCI partners with an invaluable set of decision-support tools that can be used to identify areas of high development potential and target areas for conservation and restoration.

Thirty-three years of Monitoring Vegetative Succession after Two Stand-Replacing Fires at Bandelier National Monument. Currently there is very little information about the efficacy and long-term effects of Burned Area Emergency Rehabilitation (BAER) seeding efforts for natural vegetative recovery after stand-replacing fires. To address this information gap, FORT scientists at the Jemez Mountains Field Station, located at Bandelier National Monument in New Mexico, have been collaborating with the NPS, Los Alamos National Laboratory, Student Conservation Association, and University of Arizona Tree Ring Laboratory to conduct long-term studies of post-fire, BAER-treated ponderosa pine (*Pinus ponderosa*) woodlands in and around Bandelier. One effort entailed collecting pre- and post-fire data from 1976 to 1998 in the 15,270-acre La Mesa burn of 1977, and a second effort involved collecting post-fire data from 1997 to 1998 in the 16,516-acre Dome burn of 1996. The La

USGS biologist Rebecca Oertel (on left) and visitors from University of Alicante in Spain holding plot tags. Photo by Susana Bautista, University of Alicante, Spain. Courtesy Rebecca Oertel, USGS.

Kay Beeley (NPS) on the Dome Fire Study. Invasive smooth brome is the sole vegetative ground cover in this photo. Photo by Rebecca Oertel, USGS.

Mesa plots were resampled during 2009–2010 and the Dome plots in 2010. The preliminary results indicate that several seeded species persist today, including smooth brome (*Bromus inermis*), an exotic that apparently contaminated the seed mix used at the Dome burn and became the dominant vegetation there, significantly affecting the ecosystem's natural succession. In FY10, the Dome Fire data were analyzed and summarized in a draft article to be submitted for publication in FY11, and analyses for the La Mesa data are underway. The information from these studies will be used to (1) help the NPS and U.S. Forest Service develop new adaptive management strategies for the study areas and for future stand-replacing burns in the region and (2) help guide future research for evaluating the efficacy and long-term effects of post-fire land-management practices.

Habitat Prioritization for Selected Raptor Species in Wyoming. Raptor conservation in Wyoming is a concern to the USFWS due to potential declines in raptor populations across the intermountain West. Raptors are generally sensitive to human disturbance, and increasing energy development could exacerbate declines through increased mortality (for example, collisions with wind turbines, electrocution) and habitat loss and fragmentation. Currently, the USFWS recommends site-based mitigation of land uses around known nest and roost sites, including seasonal restrictions on activities that may disturb raptors; yet, these efforts may be too conservative for a guild of migratory species with large home ranges and diverse seasonal requirements. This project entails filling a critical gap in raptor conservation by developing science-based spatial planning tools for four species in Wyoming: golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), northern harrier (*Circus cyaneus*), and prairie falcon (*Falco mexicanus*). In FY10, scientists compiled a database with more than 90,000 known raptor locations from Federal, State, and non-government agencies that, when combined with spatial data, will be used to develop scale-dependent predictive models of raptor habitat use. The predictive models will be applied in a GIS and expressed as maps that delineate high-quality seasonal habitats for raptors. Overlaying habitat models with maps of areas where the potential for energy development (wind, oil, and gas) is high will provide land managers with a process for identifying landscapes in Wyoming where the risks to raptors are greatest and where the opportunities lie for conserving raptor populations.

Assessing Bighorn Habitat in Mesa Verde National Park. Bighorn sheep (*Ovis canadensis*) were extirpated from Mesa Verde National Park, Colorado, in the early 1900s. To re-establish a bighorn population in the park, 14 Rocky Mountain bighorn sheep (*O. c. canadensis*) were released in the park's southwest region during 1946, but dispersal and survival have been poor. Moreover, colonization by bighorns from outside the region is not occurring because the next-closest population is 80 miles away and is a different subspecies (*O. c. nelsonii*). In the early 1990s, the NPS and USGS collaborated to assess bighorn habitats on NPS lands of the intermountain West, and it was determined that large areas of dense vegetation made most of Mesa Verde National Park unsuitable for bighorns. Since that time, five major wildfires have occurred in and adjacent to the park, significantly changing the park's habitats. In FY10, the NPS requested assistance from FORT's ungulate ecologists to re-assess bighorn habitat in Mesa Verde

Park resource management staff measure visibility through vegetation for the bighorn sheep study in Mesa Verde National Park, Colorado. NPS photo.

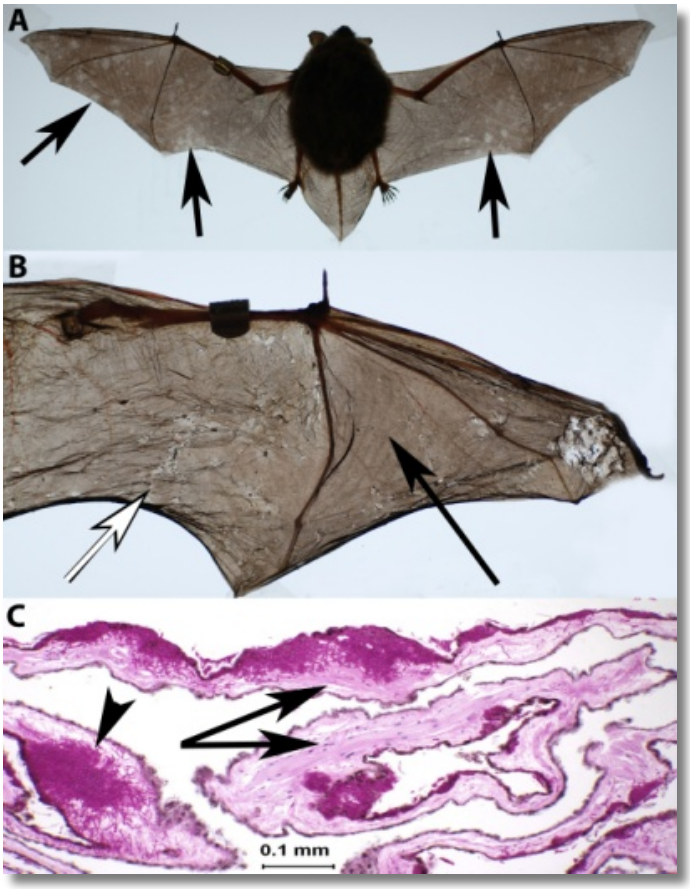
and nearby public lands. Using a GIS-based bighorn habitat suitability model that had been tested and improved by USGS, FORT combined spatial data on vegetation, topography, barriers to bighorn movement, water sources, domestic sheep grazing, and human disturbance to eliminate unsuitable habitat areas of the park. Subsequently, field sampling was conducted in the remaining areas to estimate horizontal visibility within each vegetation type. This information was then incorporated into the GIS model to refine estimates of the suitability of bighorn habitat in Mesa Verde National Park. The same procedure was used to identify suitable lambing, summer, and winter habitat. The results were mapped and reported in a final document, which will be used by the park's natural resource managers as well as NPS's collaborators from the Colorado Division of Wildlife, BLM, and Ute Mountain Indian Tribe to determine the feasibility of reintroducing desert bighorn sheep to the park in the near future.

Population Connectivity of Greater Sage-Grouse in Wyoming Using Genetics, GIS, and Seasonal Habitat Models. The distribution and abundance of greater sage-grouse (*Centrocercus urophasianus*) have declined markedly throughout their entire range likely due to the loss, fragmentation, and degradation of sagebrush habitat. Although Wyoming contains the largest populations of greater sage-grouse, substantial impacts from habitat loss and recent energy development continue to threaten these populations. The movement of individuals among subdivided populations is often essential for population persistence but can be hindered by various landscape features. The resulting population isolation can have deleterious impacts on population persistence. Thus, identification of populations and connectivity levels among them can inform the prioritization of habitats for conservation and identify habitat and anthropogenic features that impair the connectivity among populations. In 2010, FORT scientists initiated a new study to collect fine-scale genetic data that will be integrated with seasonal predictive habitat models for greater sage-grouse across Wyoming. Together these elements will provide a comprehensive understanding of habitat use and connectivity for this species. Cooperating agencies include the BLM, Wyoming Department of Game and Fish, USFWS, and Colorado State University.

Wildlife and Terrestrial Resources

Science conducted in this area provides a foundation for the conservation of terrestrial plants, wildlife, and habitats by developing the basic biological information that partners need to formulate adaptive management strategies. This work seeks to identify factors that contribute to, or limit, conservation and recovery efforts for species-at-risk and to provide tools and techniques, such as predictive models, decision-support systems, and expert systems, for science-based management of wildlife populations and their habitats. Further, this research aims to address emerging and future issues of importance to our partners by building additional capabilities, expertise, and capacity.

White-Nose Syndrome: New Insights and Continued Investigations. White-nose syndrome, a disease characterized by the presence of a highly invasive white fungus (*Geomyces destructans*) that infects the skin of bats, continues to devastate populations of hibernating bats in the eastern United States. WNS has spread during the past four winters from a small area of New York to a region now covering at least 190,000 square kilometers, causing unprecedented mortality of hibernating bats in 11 States and 2 Canadian Provinces. WNS poses a major threat to four species and subspecies of hibernating cave bats listed under the Federal Endangered Species Act, as well as approximately 20 other species of bats that hibernate in North America. During FY10, FORT continued participating in international efforts to coordinate the response to this wildlife emergency and expanded field studies



Effects of infection by the fungus *Geomyces destructans* on bat wings. (A) Back-lit photograph of wings of a little brown bat (*Myotis lucifugus*) that died of white-nose syndrome (WNS), showing subtle circular and irregular areas of pallor (arrows) in wing membrane. (B) Back-lit photograph of the wing of a dead little brown bat with significant visible pathology associated with WNS. Area of wing membrane with relatively normal tone and elasticity (black arrow), compared to an area that has lost tone, elasticity and surface sheen, with irregular pigmentation and areas of contraction (white arrow). (C) Periodic acid Schiff-stained, 4-micrometer histologic section of wing membrane from *M. lucifugus* showing extensive fungal infection by *G. destructans*. Fungal hyphae replace muscle bundles (arrows); invasion can become transdermal with associated edema (arrowhead). Image by Carol Meteyer, USGS. Adapted from Cryan, P.M., Meteyer, C.U., Boyles, J.G., and Blehert, D.S., 2010, Wing pathology associated with white-nose syndrome in bats suggests life-threatening disruption of physiology: BMC Biology, v. 8, p. 135.

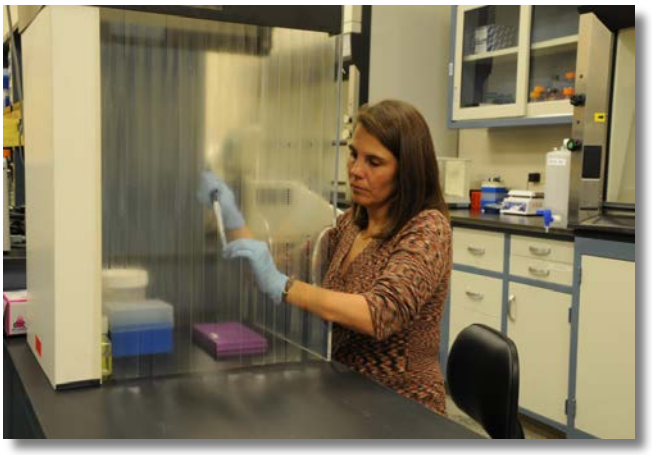
into the causes and consequences of the disease. Two landmark papers grew out of this work that advanced scientific understanding of the behavior of this disease and how it may be killing bats (see *http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22884* and *http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=23040*). FORT also helped the NPS coordinate a WNS epidemiology workshop in the spring of 2010, resulting in a 2011 paper in *Conservation Biology* that provides recommendations for better incorporating epidemiological methods into WNS investigations. FORT field studies into how *G. destructans* kills bats continued, including a novel video-monitoring project that for the first time watches bats for entire winters in caves and mines to test the hypothesis that skin infection by *G. destructans* kills bats by triggering unsustainable aberrant behaviors during hibernation. In cooperation with scientists at the USGS National Wildlife Health Center and several States and universities, FORT also researched the physiological effects of fungal skin infection on hibernating bats through field- and laboratory-based studies. Ongoing WNS activities at FORT also include using habitat-association modeling to predict the potential spread of WNS and development of a national disease-tracking database to help coordinate the emergency response.

Investigating the Causes of Bat Mortalities at Wind Turbines. Surprising numbers of migratory tree-roosting bats are being found dead beneath industrial-scale wind turbines during late summer and autumn in both North America and Europe. There are no other well-documented threats to populations of migratory tree bats that cause mortality of similar magnitude to that observed at wind turbines. Just three migratory species compose the vast majority of bat kills at turbines in North America, and there are indications that turbines may actually attract migrating individuals toward their blades; yet the causes of high bat susceptibility to turbines remain unknown. Hoary bats (*Lasiurus cinereus*) currently compose about half of all documented fatalities of bats at turbines in North America, and tens of thousands are likely perishing at turbines each year. Building upon earlier research on hoary bats, FORT scientists are working to establish the causes of bat susceptibility to wind turbines in hopes of identifying better ways of avoiding and minimizing fatality. During FY10, FORT scientists continued a project in which they used stable isotope analysis to infer the migratory origins and behaviors of hoary bats killed at wind turbines. Other ongoing research during FY10 at FORT included investigations into whether mating and feeding might play roles in the susceptibility of hoary bats to wind turbines. Bat researchers at FORT and the USGS Pacific Island Ecosystems Research Center worked collaboratively during FY10 to design and build a new type of surveillance video system capable of imaging small bats and birds in the dark around the highest reaches (>120 meters) of wind turbines at night. This video system shows promise for studying bat behavior at turbines, assessing the presence of endangered species around turbines (such as the Hawaiian hoary bat), and perhaps monitoring turbines for wildlife in offshore environments.

Hoary bat, one of three species of migratory bat prone to fatalities at wind turbines. Photo by Paul Cryan, USGS.


Exploring the Effects of the Amphibian Chytrid Fungus on Population Dynamics in the Rocky Mountains. The amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) is a key factor in many of the observed declines in amphibian populations from Australia to Central America to California. Understanding how wild populations respond to this emerging pathogen is critical for the purpose of informing management and conservation actions. This disease has been identified in endangered species as well as species that are currently classified as common. In the western United States there is a continuum of population-level responses to this disease, ranging from extirpation to persistence. In collaboration with partners, FORT developed proposals and secured competitive funding for 2005 to 2010 to address this need. This project is aimed at elucidating what happens to amphibian populations when they are stressed by disease and how different demographic parameters (for example, survival and recruitment) respond. By studying both infected and uninfected populations and using robust statistical methods to provide estimates for key demographic parameters, our team can provide information critical to management. In FY10, results from various aspects of this project were published in *Conservation Biology* and *Methods in Ecology and Evolution*. Results from this project provide management input for State-listed endangered boreal toads in Rocky Mountain National Park and other Colorado locales. Long-term data and monitoring associated with the project contribute to databases and synthesis exercises by the USGS Amphibian Research and Monitoring

Initiative. FORT researchers work at a number of study sites in the southern Rocky Mountains and collaborate with multiple partners, including other USGS groups, Bridger-Teton National Forest, San Isabel National Forest, Rocky Mountain National Park, Colorado State University, and the Colorado Natural Heritage Program.



FORT geneticist Sara Oyler-McCance sets up a DNA sequencing reaction in the new facility at FORT. Photo by Dean Biggins, USGS.

Molecular Ecology Laboratory Relocates to FORT. The use of molecular genetics tools has become increasingly important in addressing conservation issues pertaining to plants and animals. Genetics information is essential for the sound management of species, populations, and sometimes even individuals, as well as for the development of long-term management strategies and regulatory decisions by DOI and other resource-management agencies. To address this need, in 2002 FORT and several partners established and directed a genetics and systematics laboratory at the University of Denver's Department of Biology through a cooperative partnership. Because of diverging interests and new USGS opportunities and laboratory space, in FY10 FORT's geneticists were relocated to the FORT headquarters building in Fort Collins to establish a new in-house molecular genetics laboratory. With state-of-the-art equipment and two FORT geneticists, the new FORT Molecular Ecology Laboratory is providing genetics research through numerous studies in support of the USGS mission.

Using DNA to Estimate Population Demographics. FORT scientists are conducting several research projects involving the use of DNA extracted from feces as an individual marker for mark-recapture studies to estimate demographic parameters (molecular tagging). This work is particularly difficult in that the quantity and quality of DNA from fecal material is very low, making polymerase chain reaction (PCR) amplification difficult and genotyping prone to error. Although techniques to extract DNA from feces have been developed and optimized for a few species (particularly large mammals), many species remain problematic. Because traditional mark-recapture methods cannot be applied to all species, there is great interest from management agencies in determining whether molecular tagging can be used for selected species. The endangered Indiana bat and greater and Gunnison's sage-grouse are three such species. The Indiana bat is particularly difficult to type because the fecal pellets are extremely small, whereas successful extraction of DNA from sage-grouse pellets has been deemed by some to be impossible due to secondary compounds associated with sagebrush in the fecal pellets. FORT scientists have developed new

FORT geneticist Jennifer Fike loads samples of DNA sequences into the automated DNA sequencer in the new facility at FORT. Photo by Dean Biggins, USGS.

microsatellite markers for Indiana bat and both sage-grouse species and have successfully optimized extraction procedures, resolving issues that severely limited these applications previously. Studies are ongoing to estimate population sizes and survival rates for both species of sage-grouse and to investigate the relatedness of Indiana bat colonies and estimate population size. Lastly, FORT scientists, in collaboration with the Colorado Division of Wildlife (CDOW), are conducting a controlled experiment with captive mountain lions to investigate and quantify characteristics associated with the degradation of DNA extracted from mountain lion feces. This information will allow the CDOW to develop a protocol (that is, at what age and under what conditions feces can be used in molecular tagging) for the estimation of demographic rates in mountain lions, using DNA extracted from feces. Information from this study will provide insight into what impact environmental conditions may have on the use of this methodology for other species as well.

Immunocontraception to Control Reproductive Rates in Wild Horses. Rapid growth of wild horse populations continues to present a challenge to agencies responsible for their management. With growth rates as high as 25 percent per year, wild horses can rapidly exceed the carrying capacity of their ranges and detrimentally affect water supplies, soils, vegetation, and wildlife. In FY10, in cooperation with the BLM and the Pryor Mountain Wild Mustang Center, FORT scientists continued monitoring mares previously treated with an immunocontraceptive (porcine zona pellucida, or PZP) for return to fertility and seasonality of foal births in three herds in Montana, Wyoming, and Colorado. In cooperation with BLM and Oregon State University, FORT scientists also initiated a study on the safety and efficacy of SpayVac® (Immunovaccine, Inc., Halifax, Nova Scotia, Canada), an alternative formulation of PZP that has shown promise in providing multiple years of infertility with a single dose. FORT scientists also cooperated with Colorado State University and the National Park Service on a study of the effects of a different vaccine (GonaCon) on wild mares at Theodore Roosevelt National Park in North Dakota.

Foraging Ecology of an Endangered Seabird. The Hawaiian petrel (*Pterodroma sandwichensis*) exemplifies the seabird paradox—they travel great distances (up to 10,000 kilometers) to forage, yet are reluctant to disperse among nearby breeding sites. The high mobility of this enigmatic and endangered species has led to an incomplete natural history, hindering conservation efforts. In collaboration with colleagues at Michigan State University and the Smithsonian Institute, FORT investigators applied stable isotope and molecular genetic techniques to study the long-term, at-sea foraging ecology and population structure of the Hawaiian petrel. These topics are being explored by analyzing modern samples from depredated carcasses and radiocarbon-dated bones of petrels that died during the past 3,000 years. Results have revealed novel insights, including substantiation that modern and ancient Hawaiian petrel breeding colonies are genetically divergent. Isotopic data indicate that at-sea foraging segregation is maintained by spatial constraints rather than dietary preferences, and long-term declines in trophic level are best explained by the onset of industrial fishing, rather than changes in foraging location. This information provides an improved understanding of Hawaiian petrel foraging ecology and population structure and establishes a need for developing conservation strategies for each of the islands they populate.

Hawaiian petrel. Photo © Jim Denny. Used with permission.

Bird Migration Patterns in the Arid Southwest. Twice each year, millions of North American landbirds migrate thousands of miles between their breeding and wintering grounds. Research has shown that a disproportionate amount of mortality occurs during these relatively short migration periods. Land birds face a series of natural and anthropogenic challenges to a successful migration. As recognition of these challenges grows, increased understanding of the behavior of migratory birds en route and the types of habitats used, including on-the-ground stopover habitat and migratory aerohabitat, can help inform natural resource decisionmakers and enable the protection of on-the-ground and above-the-ground habitats necessary for successful migration. The United States–Mexico borderlands region typifies the potentially inhospitable arid and mountainous landscapes that western birds must traverse during migration; the great majority of western migratory species funnel through this region. Thus, conservation and protection of important migratory habitats in this region are crucial. Recognizing the need for research at broader spatial scales than could be conducted using traditional field methodologies, FORT collaborated with the USFWS and Mississippi State University to investigate the use of weather surveillance radar to study bird movements at broad spatial and temporal scales. A report of their findings, *Bird Migration Patterns in the Arid Southwest—Final Report*, was published in 2010 (*http://pubs.usgs.gov/of/2010/1271/pdf/OF10-1271.pdf*), providing information on migrant flight altitudes, speeds, direction of travel, migration routes, and the type of habitats used during migration stopovers. The results indicate that the use and importance of stopover sites is very complex, and broad generalizations oversimplify how these areas are used. This report is expected to be used by managers and scientists as a basis for future research, monitoring, and management of migratory birds and their habitats in the United States–Mexico Borderlands region.

Sharing the Wealth: Access to Products

Products and Publications

During FY10, FORT scientists delivered 150 products, 121 of which were publications (with several more in press). For a list of all our products, many of which are available online, visit *http://www.fort.usgs.gov/Products/*. Appendix 1 lists publications from FY10 by USGS program element; Appendix II does the same for other types of products.

Sharing the Wealth: Access to Expertise

Workshops and Training

Recommended Methods for Range-Wide Monitoring of Prairie Dogs in the United States. One of the greatest challenges for conserving grassland, prairie scrub, and shrub-steppe ecosystems is maintaining prairie dog populations across the landscape. Of the four species of prairie dogs found in the United States, the Utah prairie dog (*Cynomys parvidens*) is listed under the Endangered Species Act as threatened, the Gunnison's prairie dog (*C. gunnisoni*) is a candidate for listing in a portion of its range, and the black-tailed prairie dog (*C. ludovicianus*) and white-tailed prairie dog (*C. leucurus*) have been proposed for listing at least once in recent history. Although the USFWS determined that listing is not warranted for either the black-tailed or the white-tailed prairie dog, the listing petitions and associated reviews demonstrated the need for the States to monitor and manage for self-sustaining populations. In response to these findings, a multi-state conservation effort was initiated for the non-listed species that included several proposed actions, among them (1) developing a range-wide monitoring protocol for each species using a statistically valid sampling procedure that would

allow comparable analyses across States, and (2) monitoring prairie dog status every 3 to 5 years, depending upon the species. To date, all 11 States are currently monitoring prairie dog status; however, for some species, the inconsistency in survey methodology has made it difficult to compare data from year to year or from state to state. Consequently, the Western Association of Fish and Wildlife Agencies (WAFWA), in coordination with USFWS, requested assistance from FORT scientists to address this concern. FORT hosted a prairie dog survey methodology workshop on January 25–28, 2010, in Fort Collins, Colo. The workshop provided all WAFWA partners and interested parties with the opportunity to present their survey methodology to a review panel made up of experts in the fields of quantitative biology, population biology, species biology, and biostatistics. All States provided written material for the panel to consider and most States provided oral presentations at the workshop. Additionally, one tribe and one non-governmental organization provided written material and an oral presentation at the workshop. A report is currently being prepared presenting (1) the panel's survey methodology recommendations for each of the four species of prairie dogs found in the United States, and (2) a list of action items to facilitate implementation of the recommended methodology for the black-tailed prairie dog.

Juvenile prairie dogs. Photo by Dean Biggins, USGS.

Brown Treesnake Rapid Response Team Training Workshops. Brown treesnakes have caused and continue to cause major problems for the ecology, economy, and quality of life on Guam. In 2002 a multi-agency Rapid Response Team (RRT) led by the USGS was established to assist in detection and capture of brown treesnakes on recipient islands after being accidentally transported from Guam. The RRT has incorporated USGS research results, such as (1) means to improve snake detectability at low densities, (2) effectiveness of control tools in rodent-rich environments, and (3) predicting movements of snakes translocated accidentally. Since its creation, the RRT has conducted 2 to 5 training courses annually and 21 field operations. During FY10, one field operation was conducted on the island of Guam at the request of the Guam Department of Agriculture. This operation involved searching for a non-native snake with personnel from the department, USDA Wildlife Services, and USGS. Numerous outreach and speaking engagements were conducted on Guam, including visits to the research laboratory by several school groups, presentations at University of Guam venues, and running an invasive/native species booth with the Guam Department of Agriculture for the University of Guam Charter Day. Two outreach trips were conducted during FY10 that involved visits to Saipan, Majuro, Kosrae, Pohnpei, and Chuuk, with numerous speaking engagements on each island. During FY10, the RRT provided assistance to the National Invasive Species Council for the Micronesia Biosecurity Plan

Rapid Response Team members Tom Hinkle (second from right) and Eli Wostl (far right) show young Japanese visitors a brown treesnake at the USGS Research Laboratory on Guam. Photo by James Stanford, USGS.

(MBP), including MBP biological team support during island visits throughout the region, and field support to USGS efforts in Papua, New Guinea, and to USFWS efforts in the Northern Mariana Islands. Cooperators include the DOI Office of Insular Affairs; USFWS; Hawaii's Invasive Species Committees, Coordinating Group on Alien Pest Species, Department of Agriculture, and Department of Forestry and Wildlife; DOD; Guam Division of Aquatic and Wildlife Resources; and USDA Wildlife Services and Animal and Plant Health Inspection Service (APHIS). Additional quarantine, agriculture, and natural resource cooperators include officials from the Federated States of Micronesia, the Republic of the Marshall Islands, the Commonwealth of the Northern Mariana Islands, and the Republic of Palau.

Making a Difference (Customer Satisfaction)

Letters and Emails: A Selection

- Letter from USGS Director Marcia K. McNutt to FORT computer engineer Tim Kern for Deepwater Horizon Oil Budget Calculator (see p. 5) development:

  The Deepwater Horizon oil spill was a great tragedy for our Nation. However, the impact was lessened because of the many dedicated professionals who contributed to the U.S. Geological Survey (USGS) response. I want to thank you for your personal sacrifices and contributions to this monumental effort. The hard work of many USGS employees greatly benefited the Nation during these very busy and difficult months.

  The work performed by the USGS included collecting and analyzing water samples, providing geospatial support to other agencies, interpreting imagery, dealing with wildlife health issues, participating in hundreds of conference calls and meetings, and preparing numerous reports and scientific documents for a variety of audiences. This is just a sampling of the collective effort provided by you and your coworkers.

  I feel very fortunate to work among so many talented professionals. Thank you again for your personal diligence in working on the USGS oil spill response. I congratulate you on a job well done.

- From Therese Johnson, Biologist, Rocky Mountain National Park, Estes Park Colorado, regarding scientist Linda Zeigenfuss' vegetation monitoring plan for the park:

  I'd like to pass along my appreciation for the fantastic job Linda Zeigenfuss has done on her project developing a vegetation monitoring plan for Rocky Mountain National Park. Over the past few years this project went through a variety of modifications due to changes in our funding availability and the Park's needs as we completed and began implementing our Elk and Vegetation Management Plan. Linda was extremely flexible and accommodating through these changes, and really went above and beyond what I would generally expect to make sure the Park's needs were met. Most recently, at our request, Linda worked with me to incorporate a discussion on how the Park plans to apply monitoring protocols relative to our vegetation objectives into the final report. This caused a delay in the project, but having this information included in the monitoring report will be very helpful to us as we continue to communicate our adaptive management process to various stakeholders. Linda's willingness to work with us on this despite impacts on her schedule is greatly appreciated. Linda has kept us well informed on the status of the USGS editing process and we are comfortable with the timing on this last phase of the final report. The monitoring protocols Linda developed, along with the established plots,

baseline data and initial analysis, will be vitally important as the Park moves forward in adaptively managing elk and their habitat in the Park.

- From Robert V. Abbey, Director, Bureau of Land Management, Washington, D.C., regarding Ecosystem Dynamics Branch Chief Zack Bowen's involvement in the National Landscape Conservation System summit:

  On behalf of the Bureau of Land Management (BLM) and the National Landscape Conservation System (NLCS) and Community Partnerships directorate, I want to personally thank you for your participation in the recent NLCS Summit.

  Your willingness to serve as co-lead for the "Integration of Science and Management" track and your active involvement in the brainstorming sessions with BLM staff and other partners helped to ensure a lively and fruitful discussion.

  We are looking forward to continuing to work with you and our many partners in our efforts to enhance the integration of science and management in NLCS and throughout BLM.

- From Ruth Welch, Associate State Director, Bureau of Land Management, Wyoming State Office, Cheyenne, to Zack Bowen, Ecosystems Dynamics Branch Chief, regarding development of an EcoRegional Assessment and associated presentation:

  Thank you for spending time with us at our BLM Wyoming Managers' meeting. All of us appreciate your time and your expertise.

  The EcoRegional Assessment presents great opportunities for our managers and is an excellent tool to help us in our planning processes. We are grateful for the work and commitment given to it.

  Thanks again for your excellent presentation and your willingness to visit with individual members of our team afterward. Please continue to let us know what we can do.

- From Paul Exter, USGS Chief Technology Officer, this summary of accomplishments and contributions for a Star Award for FORT IT Lead Jeff Schafer:

  Ensuring that USGS networks and systems are secure and protecting the integrity of the data they house is one of the most critical issues facing the USGS.... During the past year, the ITSOT [Geospatial Information Office Information Technology Security Operations Team] has identified and deployed new technologies to mitigate threats to [USGS] information assets and improve capabilities for identification and mitigation of malicious code at the desktop. Without the leadership of Jeff Schafer, the USGS would not have met the stringent requirements for improved operational security and protecting assets from malicious code. In addition to his primary role as the Fort Collins Lead IT Specialist, Jeff also served on the ITSOT as a subject matter expert on malicious code protection and incident response. In this extended capacity, he served as liaison to USGS management and regional representatives, chaired team meetings, set priorities, assigned tasks, and worked with the team leads and individual team members to ensure resources and management support were available and committed to the activities of the team.…Jeff's consistently high-level and quality work is greatly appreciated and formally recognized with presentation of this award. Thanks.

- From Chris J. Larsen, 2010 Missouri River Conference Planning Committee Chair, to Ecosystem Dynamics Branch Chief Zack Bowen on the contributions of FORT scientists Mike Scott and Greg Auble:

On behalf of the Planning Committee for the 2010 Missouri River Natural Resources Conference—Bi-OP Forum, I wish to extend my appreciation for the involvement of your staff in our recent Conference. The poster and oral presentations by Dr. Michael Scott and Dr. Greg Auble were well received. Specifically, the presentations on "Historical Riparian Cover Types in the Missouri Breaks National Monument" and "Cottonwood Seedling Demography Along the Upper Missouri River" contributed significantly to our diverse scientific offerings for this year's conference. The latter presentation did, in fact, receive a second place award in our poster session.

- From Serena J. Rinker, Interpretive Specialist, Arthur R. Marshall Loxatachee National Wildlife Refuge, Boynton Beach, Fla., to FORT biologist Ron Rozar (March 6, 2010):

On behalf of the Arthur R. Marshall Loxatachee National Wildlife Refuge, U.S. Fish and Wildlife Service and the Audubon Society of the Everglades, I would like to thank you for making our eleventh annual Everglades Day Festival a huge success.

This event, co-sponsored by the Audubon Society of the Everglades, the refuge, and the Friends of the Loxahatchee Refuge, was a success because of your participation. We estimated that around 4,400 people gained a better understanding and appreciation of…this national treasure right in their own backyard.

Thank you again. Your participation was very much appreciated.

- From Cynthia K. Dohner, Regional Director, U.S. Fish and Wildlife Service Region 4, Atlanta, GA, to biologist Ron Rozar (Feb. 10, 2010):

On behalf of the Service Directorate I want to personally thank you for attending our meeting at Loxahatchee [Florida] last week. Thanks for taking the time from your hectic schedule to speak to us about the invasion of pythons in the Florida Keys and Everglades.

It is not often that the Directorate staff has live demonstrations and the opportunity to literally have a hands-on experience to handle snakes. You provided a unique opportunity to learn about pythons.

As our organization approaches the challenges of dangerous invasives encroaching into our territory it is people like you who will make the difference. Thanks again for making this session of our field trip more interesting.

- Letter from Sheila Colwell, Wildlife Biologist with the NPS Northeast Region, to FORT Research Biologist Paul Cryan:

On behalf of the NPS white-nose syndrome webinar planning committee, I'd like to extend another huge thanks for presenting your talk on current white-nose syndrome research. You did a fantastic job with the session and were an important part of the webinar's success. The information you presented was right on target for our viewers, and my only regret is that we couldn't give you more time. We'd love to have you involved in future workshops/webinars.

- Email from Nathaniel Hawley, Deputy Director, DOI Office of Youth in Natural Resources, to FORT scientist Ernie Valdez, who helped staff a USGS table at the first DOI agency-wide youth employment program held at the Southwest Indian Polytechnic Institute (SIPI) in Albuquerque, N. Mex. (April 15, 2010):

Subject: SIPI Success - Thank you sooooo much.

…I had so much fun at the event and working with each and every one of you, it really firms up my belief that Interior is the coolest place to work!!!

This event was a huge step in the right direction for our Secretary's Youth Initiative.

I know that some of your bureaus/agencies came to the table with some positions/internships to offer the students. I was therefore curious if any offers were made during or after the event….

Ed. Note: FORT did offer a summer student-contract position at the Arid Lands Field Station in Albuquerque to one of the applicants from this event. She successfully completed it, and as a result of the experience has expressed interest in majoring in wildlife conservation. This was reported to DOI, resulting in the following response from Rhea Suh, Assistant Secretary of Policy, Management, and Budget:

A very warm thank you for sharing this story with us. I'm so happy to hear of this outcome and glad that the fair actually is resulting in opportunity!

USGS scientists Ernie Valdez (FORT; left) and Phillip Bowman (Water Resources, Albuquerque; right) staff a table at the DOI agency-wide youth employment program held at the Southwest Indian Polytechnic Institute in Albuquerque, New Mexico. USGS photo.

Non-USGS Awards

- Jason Ransom was awarded a ***Colorado State University Center for Collaborative Conservation Fellowship*** for khulan (*Equus hemionus*) conservation efforts in Mongolia, February 2010.
- Steve Germaine received a ***Rocky Mountain Arsenal National Wildlife Refuge Star Award*** for his work with them studying bison grazing ecology on the refuge, September 2010.
- Greg Auble and Mike Scott received a ***Best Poster Award*** at the 2010 Annual Meeting of the Missouri River Natural Resources Commission, Nebraska City, Neb., March 2010.
- Thomas Stohlgren was recognized as ***one of the top ten most productive scientists in the world in the field of biological invasions*** (Qiu and others, 2009, Scientometrics, v. 81, no. 3, p. 601–610). The independent research team evaluated the scientific contributions and impacts of over 7,261 authors from 1,905 institutions/agencies and from 100 countries.
- Gordon Rodda, Robert Reed, Catherine Jarnevich, Juliette Wilson (ASRC-FORT), Jennifer Shoemaker, Sharon Gross, David Hallac, Bill Lukas, Art Roybal (USFWS), and Ray W. "Skip" Snow (NPS) received the ***U.S. Department of the Interior Partners in Conservation Award***, presented by USGS Director Marcia K. McNutt for "Giant Constrictor Risk Assessment," in recognition of outstanding conservation achievements attained through collaboration and partnerships with others, April 2010.

For More Information

To learn more about FORT research staff, projects, science publications and products, news, and events, visit *www.fort.usgs.gov*. Additionally, Appendix III lists pertinent staff appointments and activities from FY10.

Appendix I: USGS Mission Areas, Disciplines, and Programs Supported by FY 2010 FORT Scientific and Technical Accomplishments

Table 1. USGS Mission Areas, Disciplines, and Programs supported by FY 2010 FORT scientific and technical accomplishments, as reported in this document. Task accomplishments are listed by their primary USGS Programs.

[Admin., Administrative; GIS, geographic information system; CC, Climate Change; FAER, Fisheries: Aquatic and Endangered Resources; GD, Geology Discipline; GEOG, Geography Discipline; GIO, Geospatial Information Office; INV, Invasive Species; ST, Status and Trends of Biological Resources; TFME, Terrestrial, Freshwater, and Marine Ecosystems; WRD, Water Discipline; WTR, Wildlife, Terrestrial, and Marine Resources]

Project by Program	USGS mission area addressed							Other programs' goals met; other USGS disciplines involved
	Eco-systems	Climate and Land-Use Change	Energy and Minerals, and Environmental Health	Natural Hazards	Water	Core Science Systems	Admin. and Enterprise Information	
Biological Informatics								
Modeling with High Throughput Computing	✔	✔	✔		✔	✔		
GIS Data Library and Search Tool						✔		
Climate and Land-Use Change								
Climate Change and Riparian Cottonwood Forests in North Dakota	✔	✔			✔			WRD
Enterprise Information								
USGS Centralized AntiMalware and Host-Based Intrusion Prevention							✔	GIO
Oil Budget Calculator for Flow Rate Technical Group			✔			✔		GIO

Project by Program	USGS mission area addressed							Other programs' goals met; other USGS disciplines involved
	Eco-systems	Climate and Land-Use Change	Energy and Minerals, and Environmental Health	Natural Hazards	Water	Core Science Systems	Admin. and Enterprise Information	
ScienceBase Data Repository and Catalog						✔		GD, GEOG, GIO, WRD
Fisheries: Aquatic and Endangered Resources								
Launch of the Diatoms of the United States *Web Site*	✔					✔		TFME
Investigation of the invasive diatom Didymosphenia geminata	✔							INV
Sensitivity Analysis of Aquatic Habitat Modeling Techniques	✔				✔			
Aquatic Species Habitat Assessment Using Hydrodynamic Models in California and New York	✔				✔			ST, TFME
Invasive Species								
Control and Prevention of the Invasive Brown Treesnake	✔							
Control of Invasive Giant Constrictor Snakes in Florida	✔							ST
Control of Invasive Water Snakes in California	✔							ST
Biological Invasion of Riparian Ecosystems: Saltcedar and Russian Olive State-of-the-Science	✔				✔			ST, TFME; WRD
Reptile and Non-Volant Small Mammal Surveys of Pagan Island	✔							

Project by Program	USGS mission area addressed							Other programs' goals met; other USGS disciplines involved
	Eco-systems	Climate and Land-Use Change	Energy and Minerals, and Environmental Health	Natural Hazards	Water	Core Science Systems	Admin. and Enterprise Information	
Delivering Invasive Species Research Results to DOI and Other Land Managers	✔	✔				✔	✔	ST, TFME
Brown Treesnake Rapid Response Team Training Workshops	✔					✔		
Status and Trends of Biological Resources								
Population Assessment of the Mariana Fruit Bat	✔							WTR
Study of the Users, Uses, and Value of Landsat Imagery	✔							
Implications of Climate Change on Wetland-Dependent Birds and Grassland Birds	✔	✔						CC. WTR
Spatial Mapping and Attribution of Wyoming Wind Turbines	✔		✔					
Socioeconomic Considerations for National Wildlife Refuge Management and Planning	✔							
Recommended Methods for Range-Wide Monitoring of Prairie Dogs in the United States	✔							WTR
Terrestrial, Freshwater, and Marine Ecosystems								
Streamflow in Black Canyon of the Gunnison	✔				✔			FAER

Project by Program	USGS mission area addressed							Other programs' goals met; other USGS disciplines involved
	Eco-systems	Climate and Land-Use Change	Energy and Minerals, and Environmental Health	Natural Hazards	Water	Core Science Systems	Admin. and Enterprise Information	
Raven (A) Small Unmanned Aircraft System (sUAS) Capabilities Established	✔					✔		ST; GEOG
Assessing the Consequences of Energy Development in Western Lands	✔		✔			✔		ST; GD, GEOG, GIO, WRD
Integrated Assessment for the Wyoming Landscape Conservation Initiative	✔		✔					ST, WTR; GD, GEOG, GIO, WRD
Habitat Prioritization for Selected Raptor Species in Wyoming	✔		✔					ST, WTR
Assessing Bighorn Habitat in Mesa Verde National Park	✔							WTR
Population Connectivity of Greater Sage-Grouse in Wyoming Using Genetics, GIS, and Seasonal Habitat Models	✔		✔					WTR
Thirty-three Years of Monitoring Vegetative Succession after Two Stand-Replacing Fires at Bandelier National Monument.	✔							INV, WTR
Wildlife and Terrestrial Resources								
Exploring the Effects of the Amphibian Chytrid Fungus on Population Dynamics in the Rocky Mountains	✔							ST, TFME; WRD
Immunocontraception to Control Reproductive Rates in Wild Horses	✔							
Bird Migration Patterns in the Arid Southwest	✔							

Project by Program	USGS mission area addressed							Other programs' goals met; other USGS disciplines involved
	Eco-systems	Climate and Land-Use Change	Energy and Minerals, and Environmental Health	Natural Hazards	Water	Core Science Systems	Admin. and Enterprise Information	
Using DNA to Estimate Population Demographics	✔							ST
Investigating the Causes of Bat Mortalities at Wind Turbines	✔		✔					ST
White-Nose Syndrome: New insights and Continued Investigations	✔							ST
Molecular Ecology Lab Relocates to FORT	✔							
Foraging Ecology of an Endangered Seabird	✔							GD

Appendix II: FORT Publications Delivered in FY 2010

Publication Type	Citation
Biological Informatics	
Journal article	Hagen, C.A., J.C. Pitman, B.K. Sandercock, R.J. Robel, D.H. Wolfe, R.D. Applegate, and S.J. Oyler-McCance. 2010. Regional Variation in mtDNA of the Lesser Prairie-Chicken. The Condor 112(1): 29-37.
Book Chapter	O'Shea, T.J. and J.J. Johnston. 2009. Environmental contaminants and bats: Investigating exposure and effects. In: T.H. Kuntz and S. Parsons (eds.). Ecological and behavioral methods for the study of bats. Baltimore: Johns Hopkins University Press. p. 500-528.
Science feature	Wilson, J., G. Rodda, and R. Reed. 2009. Giant Constrictor Risk Assessment: Frequently Asked Questions. http://www.fort.usgs.gov/FLConstrictors/FAQ.asp.
Science feature	Wilson, J., R. Reed, and G. Rodda. 2009. Giant Constrictor Snakes in Florida: A Sizeable Research Challenge. http://www.fort.usgs.gov/FLConstrictors/.
Open-File Report	Wilson, J.T. (Comp.). 2010. Fort Collins Science Center—Fiscal year 2009 science accomplishments: U.S. Geological Survey Open File Report 2010–1148. 47 p.
Science feature	Wilson, J.T., G.T. Auble, and R.E. Zuellig. 2009. Riverine Science at the Fort Collins Science Center. http://www.fort.usgs.gov/WaterWrks/.
Climate and Land-Use Change	
Journal article	Adams, H.D., A.K. Macalady, D.D. Breshears, C.D. Allen, N.L. Stephenson, S.R. Saleska, T.E. Huxman, and N.G. McDowell. 2010. Climate-Induced Tree Mortality: Earth System Consequences. Eos, Transactions, American Geophysical Union 91(17): 153-154.
Fisheries: Aquatic Endangered Resources	
Scientific Investigations Report	Arnold, L.R., C.S. Mladinich, W.H. Langer, and J.S. Daniels. 2010. Land-use analysis and simulated effects of land-use change and aggregate mining on groundwater flow in the South Platte River valley, Brighton to Fort Lupton, Colorado: U.S. Geological Survey Scientific Investigations Report 2010–5019. 117 p.
Journal article	Blum, M., D.M. Walters, N.M. Burkhead, B.J. Freeman, and B.A. Porter. 2010. Reproductive isolation and the expansion of an invasive hybrid swarm. Biological Invasions 12:2825-2836.
Journal article	Campbell, S.G. and J. Heasley. 2009. Reshaping the annual hydrograph at Iron Gate Dam to benefit anadromous fish populations in the Klamath River, CA. Journal of Environmental Hydrology 17: Paper 27.
Journal article	Daniels, J.S. (Thullen), B.S. Cade, and J.J. Sartoris. 2010. Measuring Bulrush Culm Relationships to Estimate Plant Biomass Within a Southern California Treatment Wetland. Wetlands 30(2): 231-239.
Journal article	Waddle, T. 2010. Field evaluation of a two-dimensional hydrodynamic model near boulders for habitat calculation. River Research and Applications 26(6): 730-741.

Open-File Report	Waddle, T.J. and K.D. Bovee. 2010. Environmental flow studies of the Fort Collins Science Center, U.S. Geological Survey—Cherry Creek, Arizona: U.S. Geological Survey Open-File Report 2009–1272. 161 p.
Journal article	Walters, D.M., A.H. Roy, and D.S. Leigh. 2009. Environmental indicators of macroinvertebrate and fish assemblage integrity in urbanizing watersheds. Ecological Indicators 9:1222-1233.
Invasive Species	
Journal article	Allen, J.A., C.S. Brown, and T.J. Stohlgren. 2009. Non-native plant invasions of United States National Parks. Biological Invasions 11(10): 2195-2207.
Journal article	Beauchamp, V.B., C. Walz, and P.B. Shafroth. 2009. Salinity tolerance and mycorrhizal responsiveness of native xeroriparian plants in semi-arid western USA. Applied Soil Ecology 43(2-3): 175-184.
Journal article	Christy, M.T., A.A. Yackel Adams, G.H. Rodda, J.A. Savidge, and C.L. Tyrrell. 2010. Modelling detection probabilities to evaluate management and control tools for an invasive species. Journal of Applied Ecology 47(1): 106-113.
Journal article	Esaias, W., J. Nightingale, J. Morisette, P. Ma, J. Nickeson, R. Wolfe, C. Jarnevich, T. Holcombe, and T. Stohlgren. 2009. NASA and USGS invest in invasive species modeling to evaluate habitat for Africanized Honey Bees. The Earth Observer 21(6): 4-8.
Science feature	Holcombe, T. and J. Morisette. 2010. Resource for Advanced Modeling (RAM). http://www.fort.usgs.gov/products/publications/pub_Abstracttract.asp?PubID=22811.
Journal article	Holcombe, T.R., T.J. Stohlgren, and C.S. Jarnevich. 2010. From Points to Forecasts: Predicting Invasive Species Habitat Suitability in the Near Term. Diversity 2(5): 738-767.
Journal article	Lardner, B., J.A. Savidge, G.H. Rodda, and R.N. Reed. 2009. Prey preferences and prey acceptance in juvenile Brown Treesnakes (*Boiga irregularis*). Herpetological Conservation and Biology 4(3): 313-323.
Journal article	Lardner, B., J.A. Savidge, G.H. Rodda, R.N. Reed, and A.A. Yackel Adams. 2009. The results of nocturnal visual surveys are influenced by lamp properties. Applied Herpetology 6(4): 391-396.
Paper in Scientific Investigations Report	Merritt, D.M. and P.B. Shafroth. 2010. Demonstration projects and long-term considerations associated with saltcedar and Russian olive control and riparian restoration. In: P.B. Shafroth, C.A. Brown, and D.M. Merritt (eds.). Saltcedar and Russian olive control demonstration act science assessment. Scientific Investigations Report 2009-5247. p. 139-143.
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Journal article	Baron, J.S., L. Gunderson, C.D. Allen, E. Fleishman, D.H. McKenzie, L.A. Meyerson, J. Oropeza, and N. Stephenson. 2009. Options for National Parks and Reserves for adapting to climate change. Environmental Management 44(6): 1033-1042.
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Appendix III: Other FORT Products Delivered in FY 2010

Product Type	Citation
Biological Informatics	
Audio podcast	Baron, J., and M. Lubeck. 2009. Too Much of a Good Thing: Increasing Nitrogen Deposition in Lakes [Audio Podcast]. http://www.usgs.gov/corecast/details.asp?ep=109
Audio podcast	Cryan, P., and J.T. Wilson. 2009. Wind Energy: A Scare for Bats and Birds [Audio Podcast]. http://www.usgs.gov/corecast/details.asp?ep=107
Decision Support System	Jonah Infill Data Management System (JIDMS), v.2.0, August 2010.
Decision Support System	MultiModal Transportation Planning, Pilot 1.0, June 2010.
Decision Support System	SocioEcon Decision Support System, v.2.0, May 2010.
Decision Support System	Species Habitat Relationship Information Management Program (SHRIMP), v. 2.0, September 2010.
Web application	Refuge User Visitation Target Area Identification (RefPOC). v.1.0, May 2010.
Web science feature	Kern, T., J.T. Wilson, S. Bristol, and S. Tekell. 2010. Tailor Made: Web Applications for Natural Resources Science and Management. http://www.fort.usgs.gov/WebApps/
Web science feature	O'Donnell, Michael, and Tammy Fancher. 2010. Resources for Understanding the Effects of Wind Energy Development. http://www.fort.usgs.gov/WindEnergy/
Web science feature	Wilson, J.T., G.T. Auble, and R.E. Zuellig. 2009. Riverine Science at the Fort Collins Science Center. http://www.fort.usgs.gov/WaterWrks/
Web site	Holcombe, Tracy. 2010. Resource for Advanced Modeling (RAM). http://www.fort.usgs.gov/RAM/
Enterprise Information	
Decision Support System	USGS Frequently Asked Questions, v. 1.0, August 2010.
iPhone/Web application	iFeltIt, Pilot 1.0, September 2010.
Web application	Climate Montoring, v. 1.4, September 2010.
Web application	Data Integration Development Project Data Product Uploader and Repository, v.1.0, September 2010.
Web application	Flow Rate Technical Group Oil Budget Tracking Tool, v. 1.0, June 2010.
Web application	Human Capital Document Review and Management System, v. 1.0, November 2009.
Web application	myUSGS, v. 3.1–3.25, November 2009–September 2010.
Web application	Professional Pages, v. 2.0, May 2010.
Web application	Radio Asset Inventory System, v. 1.0, October 2009; v. 2.0, September 2010.
Web application	ScienceBase Catalog, v. 1.0, March 2010.
Web application	ScienceBase Directory, v. 1.0, July 2010.
Web application	ScienceBase EventManager, v. 1.0, January 2010.
Web application	ScienceBase Map Services, v. 1.0, March 2010.

Web application	ShakeCastRemote, Pilot 1.0, June 2010.
Web application	WaterSMART, v. 1.0, February 2010.
Invasives	
Web science feature	Wilson, J., R. Reed, and G. Rodda. 2009. Giant Constrictor Snakes in Florida: A Sizeable Research Challenge. http://www.fort.usgs.gov/FLConstrictors/.
Audio podcast	Reed, R., and J.T. Wilson. 2009. Science Seeks to Stem Snake Surge [Audio Podcast]. http://gallery.usgs.gov/audios/320
Web application	National Invasive Species Council Performance Tracking, v. 1.0, July 2010.

Appendix IV: FORT Staff Accomplishments and Activities

Staff Appointments and Committee Assignments

1. Cameron Aldridge, **Special symposium at the Society for Conservation Biology's 24th International Congress for Conservation Biology, "Bridging the Science-Policy Gap in Implementation of Critical Habitat under the U.S. Endangered Species Act [ESA] and Canada's Species at Risk Act [SARA],"** Edmonton, Alberta, Canada: Co-host.

2. Jill Baron, ***Issues in Ecology***: Editor-in-Chief.

3. Jill Baron, ***Ecological Applications,*** **Editorial Board**: Member.

4. Jill Baron, ***Mountain Research and Development,*** **Editorial Board**: Member.

5. Jill Baron, **FORT Science Advisory Board**: Chair.

6. Jill Baron, **USGS Global Change Science Advisory Committee**: Member.

7. Jill Baron, **Domain Science and Education Coordination Committee, National Ecological Observatory Network (NEON) Domains 10 and 13**: Member.

8. Jill Baron, **HJ Andrews Long-term Ecological Research Program**: Science adviser.

9. Jill Baron, **American Association for the Advancement of Science, Geology and Geography Steering Committee**: Member.

10. Jill Baron, **Colorado State University Department of Ecosystem Science and Sustainability, Search Committee for Ecosystem Ecologists**: Member.

11. Lea' R. Bonewell, **Western Bat Working Group:** Member.

12. Lea' R. Bonewell, **Colorado Bat Working Group:** Secretary and member.

13. Lea' R. Bonewell, **Colorado Bat Society, Board of Directors**: Member; **Membership Committee**: Chair; **Conservation Committee**: Member.

14. Lea' R. Bonewell, **Colorado White Nose Syndrome Group**: Member.

15. Lea' R. Bonewell, **Journal of Herpetology:** Invited referee.

16. Nina Burkardt, **University of Florida, Interdisciplinary Ecology Graduate Program, Ph.D. Committee**: Member; **USGS Southeast Ecological Science Center**: USGS mentor (for the same Ph.D. student-employee).

17. Leanne Hanson, **USGS Modeling Conference Steering Committee**: Member; **Water Census Session**: Chair.

18. Erik Hernandez, **USGS Bureau Windows Technical Support Team**: Member.

19. Tracy Holcombe, **Ecological Society of America, Rocky Mountain Chapter:** President and member.

20. Tracy Holcombe, ***Diversity and Distributions, Current Zoology*:** Invited referee.

21. Catherine Jarnevich, ***Biological Invasions, Landscape Ecology, Plant and Soil, Ecological Applications, Journal of Herpetology, Diversity and Distributions***: Invited referee.

22. Tim Kern, **Community for Data Integration, Product Owners Team**: Member.

23. Holly Miller, **Interactions of Society and the Environment Seminar Series, Organizing Committee**: Member.

24. Jeff Morisette, **USA National Phenology Network, National Coordinating Office**: Remote Sensing/Land-Surface Phenology Coordinator.

25. Jeff Morisette, **Committee on Earth Observing Satellites, Land Product Validation Subgroup, Phenology Working Group**: Lead.

26. Jeff Morisette, **Southern Arizona Buffelgrass Coordinating Center**: Co-organizer.

27. Erin Muths, ***Journal of Herpetology***: Co-editor.

28. Erin Muths, ***Amphibia-Reptilia*** **Advisory Editorial Board**: Member.

29. Erin Muths, ***Animal Conservation***: Guest editor.

30. Erin Muths, ***Herpetological Conservation & Biology*** **Editorial Guild**: Member.

31. Erin Muths, **National Science & Engineering Council of Canada, Discovery Grant Program**: Reviewer.

32. Erin Muths, **Herpetologists' League, EE Williams Graduate Student Grant Committee**: Chair.

33. Erin Muths, **Colorado State University**: Faculty affiliate.

34. Erin Muths, **Boreal Toad Recovery Team:** Member.

35. Erin Muths, **Reintroduction Protocol Committee**: Member.

36. Erin Muths, **Herpetologists' League, Board of Trustees**: Member.

37. Erin Muths, **Southwest Partners in Amphibian and Reptile Conservation Steering Committee**: Member.

38. Erin Muths, **Save The Frogs! Advisory Board:** Member.

39. Jason Ransom, **International Union of Conservation and Nature (IUCN) Species Survival Commission, Equid Specialist Group**: Member.

40. Robert Reed, **Herpetological Review:** Associate editor.

41. Robert Reed, **University of Nevada-Las Vegas Ph.D. committee:** Graduate advisor.

42. Gordon Rodda, **Mariana Crow Recovery Team:** Member.

43. Gordon Rodda, **Guam Kingfisher Recovery Team:** Member.

44. Gordon Rodda, **USGS FORT Director's Discretionary Fund**: Primary referee.

45. Butch Roelle, **Bureau of Land Management Wild Horse and Burro Program, Research Advisory Team**: Member.

46. Jeff Schafer, **Department of the Interior (DOI) Enterprise Endpoint Security Team**: Subject matter expert.

47. Jeff Schafer, **DOI Infrastructure Consolidation Thin Computing Functional Group**: Lead engineer.

48. Jeff Schafer, **USGS Wide-Area Network Optimization Team**: Member.

49. Rudy M. Schuster, **DOI Strategic Sciences Working Group Mississippi Canyon 252/Deepwater Horizon Oil Spill**: Member

50. Rudy M. Schuster, **Inter-agency Working Group on Ocean Social Sciences**: Member

51. Rudy M. Schuster, **U.S. Fish and Wildlife Service Long Range Transportation Planning Team, Visitor Experience Sub-group**: Member

52. Mike Scott, **Escalante River Watershed Partnership Science Committee**: Member.

53. Mike Scott, **Watershed Sciences Department, Utah State University**: Adjunct assistant professor.

54. Mike Scott, **Utah State University, Watershed Sciences Department, Ph.D. Committee**: Member.

55. Mike Scott, **Border Monitoring Working Group** (a DOI-sponsored committee of government and academic experts tasked with writing an environmental monitoring plan for the United States–Mexico border fence for the Department of Homeland Security), **Writing Team:** Member (riparian ecosystem expertise).

56. Natalie Sexton, **Organizing Committee for Interactions of Society and the Environment Seminar Series**: Member.

57. Pat Shafroth, **Big Bend Binational Conservation Cooperative, Science Committee**: Member.

58. Pat Shafroth, ***Arid Ecosystems*** **Editorial Board**: Member.

59. Susan K. Skagen, **Program for Regional and International Shorebird Monitoring (PRISM)**: Co-chair.

60. Susan K. Skagen, **North American Bird Conservation Initiative (NABCI), Monitoring Subcommittee and Data Management Team**: Member.

61. Susan K. Skagen, **Playa Lakes Joint Venture, Scientific Advisory Team**: Member.

62. Susan K. Skagen, **Cooper Ornithological Society**, **Student Travel & Paper Awards Committee**: Co-chair.

63. Sarah Spaulding, **2009 North American Diatom Symposium:** Lead organizer.

64. Sarah Spaulding, **International Society for Diatom Research, Advisory Council:** Member.

65. Sarah Spaulding, **University of Colorado Institute for Arctic and Alpine Research, INSTAAR Directorate**: Research Scientist II, member.

66. Sarah Spaulding, **Grand Teton National Park, Science Advisory Panel on Aquatic Invasive Species**: Member.

67. Sarah Spaulding, **University of Colorado, INSTAAR Executive Committee and Research Faculty Committee**: Member.

68. Sarah Spaulding, ***Journal of Phycology*****, Editorial Board**: Member.

69. Sarah Spaulding, **International Diatom Society**: Council member.

70. Sarah Spaulding, **Diatoms of the U.S., Editorial Review Board**: Chair.

71. Sarah Spaulding, **Southern California Water Quality Committee, Advisory Board**: Member.

72. Sarah Spaulding, **Graduate Student Advisory Committees (7)**: Member.

73. James Stanford, **Pacific Island Learning Network**: Member.

74. James Stanford, **Guam Invasive Species Advisory Committee**: Secretary and member.

75. James Stanford, **Local Interagency Networking Committee**: USGS liaison.

76. James Stanford, **Regional Invasive Species Council**: Resource contact.

77. James Stanford, **Guam Environmental Education Committee**: Member.

78. Thomas Stohlgren, ***Ecology*****,** ***Ecological Monographs*****, and** ***Ecological Applications*** **Editorial Boards**: Member.

79. Thomas Stohlgren, **National Ecological Observation Network (NEON)**: USGS liaison.

80. Thomas Stohlgren, **Colorado State University, Natural Resource Ecology Lab, Ph.D. and Master's Committees**: Member.

81. David Walters, **Clemson University, Departments of Biological Sciences and Environmental Engineering and Earth Sciences**: Adjunct professor.

82. David Walters, **Department of Ecology and Evolution, Tulane University**: Adjunct professor.

83. David Walters, **Platte River Peer Review Panel**: **Terns and Plovers, Forage Fish, Geomorphology and Vegetation, and Water Quality**: Panel member; **Forage Fish Recovery Plan**: Reviewer.

84. David Walters, **University of Wyoming, Careers in Ecology**: Program panelist.

85. David Walters, **Black Canyon of the Gunnison Inventory and Monitoring Planning Committee**: Panel member.

86. David Walters, USEPA, **Great Lakes National Program Office, Remedy Effectiveness Summit for Contaminated Sediments, "Moving Remedy Effectiveness Research Forward with Our Partners"**: Panel member.

Invited Presentations

1. Cameron Aldridge, invited plenary speaker, **"Sage-grouse conservation in a changing world: what does the future hold."** Restoration of Disturbed Sagebrush Steppe Symposium: Lessons from 35 years of research on oil shale lands in the Piceance Basin, Colorado State University, Fort Collins, Colo., Sept. 2010.

2. Cameron Aldridge, invited presenter, **"Lessons learned in the application of habitat models to identify critical habitat for Greater Sage-grouse."** Society for Conservation Biology's 24th International Congress for Conservation Biology. Edmonton, Alberta, Canada, July 2010.

3. Gregor Auble and Mike Scott (and others), invited presenters, **"Monitoring of cottonwood seedling demography in the Missouri Breaks National Monument."** Decade of Discovery, National Landscape Conservation System Science Symposium, Albuquerque, N. Mex., May 2010.

4. Gregor Auble (and others), invited presenters, **"Cottonwood seedling demography along the upper Missouri River."** Missouri River Natural Resources Committee Conference, Nebraska City, Neb., Mar. 2010.

5. Gregor Auble, invited speaker, **"Box elder encroachment: implications for a long-term monitoring plan."** Black Canyon of the Gunnison National Monument, Colo., Mar. 2010.

6. Gregor Auble, invited speaker, **"Application of Flow-Cottonwood-Grazing Knowledge to Missouri Breaks."** InterAgency Upper Missouri River Cottonwoods Workshop, Great Falls, Mont., Dec. 2009.

7. Jill Baron, invited event moderator, **"Options for including nitrogen management in climate policy development."** Nitrogen Side Event at the COP 15 United Nations Framework Convention on Climate Change, Copenhagen, Denmark, Dec. 2009.

8. Jill Baron, invited working group session moderator, **"Factors affecting N deposition impacts on biodiversity."** Workshop on Nitrogen Deposition, Critical Loads, and Biodiversity, sponsored by the International Nitrogen Initiative, the Convention on Long-Range Transboundary Air Pollution, and the Convention on Biological Diversity, Edinburgh, Scotland, UK, Nov. 2009.

9. Jill Baron, invited seminar speaker, **"Complex and unexpected ecosystem consequences of atmospheric deposition of acids and nutrients in temperate North America and Europe."** New Frontiers in Conservation, Forest, Range, and Watershed Stewardship fall seminar series, Colorado State University, Fort Collins, Colo., Nov. 2009.

10. Jill Baron, invited speaker, **"Introducing the John Wesley Powell Center for Analysis and Synthesis."** USGS Central Region Colloquium, Denver, Colo., Oct. 2009.

11. Jill Baron, invited speaker, **"Climate change and atmospheric deposition effects to Loch Vale watershed, Rocky Mountain National Park."** Field trip and lecture for Bureau of Reclamation, USGS, NOAA scientists of the Upper Colorado Basin, Estes Park, Colo., Oct. 2009.

12. Jill Baron, invited speaker, **"Long-term ecological research into the effects of atmospheric N deposition to Loch Vale watershed."** Field trip and lecture for Paul Taurangeau, Director, Air Pollution Control Division, Colorado Department of Public Health and Environment, Estes Park, Colo., Oct. 2009.

13. Jill Baron, invited panelist, **"The world gathers in Copenhagen: what to expect and why it is so critical to us."** Colorado State University School of Global Environmental Sustainability, Fort Collins, Colo., Nov. 2009.

14. Jill Baron, invited speaker, **"Factors affecting N deposition impacts on biodiversity"; s**ession chair and moderator, **"Workshop on nitrogen deposition, critical loads, and biodiversity,"** Edinburgh, Scotland, Nov. 2009.

15. Jill Baron, invited session moderator, **"Options for including nitrogen management in climate policy development."** Nitrogen Side Event at the COP 15 to the United Nations Framework Convention on Climate Change, Copenhagen, Denmark, Dec. 2009.

16. Jill Baron, invited speaker, **"Adapting to climate change through science management partnerships."** Joint annual meeting of Rocky Mountain National Park and Arapahoe-Roosevelt National Forests, Estes Park, Colo., Feb. 2010.

17. Jill Baron, invited speaker, **"Options for national parks and reserves for adapting to climate change."** Webinar presentation C4-Sp Webinar on adaptation options for the Crown of the Continent, Feb. 2010.

18. Jill Baron, invited panelist, **"Life after Copenhagen: what's next?"** Colorado State University School of Global Environmental Sustainability, Fort Collins, Colo., Feb. 2010.

19. Jill Baron, invited speaker, **"The Powell Center."** USGS Biological Resources Discipline Expanded Management Team Meeting, Anchorage, Ak., Apr. 2010.

20. Jill Baron, invited presenter and Steering Committee member, **"Adapting to climate change in national parks."** Adapting to Climate Change in National Forests: A Workshop for Resource Managers, Stevenson, Wash., Apr. 2010.

21. Jill Baron, invited speaker, **"Atmospheric deposition of nitrogen to high elevations of the Rocky Mountains."** Women in Science and Engineering regional meeting, Denver, Colo., May 2010.

22. Jill Baron, invited speaker, **"Sensitivity of high elevation terrestrial and aquatic ecosystems."** Workshop on nitrogen assessment science in the USA, Boulder, Colo., May 2010.

23. Jill Baron, invited speaker, **"Welcome and opening remarks."** Grand Opening of the Powell Center, Fort Collins, Colo., Aug. 2010.

24. Jill Baron, invited speaker, **"Emerging themes for global change research and sustainable development: integrative perspective."** Closing plenary talk, Global Change and the World's Mountains, Perth, Scotland, Sept. 2010.

25. Dean Biggins, invited speaker, **"A 25-year history of research responses to a series of challenges encountered during black-footed ferret recovery."** USGS Wildlife: Terrestrial and Endangered Resources Program Review, Reston, Va., Oct. 2009.

26. Dean Biggins, invited speaker, **"Plague: human health, bioterrorism, and ecology."** Prairie Dog Technical Workshop, Boulder, Colo., Nov. 2010.

27. Dean Biggins, invited speaker, "**Black-footed ferrets and the black death; impacts of an alien infectious disease on an endangered species.**" Seminar, University of South Dakota, Vermillion, S.D., April 2010.

28. Nina Burkardt, co-instructor, **"Negotiation and Conflict Resolution."** Eight-hour segment of the USGS Leadership 101 class, National Conservation Training Center, Shepherdstown, W.V., Feb. and May 2010.

29. Nina Burkardt, invited instructor, **"Negotiation Skills in Natural Resources Management."** University of Wyoming Ruckelshaus Institute class, Sheridan, Wyo., Aug. 2010.

30. Nina Burkardt invited presenter, **"Another way of looking at stakeholder evaluation: The Legal-Institutional Analysis Model."** Interdisciplinary Ecology Graduate Program seminar series, University of Florida, Gainesville, Fla., Jan. 2010.

31. Nina Burkardt, guest lecturer, Colorado State University: **"Policy analysis research in Federal agencies,"** Graduate seminar in Sociology, Nov. 2009; **"Stakeholder involvement in natural**

resource decisionmaking," Graduate seminar in Political Science, March 2010; **"Collaborative decisionmaking in natural resource management,"** Senior Capstone Seminar in Political Science, Sept. 2010, Fort Collins, Colo.

32. Nina Burkardt, invited panelist, **"The social and economic dynamics of water demand and climate change."** DOI Conference on the Environment, Portland, Ore., Apr. 2010.

33. Paul Cryan, invited speaker, **"What do we know about white-nose syndrome?"** Special symposium of the 40th Annual Meeting of the North American Society for Bat Research, Denver, Colo., Oct. 2010.

34. Paul Cryan (and others), invited speakers, **"White-nose syndrome in North America."** 15th International Bat Research Conference, Prague, Czech Republic, Aug. 2010.

35. Paul Cryan, invited speaker, **"Overview of current white-nose syndrome (WNS) research."** National Park Service WNS Webinar, Online, June 2010.

36. Paul Cryan, invited speaker, **"Update on white-nose syndrome (WNS) research and response activities at the USGS Fort Collins Science Center."** WNS Annual Symposium, Pittsburgh, Penn., May 2010.

37. Paul Cryan, invited speaker, **"Ecology of temperate zone bats."** National Institutes of Health (RAPIDD Program) sponsored workshop on mathematical modeling of infectious diseases in bats, Cambridge, UK, Jan. 2010.

38. Paul Cryan, invited speaker, **"Secret flights: discovering and conserving migrations of bats."** Invited seminar at Indiana University's Maurer School of Law, Bloomington, Ind., Nov. 2009.

39. Paul Cryan (and others), invited speakers. **"The USGS response to white-nose syndrome in bats."** USGS Wildlife Program Review, Reston, Va., Oct. 2009.

40. Paul Cryan, invited speaker, **"White-nose Syndrome: USGS research of a disease with the potential to devastate bat populations."** USGS Wildlife: Terrestrial and Endangered Resources Program Review, Reston, Va., Oct. 2009.

41. Jonathan Friedman, invited speaker, **"Climate change and tree phenology."** Departmental Seminar to Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, Colo.

42. Jonathan Friedman, invited presenter, **"Global change and tree phenology."** INSTAAR Noon Seminar, Institute of Arctic and Alpine Research, Boulder, Colo., Mar. 2010.

43. Jonathan Friedman, invited presenter, **"Detecting effects of climate change along the Little Missouri River in Theodore Roosevelt National Park."** Theodore Roosevelt National Park, Medora, N.D., Mar. 2010.

44. Jonathan Friedman, invited presenter, **"Decreases in peak flows since the 1800s indicated by age-area relations of riparian cottonwood forests."** National Park Service Aquatic Professionals Meeting, Fort Collins, Colo., Feb. 2010.

45. Jonathan Friedman, Butch Roelle, Pat Shafroth (and others), invited keynote presenters. **"Global change and riparian exotic species."** 2010 Tamarisk Symposium, Grand Junction, Colo., Jan. 2010.

46. Jonathan Friedman (and others), invited presenter, **"Erosional consequence of saltcedar control."** 2010 Tamarisk Symposium, Grand Junction, Colo., Jan. 2010.

47. Jonathan Friedman, invited keynote speaker, **"Physical and ecological processes in episodic channels."** Conference on Episodic stream channels: imperatives for assessment and environmental planning in California. Costa Mesa, Calif., Nov. 2010.

48. Jonathan Friedman, invited keynote speaker, **"Global change and riparian exotic species."** 2010 Tamarisk Symposium, Grand Junction, Colo., Jan. 2010.

49. Erik Hernandez, trainer, **"New Windows 2008 and Windows 7 technologies."** Bi-annual Information Technology Exchange Meeting (ITEM 2010), San Antonio, Tex., May 2010.

50. Tracy Holcombe, invited speaker, **"Weeds as affected by climate change."** Colorado Weed Management Association, Grand Junction, Colo., Dec. 2009.

51. Bill Iko (and others), invited speakers, **"Occurrence of West Nile virus infection in raptors at the Salton Sea, California."** 2010 Raptor Research Foundation Annual Meeting, Fort Collins, Colo., Sept. 2010

52. Tim Kern, invited presenter, **"Data Integration Development Project, Goal 3—ScienceBase Repository/Uploader."** USGS Enterprise Leadership Team, Reston, Va., June 2010.

53. Tim Kern, invited presenter, **"Data Integration Development Project, Goal 3 – ScienceBase Repository/Uploader."** USGS Council for Data Integration Workshop, Denver, Colo., Aug. 2010.

54. Tim Kern, invited presenter, **"Selecting a sustainable Web application architecture"**, presentation to the USGS ITEM Conference, San Antonio, Tex., May 2010.

55. Tim Kern, invited presenter, **"Web-based data management best practices."** USGS ITEM Conference, San Antonio, Tex., May 2010.

56. Tim Kern, invited presenter, **"Data integration support tools."** USGS ITEM Conference, San Antonio, Tex., May 2010.

57. Tim Kern, invited presenter, **"Assessing reclamation goals: the Jonah Infill Data Management System."** JIO/PAPO Reclamation Workshop, Pinedale, Wyo., May 2010.

58. Tim Kern, invited presenter, **"Web-based data management."** Southern Arizona Buffelgrass Coordinating Committee, Tucson, Ariz., May 2010.

59. Tim Kern, invited presenter, **"Using a rapid web application development framework for geospatial data management."** USGS Council for Data Integration Workshop, Madison, Wis., Jan. 2010.

60. Tim Kern, invited presenter, **"ScienceBase design and use: project components."** presentation to the USGS Council for Data Integration Workshop, Denver, Colo., Oct. 2009.

61. Tim Kern, invited presenter, **"Wyoming Landscape Conservation Initiative GIS Data Integration."** USGS Council for Data Integration Workshop, Denver, Colo., Oct. 2009.

62. Holly Miller, invited speaker, **"Users, uses, and benefits of moderate resolution imagery."** USGS Landsat Science Team meeting, Boise, Idaho, June 2010.

63. Jeff Morisette, invited speaker, **"Invasive species modeling efforts at the USGS Fort Collins Science Center."** Alaska Committee for Noxious and Invasive Plant Management (CNIPM), Ketchikan, Ak., Oct. 2009.

64. Jeff Morisette, invited speaker, **"Honeybee scale hive network."** Northern Colorado Beekeepers Association, Fort Collins, Colo., March 2010.

65. Jeff Morisette, invited speaker, **"Invasive species modeling efforts at the USGS Fort Collins Science Center."** National Wildlife Research Center Monthly Seminar, Fort Collins, Colo., Jan. 2010.

66. Jeff Morisette, invited speaker, **"The USA National Phenology Network Land Surface Phenology/Remote Sensing Phenology Program."** North Carolina State University Forestry Department seminar series, Raleigh, N.C., Apr. 2010.

67. Jeff Morisette, Invited keynote address. **"Mission data for adaptation and invasive species."** NASA's Earth Observing Missions Applications Workshop, Colorado Springs, Colo., Feb. 2010.

68. Erin Muths, invited speaker, **"Compensatory effects of recruitment and survival on population persistence—with and without disease."** Workshop on experimental disease dynamics and mitigating chytridiomycosis, University of Zurich, Switzerland, Oct. 2010.

69. Sara Oyler-McCance, invited speaker, **"Protection for endangered species: when a species definition makes the difference."** Presented to the Colorado Biology Teachers Association Annual Meeting, Denver, Colo., April 2010.

70. Sara Oyler-McCance, invited speaker, **"Molecular tagging: new methods to estimate population size using non-invasive genetic sampling."** Departmental Seminar for the Department of Biology, University of Colorado at Denver, Denver, Colo., Apr. 2010.

71. Sara Oyler-McCance and Jennifer Fike (and others), invited speakers, **"Investigation into family relationships among broad-tailed hummingbirds using molecular genetic techniques."** Annual Rocky Mountain National Park Research Conference, Estes Park, Colo., Mar. 2010.

72. Sara Oyler-McCance, invited speaker, **"Using genetic data to assist in the management of sage-grouse in light of energy development and climate change."** USGS Genetics and Genomics Showcase, Washington, D.C., Mar. 2010.

73. Sara Oyler-McCance, invited speaker, **"Utilizing genetics and genomics to better understand wildlife populations."** USGS Wildlife Program Review, Reston, Va., Oct. 2009.

74. Jason Ransom, invited speaker, **"Understanding wild horse behaviour."** International Wild Equid Conference, Northern Territory, Australia, June 2010.

75. Robert Reed, invited keynote address, **"Risk assessments for giant constrictors: background, science, and controversy."** Joint meetings of the Association of Reptile and Amphibian Veterinarians and Exotic Animal Veterinarians, South Padre Island, Tex., Oct. 2010.

76. Robert Reed, invited speaker, **"Risk assessments for giant constrictors: background, science, and controversy."** Colorado State University Ecology class, Fort Collins, Colo., Apr. 2010.

77. Gordon Rodda, invited speaker, **"Python update: key issues for Southwest Florida."** Southwest Cooperative Invasive Species Management Area (CISMA) workshop, Naples, Fla., Dec. 2009.

78. Gordon Rodda, invited speaker, **"America's animal invasions: what are the roles for USGS scientists in ecology, control, and policy?"** Colorado State University, Ecology class, Fort Collins, Colo., Apr. 2010.

79. Gordon Rodda, invited speaker, **"The seduction of MaxEnt: challenges in identifying sites climatically matched to the native ranges of animal invaders."** Joint Meeting of Ichthyologists and Herpetologists, Providence, R.I., July 2010.

80. Ron Rozar, invited speaker, **"Burmese Python management in southern Florida."** U.S. Fish and Wildlife Service Directorate Meeting, Loxahatchee National Wildlife Refuge, Boynton Beach, Fla., Jan. 2010.

81. Ron Rozar, invited speaker, **"Pythons and native snakes in the Keys."** The Delicate Balance of Nature lecture series, Pennekamp Coral Reef State Park, Key Largo, Fla., Feb. 2010.

82. Ron Rozar, invited speaker, **"Pythons on the prowl in the Keys."** National Marine Sanctuaries seminar series, Florida Keys Community College, Key West, Fla., Feb. 2010.

83. Ron Rozar, invited speaker, **"Python research."** Loxahatchee National Wildlife Refuge–Everglades Days Festival, Boynton Beach, Fla., Feb. 2010.

84. Ron Rozar, invited speaker, **"Python control in the Florida Keys."** Everglades Restoration Meeting, U.S. Fish and Wildlife Service Ecological Services Office, Vero Beach, Fla., Apr. 2010.

85. Ron Rozar, invited speaker, **"Invasive constrictors in southern Florida."** Meeting of U.S. Fish and Wildlife Service Assistant Regional Directors for Fisheries and Aquatic Invasive Species, Everglades National Park, Homestead, Fla., May 2010.

86. Janet Ruth, invited speaker, **"Identification of winter sparrows and associates."** Friends of the Audubon Research Ranch, Elgin, Ariz., Nov. 2009.

87. Janet Ruth, invited speaker, **"Ten years of research on grassland birds in Arizona."** Science on the Sonoita Plain: Quarterly Meeting of the Sonoita Valley Planning Partnership, Audubon Research Ranch, Elgin, Ariz., Aug. 2010.

88. Natalie Sexton, invited speaker, **"Users, Uses, and Benefits of Moderate Resolution Imagery."** USGS Landsat Science Team meeting, Boise, Idaho, June 2010.

89. James Stanford and Shane Siers, invited speakers, **"USGS-BRD BTS project and status of biosecurity in non-U.S. States of Micronesia."** Micronesian Bio-security Plan All-Hands Meeting, Tumon, Guam, Jan. 2010.

90. Jeff Schafer, instructor, **"Multi-vendor virtualization."** Class for USGS IT personnel, Information Technology Exchange Meeting (ITEM 2010), San Antonio, Tex., May 2010.

91. Michael Scott and Greg Auble, invited presenters, **"Historical cover types and riparian management along the Missouri River in the Missouri Breaks National Monument."** Decade of Discovery, National Landscape Conservation System Science Symposium, Albuquerque, N. Mex., May 2010.

92. Michael Scott and Greg Auble (and others), invited presenters, **"Historical riparian cover types in the Missouri Breaks National Monument."** Missouri River Natural Resources Committee Conference, Nebraska City, Neb., Mar. 2010.

93. Pat Shafroth (and others), invited speaker, **"Site factors and natural processes influencing vegetation recovery following biological control of *Tamarix*: implications for restoration."** 2010 Tamarisk Symposium, Grand Junction, Colo., Jan. 2010.

94. Pat Shafroth, invited speaker, **"Elwha River vegetation research."** Society for Ecological Restoration International Northwest Chapter and the Washington Chapter of The Wildlife Society Regional Conference, Tulalip, Wash., Feb. 2010.

95. Susan Skagen, invited speaker, **"Forecasting the effects of sedimentation and climate change on prairie wetlands: implications for migrating shorebirds."** Symposium on Advances in Shorebird Conservation, AOU/COS/SCO Annual Meeting, San Diego, Calif., Feb. 2010.

96. Sarah Spaulding, invited speaker, **"Diatom community and ecosystem response: atmospheric deposition, climate change, and species invasion."** National Park Service, Air Resources Division, Lakewood, Colo., Mar. 2010.

97. Sarah Spaulding, course guest lecturer and field leader, **"Winter Ecology."** University of Colorado Mountain Research Station, Nederland, Colo., Feb. 2010.

98. Sarah Spaulding, invited speaker, **"The role of iron in blooms of *Didymosphenia geminata.*"** USGS Water Science Day, University of Colorado, Boulder, Colo., June 2010.

99. Sarah Spaulding, invited workshop presenter, **"Introduction to the freshwater diatom genera: learning to 'see' diatoms."** North American Benthological Society one day course, North American Benthological Society Annual Meeting, Santa Fe, N. Mex., June 2010.

100. Sarah Spaulding, invited speaker, **"Special Session on *Didymosphenia geminata*"** American Society of Limnology and Oceanography Annual Meeting, Santa Fe, N. Mex., June 2010.

101. Sarah Spaulding, invited field expert and speaker, **Chilean Research Institute, Centro de investigacion en ecosistemas de la Patagonia (CIEP)**, Coyhaique, Chile, July 2010.

102. Sarah Spaulding, invited field expert, **"Boulder Creek Watershed."** All-day field trip for Geological Society of America Annual Meeting, Boulder, Colo., Sept. 2010.

103. Thomas Stohlgren, invited speaker, **"Forecasting weed invasions with climate change."** Weed Science Association and Society of Range Management meeting, Denver, Colo., Feb. 2010.

104. Thomas Stohlgren, invited keynote address, **"Ecological Forecasting in Conservation Biology."** Texas Conservation Biology meetings, Galveston, Tex., Feb. 2010.

105. Thomas Stohlgren, invited speaker, **"Global Plant Invasions and Ecological Forecasting."** University of Sapienza, Rome, Italy, Apr. 2010.

106. Thomas Stohlgren, invited speaker, **"Modeling species distributions online."** First NEON-NSF-ESA Webinar to participants at 30 universities across the United States, April 2010; Webinar for Indiana University and the U.S. Fish and Wildlife Service, Sept. 2010.

107. Craig Stricker, invited speaker, **"A review of hydrogen, oxygen, and sulfur isotope geochemistry with applications to ecological studies."** Spring Institute in Stable Isotope Biogeochemistry, Michigan State University, East Lansing, Mich., 2010.

108. Terry Waddle, invited workshop organizer and instructor, **"Use of the River2D Hydrodynamic Model in Aquatic Habitat Analysis,"** California-Nevada Chapter of the American Fisheries Society, Redding, Calif., Mar. 2010.

109. David Walters, invited speaker, **"Characterization of selenium and mercury exposure in the Colorado River food web in the Grand Canyon."** 2009 Colorado River Basin Science and Resource Management Symposium, Scottsdale, Ariz., Nov. 2009.

110. David Walters, invited speaker, **"The dark side of subsidies: Tracking contaminant export from aquatic to terrestrial ecosystems."** Colorado State University, Fort Collins, Colo., Oct. 2009, and The Ohio State University, Columbus, Ohio, Feb. 2010.

111. David Walters, invited speaker, **"Overview of the GLNPO/ORD/BRD research efforts on Ottawa River."** USEPA Remedy Effectiveness Summit for Contaminated Sediments. Toledo, Ohio, Sept. 2010.

112. David Walters, invited speaker, **"Using riparian spiders as sentinels of PCB export and risk at contaminated sediment sites."** Society of Environmental Toxicology and Chemistry, New Orleans, La., Nov. 2009. Selected for USGS media tip-sheet (~10 selected from 70 USGS abstracts).

113. Linda Zeigenfuss and Kate Schoenecker, invited speakers. **"Elk, bison, and vegetation dynamics in the Great Sand Dunes ecosystem."** Colorado Field Institute Winter Lecture Series, Alamosa, Colo., April 2010.

Publishing support provided by:
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