



Fort Collins Science Center Fiscal Year 2008 Science Accomplishments

Compiled by Juliette T. Wilson



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Introduced Burmese pythons have become established in the greater Everglades ecosystem and are expanding their range in south Florida. FORT scientists and cooperating investigators are developing techniques for detecting, capturing, and controlling populations of giant constricting snakes in Florida and elsewhere. Here, researchers at Everglades National Park, along with FORT research zoologist Gordon Rodda (holding snake at far right end), implant a radio transmitter in a 16', 155-lb female Burmese python. Radio tracking builds understanding of where pythons spend their time and therefore where they can be controlled in practice. Photograph by Lorie Oberhofer, Everglades National Park.

Fort Collins Science Center Fiscal Year 2008 Science Accomplishments

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Science for Natural Resource Management

Public land and natural resource managers in the United States are confronted with increasingly complex decisions that have important ramifications for both ecological and human systems. The scientists and technical professionals at the U.S. Geological Survey (USGS) Fort Collins Science Center (FORT)—many of whom are at the very forefront of their fields—constitute a unique blend of ecological, socioeconomic, and technological expertise. Because of this diverse talent, FORT staff are able to apply a systems approach to investigating complicated ecological problems in a way that helps answer critical management questions. In addition, FORT has a long record of working closely with the academic community through cooperative agreements and other collaborations. FORT is deeply engaged with other USGS science centers and partners throughout the Department of the Interior (DOI). We can, and often do, incorporate the expertise of these partners in providing a full complement of “the right people” to effectively tackle the multifaceted research problems of today’s resource management world.



This Greater Sage-Grouse chick weighs in, dwarfed by the pan atop the scale. It will be fitted with a radio transmitter to track its movements and survival. Photograph ©Cameron Aldridge, Colorado State University and USGS. Used with permission.

In Fiscal Year 2008 (FY08), FORT’s scientific and technical professionals continued research vital to DOI science and management needs. FORT work also supported the science needs of other Federal and State agencies as well as non-government organizations. Specifically, FORT research and technical assistance focused on client and partner needs and goals in the areas of biological information management and delivery, fisheries and aquatic systems, invasive species, status and trends of biological resources (including human dimensions), terrestrial ecosystems, and wildlife resources. In the process, FORT science addressed natural-science

¹ ASRC Management Services, under contract to the U.S. Geological Survey, Fort Collins, Colo.

information needs identified in the *USGS Science Strategy* (http://www.usgs.gov/science_strategy/), including understanding and predicting change in ecosystems, climate variability and change, energy development and land management, human health and wildlife, and freshwater ecosystems. Several science projects expanded in FY08 to meet these evolving needs. The table in Appendix IV shows how FORT accomplishments in 2008 relate to specific science strategy areas.

2008 Science Accomplishments

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



= major collaborative venture



= integrated science projects involving other USGS disciplines



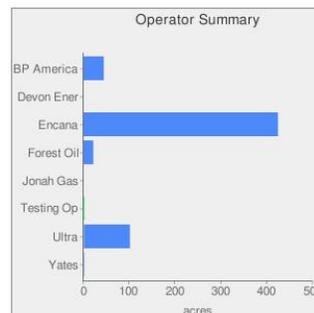
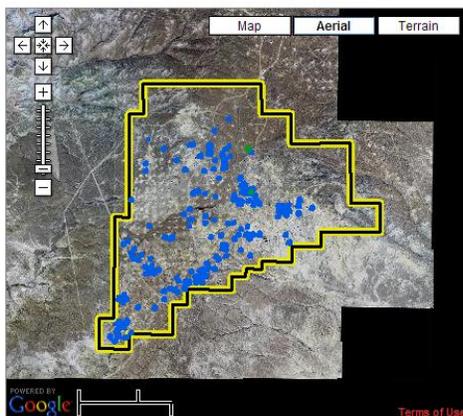
= new science direction

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 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.

FORT Web Applications and Services. Effectively presenting and applying biological information to natural resource issues continues to be a priority need of natural resource

Welcome to The Jonah Infill Data Management System



Screen capture from the Jonah Infill Data Management System, which tracks data and information associated with surface disturbance and reclamation efforts in the Jonah Natural Gas Field, Wyo. USGS image.

Select an operator to view in detail:

agencies. Over the years, FORT's Web Applications Team has provided applications development, infrastructure design and implementation, and technical support for a range of Web-based products designed to present and apply natural resource information more effectively. Currently, the team is working with FORT scientists to develop records management, document management, online mapping and modeling, and decision support systems. These systems address issues confronted by scientists working with habitat–energy development conflicts, socioeconomic issues, invasive species, resource mapping, and statistical assessment. In FY08, FORT generated and began testing pilots of several decision-support systems, including a socioeconomic resource management planner, an interagency project management system, and Web services for sharing and mapping large datasets for partners in the Wyoming Landscape Conservation Initiative. For the Invasive Species Modeling and Assessment System, the Web development team held a demonstration workshop for various Interior and agency officials (see “Workshops,” p. 25) and used their feedback to begin refining the application.

Metadata Development and Quality Control. In order to increase the availability of biological data and information, in FY08 the FORT Metadata Team created metadata for FORT publications and for information and data products at the project and dataset levels. Metadata produced are compliant with the Federal Geographic Data Committee Biological Data Profile (FGDC/BDP) metadata standards and are served on the National Biological Information Infrastructure (NBII) Clearinghouse. Also, the FORT Metadata Team again served as a national contact for metadata submitted to the NBII Principal node, performing quality control steps to ensure that metadata prepared for serving online have appropriate content and meet the syntax rules specified in the FGDC/BDP Content Standards. FORT staff also instructed sections of two NBII-sponsored metadata training courses.



USGS Scientist Serves as Liaison to the National Ecological Observatory Network.

In FY08, FORT research ecologist Tom Stohlgren began serving a 3-year detail as a USGS liaison to the National Ecological Observatory Network (NEON). In this capacity, Dr. Stohlgren has provided scientific guidance on several important aspects of program planning, protocol development, and field-testing of biodiversity sampling. NEON is a continental-scale research platform for discovering and understanding the impacts of climate change, land-use change, and invasive species on ecology. NEON will gather long-term data on ecological responses of the biosphere to changes in land use and climate, and on feedbacks with the geosphere, hydrosphere, and atmosphere. Through this commitment of a USGS liaison, the USGS has been an essential partner to NEON as the cooperators design the “domain” strategy and develop data-gathering protocols. When implemented, these strategies and protocols will augment the scientific understanding and theory required to manage the Nation’s ecological challenges.

Enterprise Information

This work involves creating elements of the USGS integrated information environment.



Integrated Information Environment Support. The USGS Geospatial Information Office (GIO) currently leads the effort to expand the existing USGS Web-based toolkit. These applications and services act as the foundation for the integrated information environment,

supporting science and decisionmaking. In partnership with the GIO, FORT has developed a centralized suite of applications, services, and infrastructure designed to make collaboration within a science community—and deployment of community-specific applications—faster and easier. The adoption of open standards for guiding application development and information interoperability means that software developers working with scientists will have a defined, supported, and secure platform to deploy high-end, project-specific applications with no ongoing license costs. Multiple components were released to production in FY08. For example, the FORT Web Applications Team:

- worked with the Central Region GIO to deploy V3.0 and V4.0 of MyUSGS, the base application that encapsulates these collaboration and deployment tools;
- designed, built, implemented, and now maintains People-Locations-Organizations-Teams (PLOT), a “broker Web server” that harvests data from various official data stores, builds relations among all the different databases, and generates Web services for each of these related data;
- designed and developed a way for USGS scientists and managers to add and edit content on their Web sites through a simple form interface (Simple Content Information Management, or SCIM);
- worked with the USGS geography center in Rolla, Mo., to provide secure authentication methods, build and maintain data structures, deliver Web mapping and feature services, and deploy application enhancements for the Comprehensive Science Catalog, which in turn provides data services that can be used by any partner site;
- worked with USGS headquarters personnel to provide secure authentication methods, build and maintain data structures, and deploy application additions and corrections for the Geospatial Management Information System; and
- completed Phase II implementation of the Central Region Application Hosting Center, which consists of over 30 application and database servers and acts as the primary hosting platform for data, document, and GIS management systems.

Wireless Solutions. As part of a continuing effort to improve the information services available to FORT scientists and partners, in FY2008 FORT Information Technology (IT) staff implemented a wireless network. This new network allows for greater convenience and improved productivity of staff and allows FORT partners access to the Internet and email while visiting the Center. The system includes a streamlined process to provide controlled access to the secured network and integrates a ticketing system with authentication. The architecture enables our wireless network to equal wired connections in terms of performance and security while providing the mobility, productivity, and life-cycle cost benefits that come from a wire-free network. Our solution, which incorporates centralized management to control access and secure the network, takes a new approach to wireless implementation; and, as one of the first for the USGS, it provides a model for other wireless implementations within the Bureau.

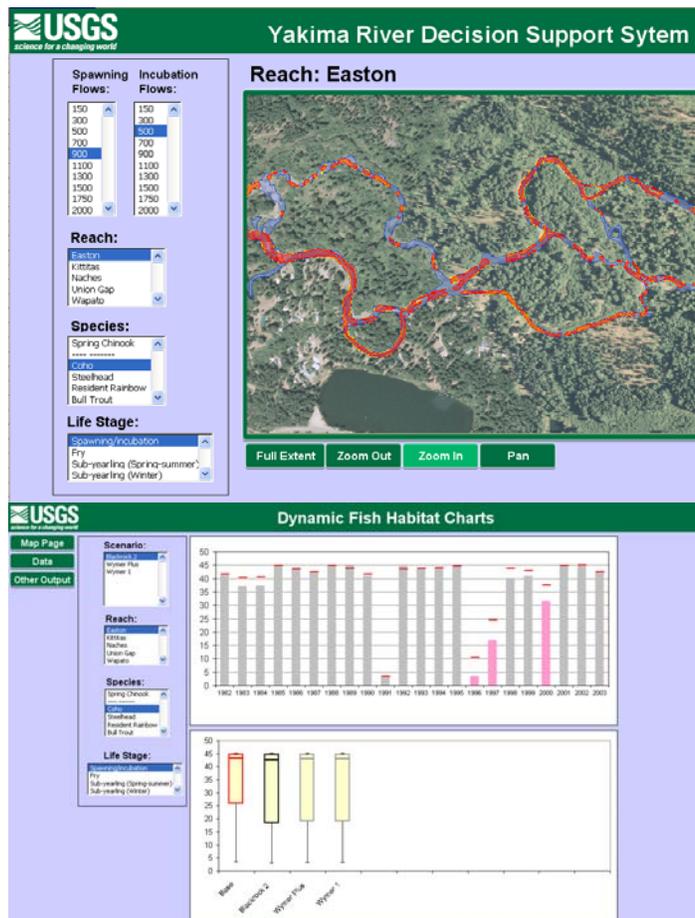
Network Security. FORT staff provide technical assistance and develop anti-malware solutions and processes for the USGS IT Security Operations Team (ITSOT) and Computer Security Incident Response Team (CSIRT). Developed in partnership by the GIO and FORT Computer Operations Team, the USGS Enterprise Antivirus Solution currently provides malware

protection for more than 9,000 (and growing) USGS systems across the United States in all USGS disciplines. In addition to administering this system, FORT staff assist USGS and DOI in detecting and resolving malware issues (viruses, trojans, and the like), including variants undetectable by many antivirus products. FORT is currently designing and testing a new server architecture and deployment plan for the antivirus system, with new and improved anti-malware and intrusion detection/prevention capabilities. This new architecture will be implemented in 2009 with an eventual goal of protecting all USGS systems.

Fisheries: Aquatic and Endangered Resources

Activities related to fish and aquatic resources involve research and technical assistance that promote understanding of relationships 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.

 **Individual River Basin Management Decision Support Models.** FORT developed decision support models for the Rio Grande and Klamath, Trinity, and Yakima River basins to help resource managers estimate biological responses to complex water management decisions. The lower Isleta reach of the Middle Rio Grande in New Mexico was the location for modeling streamflow and endangered species (Rio Grande silvery minnow and southwestern willow flycatcher) habitat responses to the proposed “Bernardo Siphon” project. Modeling using the Klamath River Decision-Support System was conducted as part of the settlement negotiations process for the Klamath River Hydropower units. FORT provided the Trinity River Restoration Program and the Klamath Settlement Resolution process with technical guidance on SALMOD (Salmonid Population Model) application and testing in the Trinity River. FORT’s Yakima River Decision Support System quantifies and displays habitat impacts of multiple reservoir operation and irrigation delivery options in the upper Yakima River Basin. Finally, FORT developed *Smart River GIS*, which



Prototype geospatial information system for the Yakima River, Wash. Top: Example of a spawning–incubation habitat persistence map for Coho salmon. Bottom: Results of a habitat time series analysis for the same site and species. Images by Ken Bovee, USGS.

couples GIS and 2-dimensional hydrodynamic models to provide interactive visualization of fish habitat and fish production model-output responses to different water management options.

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 of Invasive Burmese Pythons in

Florida. Invasive Burmese pythons have become established in the Greater Everglades ecosystem and are expanding their range in southern Florida. These giant snakes (up to 20 ft and 250 lbs) are efficient predators on warm-blooded species ranging from wrens to deer and represent a novel threat to which native species are poorly adapted. In 2006, FORT scientists with expertise in controlling invasive brown treesnakes were asked by cooperating agencies to initiate a major new science direction focused on developing techniques to detect, capture, and control populations of giant constricting snakes in Florida and elsewhere. In FY08, we began development of capture tools in areas with high python densities outside Everglades National Park. Results will be applied to detecting and capturing pythons as they invade Key Largo, in support of conservation efforts for federally endangered small mammals. FORT is also conducting a risk assessment of multiple species of giant constrictors as potential invaders for use in formulating policy to prevent further invasions. Cooperating agencies include the Endangered Species and National Wildlife Refuges branches of the U.S. Fish and Wildlife Service (FWS), National Park Service (NPS), South Florida Water Management District, Florida Department of Environmental Protection, and University of Florida.



Developing eggs in Burmese python. Burmese pythons breed annually and have a maximum clutch size of 107 (average is 35), allowing their population to increase very rapidly under favorable conditions. Females can carry fertilized eggs and release them in a new location. Photograph by Lorie Oberhofer, NPS.



Considering the Impacts of Climate Change on Invasive Species. It is well established that climate is the dominant determinant of the geographic distribution of species, native or alien. Long-term management of DOI lands requires forecasts of climate change effects on harmful alien, “invasive” species that threaten U.S. ecosystems. FORT invasive species scientists have established a scientific foundation for linking climate change projections with invasive

species habitat modeling. Our project investigating the potential effects of climate changes on harmful invasive species and their distribution in the U.S. will (1) identify the highest-priority non-native species likely to invade DOI lands across the country, (2) determine how this suite of potential invasives will change under accepted climate scenarios, and (3) quantify and map the highest priority vulnerable habitats, now and in the future, focusing on short- and long-term early detection programs under competing future climate projections. A 2008 paper emanating from this work, “Near-term Climate Projections for Invasive Species Distributions,” was given at the 2008 Ecological Society of America conference and will be published in *Biological Invasions* in 2009. The research integrates habitat modeling, current climate conditions, and climate forecasting to estimate the potential spread of invasive weeds under projected climate scenarios for 2020 and 2035 and identify management implications.



Reptile and Small Mammal Surveys of Tinian and

Aguiguan Islands. Brown treesnakes have been largely responsible for the loss of many native birds and lizards on the island of Guam. Brown treesnakes can survive transportation from Guam, placing the entire Pacific region at risk of invasion. The island of Tinian is considered especially high risk due to its proximity to Guam, the volume of air and sea craft arriving from Guam and Saipan, and the upcoming military build-up in this region (two-thirds of Tinian is U.S. military-leased land). In order to determine a baseline of current



High densities of non-native rats (*Rattus* spp.) are present on Tinian and Aguiguan. Photograph courtesy of Ginger Haddock, ASRC Management Services.

herpetological species on Tinian (Military Lease Areas) and on nearby Aguiguan Island (also Aguijan or Goat Island), the FORT research team conducted surveys on these islands in 2008. They also conducted surveys of non-volant mammals (introduced rats and shrews in this case) on Aguiguan, which has been proposed as a mitigation area for military activities on nearby islands. The team employed visual surveys, trapping, mark-recapture, and absolute counts to determine the distribution and density of potential brown treesnake prey. Results provide management recommendations on these islands and discuss potential environmental impacts associated with the military buildup in Micronesia. Finally, the team recorded a reptile species not previously found on Tinian and located previously unknown local populations of several animals, including rare species. Rat DNA was collected on Aguiguan in light of evidence of a new species found on nearby islands. This work was done in coordination with the U.S. Fish and Wildlife Service (FWS), U.S. Navy, and Commonwealth of Northern Marianas Islands Department of Lands and Natural Resources.

Modeling Capture Probability of the Invasive Brown Treesnake. Visual searching is one technique currently used to detect and control invasive brown treesnakes, especially incipient

(beginning) 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. To facilitate development and refinement of detection and control technologies, biologists in this study identified and quantified the factors that affect visual detection of brown treesnakes. FORT scientists modeled detection probabilities as a function of individual covariates (size, sex, condition, prior capture history, and other factors) and latent, or unexplained, heterogeneity. This analysis represented the first time that detection probability has been modeled at this level of precision for any reptile worldwide. Improvement in our understanding of the causes of heterogeneity will not only refine our ability to strategically plan eradications, but also will improve the precision of abundance estimates. New data also allow comparisons of the relative efficacies of visual searches and snake trapping to help guide management planning.



The FORT Advanced Invasive Species Modeling.

Every ecosystem in the United States has been invaded to some degree by harmful non-native species, including plants, animals, and diseases. A growing number of these species have become "invasive," spreading at such a rapid rate that they have contributed to declines in native species and changes in ecosystem function. To provide ecological forecasting that will help managers anticipate and respond to this threat, FORT scientists have created an Advanced Invasive Species Modeling capability at FORT headquarters. This advanced modeling effort is leveraging funding from the USGS, NASA, National Science Foundation, FWS, and others to better document, map, and predict the spread of harmful plants, animals, and diseases in the United States. In response to this service, FORT partnerships have developed rapidly with individual landowners, citizen groups, the private sector, nongovernmental organizations, and other Federal, State, local, and tribal governments to battle invasive species. Examples include modeling pythons in Florida, Africanized honey bees throughout the Nation, tamarisk and Russian olive in the West, invasive diatoms in the northern/high-elevation parts of the country, and sudden oak death in California. FORT will continue to enhance both the modeling capability and partnerships in 2009, including building models of invasive mosquitoes, which carry several diseases transmittable to humans.



Spectral signature measurements of tamarisk. Tamarisk, an abundant invasive shrub, has become a dominant riparian woody species throughout much of the western United States. Here, scientists are using a spectrometer to measure the plant's spectral signature, which will support large-scale mapping by satellite. Invasive plants like tamarisk exacerbate the affects of a changing climate, in this case by usurping water from native plants that are already drought-stressed. Photograph by Paul Evangelista, Colorado State University. Used with permission.

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.



Integrating Agriculture and Conservation. FORT assistance to the USDA Farm Service Agency (FSA) remains focused on refining management of lands enrolled in USDA-administered conservation programs. In cooperation with the FSA, USDA Natural Resources Conservation Service, Colorado State University (CSU), and a private landowner, we continued an investigation on grazing CRP grasslands for sustainability and habitat in the shortgrass steppe. During 2008, we monitored grazing pressure and response of above-ground vegetation, roots, and soil chemistry during the growing season; preliminary data are being analyzed. Collaborating with the FSA, FWS, and Iowa Agriculture and Land Stewardship, FORT continued a long-term study investigating the environmental benefits derived from Conservation Reserve Enhancement Program (CREP) wetlands in Iowa. An evaluation of community vegetation and quantitative vegetation measurements were discussed in a progress report delivered to the FSA in August, 2008. Additionally, two existing and two scheduled CREP wetlands were visited to record amphibians and evaluate success of the program in terms of creating amphibian habitat in agricultural ecosystems. The presence of breeding amphibians could represent added ecosystem value and be an indicator of landscape health. Such long-term studies help refine USDA agricultural conservation policies and make them more beneficial to both agricultural operations and wildlife species.



FORT range scientist Mark Vandever records canopy cover of plant species in a 1–2 year old farmable wetland in Iowa. Photograph by Arthur Allen, USGS.

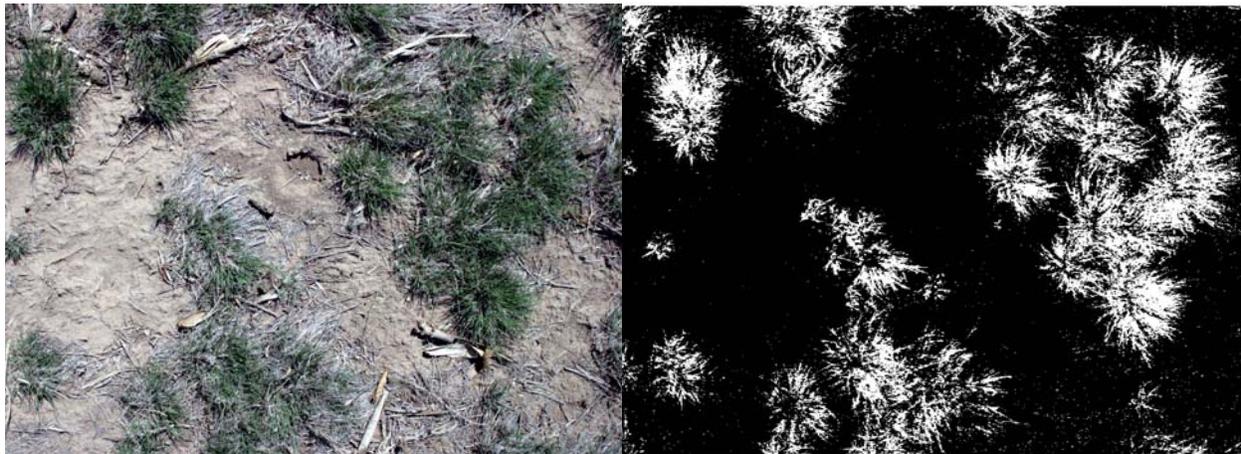


Comparative Vegetation Mapping for Lassen Volcanic National Park, Calif. The USGS-National Park Service Vegetation Mapping Program partnership is in the process of developing vegetation cover maps for most units in the National Park system. New methodologies are needed to increase the speed and accuracy of vegetation mapping, reduce the cost, and produce a quantitatively based vegetation database. In support of this effort and in collaboration with various Federal and private entities, FORT staff continued in FY08 a study comparing the widely used, traditional aerial photo-interpretation methodology with the relatively new Discrete Classification Mapping (DCM) methodology. DCM could be a more accurate and efficient mapping methodology for medium- to large-sized parks. FORT GIS

specialists converted the photo-interpreted data to GIS vector format. Concurrently, other partners developed the DCM database, designed the accuracy assessment, and collected quantitative and qualitative data at 644 locations to provide ground truth for the accuracy assessment of both databases. Acquisition of ground-truth data will allow completion of an accuracy assessment in FY09 and delivery of the two vegetation databases to the NPS.



Image Analysis for Growers to Map Weed Cover in Fallow Fields with Color Digital Images. In addition to being affordable, weed mapping must be both practical and accurate enough for decisionmaking. While mapping options exist, they tend to be expensive to implement. In partnership with the USDA Agricultural Research Service (ARS), FORT has been experimenting with weed mapping using a lower-cost system comprising an inexpensive digital camera and commercial software, a GPS receiver, and mapping software developed by FORT. The ARS developed the camera and GPS tractor-mounted system for acquiring photographs as the tractor traverses a fallow field. FORT developed the image processing algorithm and a series of software versions that read in the processed imagery and generate a weed map of the fallow field. In FY 2008, ARS and FORT completed and performed an accuracy assessment of the system, which showed that growers can get usable information about weed cover from such digital color images and maps to help them plan weed management for the next commercial crop. This methodology, or modifications thereof, also could have applications in natural resources inventory and monitoring where vegetative mapping is required.



Left: Photograph taken in a fallow farm field showing weed plants, plant debris, and bare soil. *Right:* FORT's photo processing differentiates weeds (white) from the background (black). The ratio of weed pixels to the total number of pixels in the image is an estimate of weed cover. The percent weed cover in thousands of images is used to produce a map of weed cover for the subject farm field. Images courtesy of Robert Waltermire, USGS.



Applications of Radar Technology to Studying, Conserving, and Managing Migratory Birds. Over the last few years, in cooperation with the University of Southern Mississippi, FORT has been involved in a collaborative research project using radar technology (WSR-88D weather radar) to study bird migration patterns in the southwestern borderlands region. A FORT scientist has taken the lead in developing a collaborative effort bringing together scientists from USGS and other agencies and institutions, resource managers, regulators, and utilities to discuss ways radar technology can be used to answer questions about bird (and

bat and insect) movement patterns to be applied to conservation and management actions. A USGS-FWS interagency workshop that FORT organized and facilitated in 2006, and for which we published the proceedings in 2007 (see http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22018), produced priority action items, two of which FORT addressed in 2008. Specifically, we developed a Web site (<http://www.fort.usgs.gov/radar/>) that provides information about the workshop as well as radar applications (USGS publications, links to other research, bibliographies by topic) to managers, regulators, scientists, industry, and other interested parties. We also led production of the first of several fact sheets requested by workshop participants. Entitled “Management and Research Applications of Long-Range Surveillance Radar Data for Birds, Bats, and Flying Insects,” this USGS Fact Sheet (2008-3095) provides information on applications of long-range radar to avian conservation questions (see http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22359). Also in FY08, we published the first peer-reviewed manuscript on radar technology, “Seasonal Passerine Migratory Movements over the Arid Southwest,” in *Studies in Avian Biology*, volume 37, published by the Cooper Ornithological Society. The paper provides landscape-level information about migrant flight direction, speed, and flight altitudes across the borderlands region.



As the truck-mounted X-band marine radar with standard open array antenna rotates, FORT ecologist Janet Ruth scans the horizon to verify targets detected by radar near Tucson, Ariz. Photograph courtesy of Janet Ruth, USGS.



Migratory Bird Response to Environmental Change. Understanding the relations among bird populations, agricultural practices, and changing climate is necessary for protecting migratory bird species, and many agencies within the Departments of Agriculture and the Interior are charged with developing this understanding. In collaboration with the FWS and Colorado State University, FORT scientists are developing dynamic mathematical models to clarify how agriculturally driven environmental change and global climate change will modify conditions and habitats for breeding, migrating, and wintering bird species across prairie wetland landscapes in the coming decades. As one step in this process, in FY08 we began estimating the expected amount of sediment runoff that would enter wetlands by using the Revised Universal Soil Loss Equation (RUSLE) populated with spatially explicit soil, topography, land-use, and climate data. Additionally, in collaboration with the USGS Water, Geography, and Geology Disciplines, we began development of computer models that will determine the long-term demographic consequences of climate change scenarios for migratory shorebirds. In partnership with the University of Arizona, we are determining the sensitivities of migrating songbirds to loss of riparian forests due to global change and water-use patterns. To this end, an existing database containing data from more than 30 collaborators studying avian migration along four major river systems in the desert Southwest was merged with local and regional weather and water data gathered from the USGS and NOAA. The resulting database now includes data on the timing of migration, avian diversity, and avian abundance, as well as measures of climate (such

as winter/spring temperature, winter/spring/summer precipitation), water availability (river flow, width, depth), and elevation at each avian sampling station.



Birds of the U.S.-Mexico Borderlands: Distribution, Ecology, and Conservation. The borderlands region supports a large number of bird species of conservation concern identified by numerous sources, including the FWS and Partners in Flight. However, for many of these species, scientists and resource managers lack adequate information on population trends and ecology to implement conservation actions. In response to this need, FORT ecologist Janet Ruth was the lead associate editor in producing *Birds of the US-Mexico Borderlands: Distribution, Ecology, and Conservation*, volume 37 of *Studies in Avian Biology* (SAB), published by the Cooper Ornithological Society. This volume provides new information about changes in bird distribution and abundance; trends and ecology of riparian, wetland, and grassland birds; new technology applications; and planning for bird conservation. It is one result of a symposium held at the North American Ornithological Conference in Veracruz, Mexico, in



FORT ecologist Janet Ruth holds a wintering Baird's Sparrow at a sampling site in New Mexico. USGS photograph.

October 2006. Following two years of work with authors and reviewers, the SAB volume was released to the public at the end of FY08. Within the volume, Dr. Ruth also was the lead author of the Preface, (see http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22360) sole author on a paper about Arizona Grasshopper Sparrow status and distribution (see http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22138), and third author on a paper about bird migration patterns in the borderlands region as determined by weather surveillance radar (see http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22165).



Summary and Analysis of the U.S. Government Bat Banding Files. From 1932–1972, the U.S. Fish and Wildlife Service administered and coordinated a Bat Banding Program that issued 2 million bands. Of these, approximately 1.5 million were applied to 36 species of bats by scientists, their students, and colleagues in many locations in North America. Bands were issued and copies of the permanent records are currently maintained by the USGS Patuxent Wildlife Research Center, Biological Survey Unit at the Smithsonian Institution, National Museum of Natural History, Washington, D.C. Throughout the program, banders noticed numerous negative effects of the bands on bat health and survival, leading to a moratorium on bat banding by the FWS and a resolution to cease banding by the American Society of Mammalogists in 1973. The justification for the moratorium included a recommendation to conduct a detailed evaluation of the program files to determine the value and relevance of the biological data that were accumulated in the files. However, this critical evaluation was never completed. In an effort to satisfy this need, in FY08 FORT completed a report that provides a detailed history of the program, a literature review of bat banding activities during the program, and a case study in managing data and applying current mark-recapture theory to a set of banding records from Washington State. Based on the findings of the summary and analysis, the report,

Summary and Analysis of the U.S. Government Bat Banding Program (USGS Open-File Report 2008-1363), provides several recommendations on future uses of the Bat Banding Program files (see http://www.fort.usgs.gov/products/publications/pub_abstract.asp?PubID=22435).



Assessment for Pacific Sheath-tailed Bats on Aguiguan, Commonwealth of the Northern Mariana Islands. The last remaining population of a subspecies of Pacific sheath-tailed bat was studied in June–July 2008 on Aguiguan by a team including biologists from FORT and the USGS Pacific Island Ecosystems Research Center, Hawaii. This study for the FWS consisted of assessing abundance and use of caves by these bats (candidate species under the Endangered Species Act), establishing baseline site-occupancy models of foraging habitat using echolocation calls, and obtaining life history information. Counts of individuals at caves in 2008 were higher than in 1984, 1995, and 2003. Site occupancy models show that activity and occurrence are related to canopy cover, vegetation stature, and distance to roosts, with native limestone forest the preferred foraging habitat. Fecal analysis indicates a diet of small insects, likely forest-dependent species captured near the canopy. Bat reproduction data suggest a very limited capacity for population growth. Management to enhance native forest is critical for this subspecies, and further research is needed to improve understanding of its taxonomic status.



The Use of Science in Decisionmaking. When scientific studies provide inconsistent or conflicting guidance, what's a manager to do? Because this is a high-priority question for the U.S. Bureau of Reclamation (Reclamation), they asked FORT to investigate how Reclamation managers approach disputes over the science used in water allocation decisions. Working with Reclamation's Technical Services Center to develop an understanding of this issue, FORT social scientists (1) conducted a literature review, (2) wrote a report summarizing Reclamation managers' responses to a survey and workshop panel about how they make decisions in these uncertain situations, and (3) designed a broader study to determine the mechanisms currently in use by Reclamation managers and the level of success of these mechanisms. Reclamation managers reported using a variety of tools and processes, including additional scientific study/peer review, adaptive management, collaborative management, and hybrid approaches. Although they were able to identify perceived strengths and weaknesses of these approaches, there was little convergence on a single tool or process. Our ongoing research will help answer questions about how science supports decisionmaking, and how managers can act effectively when the science used in a decision does not provide clear guidance about a single course of action.

Socioeconomic Considerations for Public Lands Management and Planning. Public land managers require clear and objective guidance on the use of socioeconomic information for management and planning. Many agencies are required by law to develop a plan for each unit or complex of public land (such as refuge Comprehensive Conservation Plans [CCPs] and BLM Resource Management Plans). These plans generally must (1) contain an analysis of social and economic conditions and (2) evaluate social and economic results from likely management scenarios to aid planning decisions and help guide management actions. FORT social scientists and economists have worked with more than 12 FWS National Wildlife Refuges and multiple BLM Resource Management Areas across the United States to provide social and economic assessments in support of their long-term planning. Research involves:

1. social analysis of public attitudes related to changes in management;
2. regional economic impact analyses of current and proposed management activities;
3. nonmarket valuation of refuge visitor benefits; and
4. stakeholder evaluations to identify and classify
 - a. the primary policies, regulations, and stakeholders affecting the land unit plan, and
 - b. obstacles and opportunities affecting the planning process.



A participant in the stakeholder evaluation for Canaan Valley National Wildlife Refuge uses the Q-sort method to identify priority refuge issues. Photograph by Natalie Sexton, USGS.

In FY08, FORT scientists conducted an in-depth stakeholder evaluation for Canaan Valley National Wildlife Refuge in West Virginia to better understand contentious community issues as well as common ground that may exist. Refuge and planning staff use this information as guidance in developing management alternatives for the CCP. The results of this evaluation were presented to stakeholders and the community at large to increase understanding of issues and improve public involvement in the planning process.



Training and Technical Assistance for Public Lands Management and Planning. The

U.S. Fish and Wildlife Service requires assistance in several aspects of CCP development: incorporating sound science, training, and creating policy and guidance documents. In FY08, FORT assisted in updating the national CCP course and taught the biological sections of the course. FORT worked with numerous individual National Wildlife Refuges, assisting refuge staff in synthesizing available science in order to develop high-quality, science-based biological objectives for the CCPs. In addition, we summarized and disseminated lessons learned through (1) presentation at the 2008 International Union for Conservation of Nature (IUCN) World Conservation Congress to an international audience in Barcelona, Spain, and (2) an essay in the e-Journal *Sustainability* entitled, “Comprehensive Conservation Planning and Sustainability within the National Wildlife Refuge System” (see <http://ejournal.nbio.org/archives/vol4iss1/communityessay.schroeder.html>).



Program Assessment for DOI Agencies. Program assessments provide information for

agencies to determine whether their programs are meeting the needs of targeted customers. In FY08, program assessments were in progress for two agencies. For the USGS, we continued our evaluation of the Gap Analysis Program (GAP) with a chain-referral sampling process to identify users of GAP data and development of a survey to be conducted in FY09. This assessment is critical to strategic planning for the GAP Program. For the FWS, we began a series of information projects and needs assessments to help guide the work of the National Conservation Training Center (NCTC). The projects include literature reviews on use of wildlife webcams, barriers to connecting children with nature, and surveys of conservation and

environmental education professionals. The surveys, to be conducted in FY09, address agency barriers to connecting children with nature, training needs of conservation/environmental education professionals with an emphasis on training via distance-education methods, and distance education as a gateway to onsite training. The background research underpinning this survey was completed in FY08. NCTC will use the results of these surveys in future planning to maximize the value and efficiency of the learning resources they provide.



Survey of Moderate-Resolution Imagery Users. Who uses moderate-resolution imagery and how do they use it? To answer that question, FORT social scientists are collaborating with the USGS Western Geography Science Center to conduct an extensive study on the uses and benefits of moderate-resolution imagery such as Landsat. Understanding the societal benefits of moderate-resolution satellite imagery and spatial data is essential as future land imaging initiatives move forward. A key component of this study is a survey of professional users of moderate-resolution imagery. FORT social scientists are leading this effort, which will evaluate the uses and societal benefits of moderate resolution imagery in general and Landsat imagery specifically. Study objectives are to (1) better understand the uses of moderate-resolution imagery, including identifying uses that have previously not been captured or detailed; (2) identifying and classifying the users of this imagery, including sectors, application areas, and how and why the imagery is being used; and (3) qualitatively and quantitatively measuring the societal benefits of moderate-resolution imagery in decisionmaking (focusing on Landsat imagery specifically). The first phase of the survey, completed in FY08, was a user assessment to identify and characterize potential users. This is important because to date, the population of moderate-resolution imagery users has been essentially unknown. The second phase of the project will be a survey of the 4,600 individuals identified during the user assessment. The survey is currently undergoing review by the Office of Management and Budget and will be conducted in early 2009. The results of the survey will be used by policymakers to inform decisions about future satellite missions and will provide a clearer picture of the current professional user community for moderate-resolution imagery in the United States.



Social and Economic Evaluation Supporting Adaptive Management for Wyoming Landscape Conservation Initiative (WLCI). Support for future energy development depends on understanding potential socioeconomic effects on communities. Several of the key drivers of change identified in the WLCI Science Strategy are social and economic issues, and this research provides the necessary social and economic context while also providing a strategy for public engagement in the dialogue surrounding energy development. Activities that affect natural resources, such as energy development, also can affect communities at all levels—including social interactions, economics, and land uses. In FY08, FORT scientists produced a draft social and economic assessment to provide a common context for the other issues addressed in the WLCI. Additionally, scientists compiled a comprehensive literature review on the social and economic research completed on energy development, with a focus on oil and gas development in the West. Documenting the impacts and lessons learned from the last boom in the 1970s provides a starting point for assessing and coping with the socioeconomic impacts of the current one. The report highlights the current state of knowledge concerning socioeconomic issues pertaining to oil and gas development in the broader context of Wyoming, Montana, and Colorado.

NEW

Science Strategy for the Wyoming Landscape Conservation Initiative.

Southwestern Wyoming's wildlife and habitat resources are increasingly affected by energy and urban/exurban development, climate change, and other key drivers of ecosystem change. To ensure that these wildlife populations and habitats persist in the face of development and other changes, the USGS and a consortium of eight public resource-management agencies proposed the Wyoming Landscape Conservation Initiative (WLCI), the overall goal of which is to implement conservation actions. Early in the WLCI's development, interested parties had identified and refined the most pressing management needs for achieving WLCI goals. In FY08, the USGS—the principal agency charged with conducting WLCI science—developed a WLCI Science Strategy to address those management needs through research, monitoring, and creating Web-based outlets for WLCI products and information. Research approaches outlined in the Science Strategy include developing conceptual models for understanding ecosystem function, identifying key drivers of change affecting WLCI ecosystems, and conducting scientific monitoring and experimental studies to better understand ecosystem processes, cumulative effects of change, and effectiveness of habitat treatments. The Strategy's overall process for conducting WLCI science is based on a model recently developed by FORT scientists, who reviewed agency (BLM, FWS, USFS, NPS, and others) approaches to resource assessment and monitoring and then developed an iterative, three-phase process that serves as the framework for monitoring wildlife in a plan for BLM. In the WLCI Science Strategy, Phase I of the framework entails synthesizing existing information to assess current conditions, determining what is already known about WLCI ecosystems, and providing a foundation for future work. Phase II involves conducting targeted research and monitoring to address gaps in data and knowledge gathered during Phase I. Phase III includes integrating new knowledge into WLCI activities and coordinating WLCI partners and collaborators. Throughout all three phases, information is made accessible to interested parties and used to guide and improve management actions, future habitat treatments, best management practices, and other conservation activities.

NEW

Coordinating and Integrating Science for the Wyoming Landscape Conservation Initiative.

The Wyoming Landscape Conservation Initiative (WLCI) was developed to help ensure that those responsible for managing southwestern Wyoming's wildlife and habitats have the necessary information and resources for sustaining or improving habitat conditions, species distributions, and population viability as energy and other development occur in that region. WLCI partners include the USGS, BLM, Wyoming Game and Fish Department, FWS, U.S. Forest Service (USFS), NPS, Bureau of Reclamation, and Wyoming Department of Agriculture. Other collaborators include additional local, State, and Federal agencies; non-profit organizations; and industries and private landowners. Because of the many cooperators, one of the many challenges is to coordinate all these entities and their activities and to integrate all the information and data resulting from WLCI efforts. In FY08, FORT dedicated a full-time scientist to serve on the WLCI Coordination Team and to be the primary liaison between the USGS and other WLCI partners and collaborators. FY08 accomplishments include:

- fostering project collaboration through public meetings;
- developing a conceptual framework for conservation planning and for project development and evaluation;

- co-authoring the WLCI Strategic and Operation plans;
- developing the strategies and objectives for, and meeting with, the WLCI Science and Technical Advisory Council, Data and Information Management Team, and Support Team;
- conceptualizing the Science and Management Integration Plan;
- providing presentations and products (especially maps) to apprise partners and the public of progress and accomplishments;
- meeting with habitat project leaders to discuss post-treatment monitoring plans, needs, and ideas; initiating development of the planning process for WLCI conservation efforts and developing areas of interest for conservation planning;
- evaluating, ranking, and selecting habitat treatments for implementation; and
- conducting tours for USGS management teams to familiarize them with WLCI issues and science needs and to discuss USGS work.



Oil pads like these dot the landscape southwest of Pinedale, Wyo. FORT scientists are developing monitoring plans and research to help WLCI partners conserve species and habitat in connection with escalating energy development and other changes. Photograph ©Cameron Aldridge, Colorado State University and USGS. Used with permission.

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.



Regional and Global Ecological Effects of Climate Variability and Change. Mountain ecosystems of the western U.S. provide irreplaceable goods and services such as water, wood, biodiversity, and recreational opportunities, but the potential responses of these systems to anticipated climatic changes are poorly understood. The overall objective of this work is to understand and predict how western mountain ecosystems will respond to climatic variability and change, and to provide the resulting information to decisionmakers and land managers. This work focuses on the extent to which disturbance regimes (such as fire and drought) will be altered and how they may affect the composition, structure, and productivity of vegetation (particularly forests). In FY08, FORT scientists continued or initiated:

- dendroclimatic, streamflow, paleoclimate, vegetation, and/or fire reconstructions for the Jemez Mountains, upper Rio Grande, and southern Rocky Mountains;
- a global change observatory research project and post-fire restoration experimental treatments at Sierra Nevada National Park and Biosphere Reserve (Spain);

- ecohydrological (runoff and erosion), fire ecology, and biogeochemical research and modeling for Bandelier National Monument;
- studies of isotopic signatures associated with climate-induced tree mortality; and
- further synthesis of climate-induced forest mortality occurring around the globe.



Drought and climate change are causing extensive forest dieback in the U.S. West as well as worldwide. Photograph shows dead ponderosa pines in the Jemez Mountains of New Mexico killed by a combination of drought stress and attacks by bark beetles on weakened trees. Photograph by Craig D. Allen, USGS.

The project also sponsored the publication of *Fire Climatology*, a special issue of the *International Journal of Wildland Fire*, to explore linkages between fire and climate histories in western North America. Also, FORT scientists submitted a successful new Western Mountain Initiative proposal for FY09–FY13. The project’s

many collaborators around the world include, among others, the USGS Water and Biological Resources Disciplines (California and Northern Rocky Mountains Science Centers); CSU, Texas A&M, and the universities of Arizona, Northern Arizona, New Mexico, California-Santa Barbara, Granada (Spain), and Alicante (Spain); and Los Alamos National Laboratory.



Grazing Ecology of Elk and Bison in Great Sand Dunes National Park and Preserve, Colo.

The Department of the Interior formally announced the establishment of a Bison Working Group to promote the recovery of North American bison, with an eye on Great Sand Dunes National Park and Preserve as a potential site for bison restoration. The newly established park already was poised to develop an ungulate management plan to avoid elk management problems; however, little was known about the Park’s elk herd. Now that this picture also may include bison, the need for reliable scientific information has intensified so that park resource managers can make science-based management decisions. In FY08, FORT scientists continued collecting data on ungulate population size, movements, body condition, and herbivory effects on vegetation communities. These data will be used in ecological models to evaluate ecosystem processes and simulate management scenarios for both elk and bison. FORT scientists analyzed



American bison grazing at Great Sand Dunes National Park and Preserve. FORT studies of elk and bison movements and population dynamics help park staff develop appropriate plans for managing the herds on the landscape. Photograph by Richard Madole, USGS.

radiotelemetry forage consumption data from elk and bison, and collaborated with U.S. Forest Service staff to continue surveys and monitoring of alpine willows. The principal investigator was invited to serve on the DOI Bison Working Group and to present her work at the 2008 Bison Conservation Conference. Project partners include the NPS, FWS, USFS, BLM, and The Nature Conservancy. The Colorado Division of Wildlife (CDOW) is a cooperator on the study.



Diatom Ecology and Taxonomy. Diatoms are robust indicators for monitoring and assessing the health of freshwater ecosystems in western North America.

FORT continues development of a Web-based identification guide and ecological resource for diatoms in this region to assist States, tribal governments, and other public organizations in using diatom data. This Web resource will help serve the needs of government agencies to achieve accurate biological assessments and will provide a tool for internally consistent and publicly accessible taxonomic data. In FY08, scientists completed an evaluation of reference conditions for selected diatom species in Utah streams, identified potential climate factors related to the nuisance blooms of stalked diatoms in both Grand Teton and Rocky Mountain National Parks, and produced a final report based on an Interagency Agreement with the Environmental Protection Agency (EPA), *An Ecological Assessment of EPA Region 8 Streams and Rivers*. Evaluation of the macroinvertebrate community composition downstream of Pactola Reservoir, S. Dak., and the areal coverage of stalked diatoms suggest that diatoms are forming nuisance blooms as a result of introduction to new areas and subsequent responses to human disturbance.



Tracking and Interpreting Chemical Changes in

Mountain Streams and Lakes. Mountain terrestrial and aquatic ecosystems are responsive to climate change and atmospheric deposition associated with human activities. To a certain extent, many soils and aquatic systems have the capacity to buffer the effects of elevated nitrogen deposition, but eventually the system can become saturated and no longer able to serve as a buffer. There is also mounting evidence that even where wet deposition of nitrogen has not increased, nitrogen export may be increasing due to increased glacial melting and resulting exposure of glacial sediments. To understand and forecast the ecological and biogeochemical responses of alpine ecosystems to these changes, FORT scientists have been monitoring the waters, soils, leaf litter, and foliar chemistry of the Loch Vale watershed in Rocky Mountain National Park, Colo. In addition, researchers measured CO₂ emissions in fertilized and unfertilized (control) forest plots. In FY08, all long-term water quality, discharge, and



FORT ecologist Jill Baron and field technician Austin Krcmarik prepare a stream gage for measuring discharge in the Loch Vale watershed, Rocky Mountain National Park, Colo. Loch Vale studies include the impacts of nitrogen deposition and climate change on alpine ecosystems. Photograph by Manolo Toro, University of Madrid. Photograph courtesy of Jill Baron, USGS.

weather records were analyzed from the Loch Vale watershed and the results published as a “Talking Point” editorial, “Fixing Nitrogen Levels,” for *environmental researchweb* (<http://environmentalresearchweb.org/cws/article/opinion/33501>). Results also were presented to professional and public audiences, and a paper is in revision for publication in *Global Change Biology*. FORT and collaborators also published a paper in *Limnology and Oceanography* (http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=22020) describing analyses of stable isotopes found in the sediments of one of the park’s alpine lakes that indicate a marked shift in nitrogen cycling since the late 1960s. Project collaborators include CSU, NPS, the USGS Water Resources Discipline, USFS, EPA, NOAA, The Nature Conservancy, Yale University, and the universities of Idaho, Maryland, North Carolina, and Alberta (Canada).



Models and Tools to Assist Environmental Flow Assessment and Implementation below Reservoirs.

Riparian and aquatic ecosystems of the Bill Williams River in Arizona are extremely dynamic and responsive to patterns of streamflow releases from Alamo Dam. The releases have been developed and implemented to promote biological diversity downstream while avoiding interference with other uses of the river corridor. Still, improved tools and models, as well as experiments and monitoring, are needed to clarify and describe the linkages between flows, geomorphic processes, and biotic responses. FORT scientists are evaluating changes in various aspects of the river ecosystem (channel morphology, woody and herbaceous riparian vegetation, beaver dam construction and longevity) and relating these changes to managed streamflows from Alamo Dam and other key factors. In FY08, a manuscript entitled “Models and Tools to Assist Environmental Flow Assessment and Implementation Below Reservoirs: Lessons from an Arid-Region River” was prepared and accepted for publication in the journal *Freshwater Biology* for a special issue on environmental flows, expected in late 2009.



Native riparian vegetation along the Bill Williams River, Arizona. Photograph by Pat Shafroth, USGS.

The paper aims to improve the overall understanding of linkages between physical processes and biotic responses, including the ability to predict whether a specified flow would remove beaver dams and vegetation. Future research will focus on clarifying key threshold responses and linkages between flow, geomorphic processes, and biotic responses. As new information becomes available, it is applied through an adaptive management framework to fine-tune dam operations. Collaborators include the FWS, Oregon State University, University of Montana, Towson State University, U.S. Army Corps of Engineers, Bureau of Reclamation, BLM, and The Nature Conservancy's Sustainable Waters Program.

Decision-Support System for Evaluating Effects of Gunnison River Flow Regimes in Black Canyon of the Gunnison National Park, Colo. The increasing use of sophisticated reservoir operations models has cast many water management decisions as choices among different operating rules or policies, each of which has associated likely sequences of streamflow. The resulting complexity of hydrologic data is combined with an increasing emphasis, in riverine ecology, on natural flow variability and the importance of multiple aspects of the flow regime. This drives evaluation of environmental effects beyond specification of a single minimum flow or optimum flow for a target organism. FORT investigators are developing decision-support systems to help fill the gap between large data sets of simulated flow data from alternatives and judgments about the relative desirability of those alternatives with respect to natural resources. The challenge of developing such decision-support systems is to accurately represent general and site-specific scientific knowledge while presenting the analysis results in a form that enables informed decisionmaking. Work in FY08 focused on a system to evaluate streamflow regimes of the Gunnison River on resources of Black Canyon of the Gunnison National Park to inform both quantification of Federal Reserved Water Rights and operation of upstream water management facilities. The final product, expected in FY09, is a USGS Open-File Report and an accompanying public-access computer program.

Aspen Ecology in the Core Elk Range of Rocky Mountain National Park, Colo. A decline in aspen on elk winter range in Rocky Mountain National Park has been observed for several decades. Previous studies have linked this decline to heavy elk browsing, but other factors, such as fire suppression and climate, also may have played a role. FORT scientists, along with collaborators from Colorado State University and the University of Tennessee, examined the age structure and genetic diversity of aspen to determine the timing and conditions of stand establishment and regeneration on the low-elevation, east side of the park. Researchers studied the characteristics of stands in order to link successful aspen regeneration to elk density and browsing, climate, and topographic variables such as elevation. The age distribution and genetic characteristics of these low-elevation winter-range stands were examined to determine the current status and possible future of aspen on this winter range. In FY08, the research team completed USGS Open-File Report 2008-1337, *Aspen Ecology in Rocky Mountain National Park: Age Distribution, Genetics, and the Effects of Elk Herbivory* (http://www.fort.usgs.gov/products/publications/pub_abstract.asp?PubID=22358) detailing the results of their 3-year study and identifying possible effects of new elk management strategies on aspen stand sustainability in Rocky Mountain National Park's elk winter range.

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 in Bats.

During the winter of 2007–2008, an affliction called White Nose Syndrome (WNS) began decimating colonies of hibernating bats in the northeastern United States. Bat colonies declined by about 70–95 percent at most of the affected caves and mines. Since then, WNS has spread to surrounding states. This type of sudden, widespread, and expanding mortality is completely unprecedented in hibernating bats. WNS is named for the presence of a previously unknown, highly invasive white fungus on affected bats. FORT response to this issue involved helping to coordinate the scientific investigation into the causes and spread of WNS. In particular, we regularly consulted biologists at the New York Department of Environmental Conservation, FWS, and USGS National Wildlife Health Center on various aspects of bat ecology as they relate to WNS. During FY08, we helped coordinate an emergency meeting that brought international experts together to assess and plan for the WNS outbreak as well as subsequent research efforts into the dynamics of WNS (<http://www.batcon.org/pdfs/WNSMtgRptFinal2.pdf>). WNS poses a major threat to 5 species and subspecies of hibernating cave bats listed under the Federal Endangered Species Act.



Image Credit: New York
Dept. of Environmental
Conservation
<http://www.dec.ny.gov/>

A little brown bat found in a New York cave exhibits white fungal growth typical of white-nose syndrome on its muzzle, ears and wings. Photograph by Al Hicks, New York Department of Environmental Conservation. Used with permission.

Wind Energy Turbines and Bat Mortality. Wind energy is one of the fastest-growing energy industries in the world, and wind turbines are killing increasing numbers of bats in both North America and Europe. Causes of bat collisions with turbines remain undetermined, although migratory species that roost in trees (“tree bats”) are disproportionately affected and their populations may be in jeopardy. This project is aimed at determining the causes of bat collisions with turbines, as well as assessing the potential consequences of turbines on susceptible bat populations. In particular, FORT biologists are studying the geographic origins of bats killed by turbines and whether bats are attracted to turbines for mating and/or feeding purposes. During FY08, samples were collected and analyzed from bats killed at 7 different wind

energy facilities in 5 states. Results of this work will be applicable to assessing the health of tree bat populations and developing management strategies to minimize the impacts of turbines on bats. The research will directly support current efforts by the FWS to establish guidelines for wildlife-friendly wind-energy development.



Emerging Viruses in Bats. Several diseases of human-health concern are thought to have originated in bats. One of these diseases is severe acute respiratory syndrome (SARS), which resulted in a near pandemic during 2002–2003. SARS is caused by a coronavirus (SARS-CoV) that is now believed to have originated through mutation of a closely related coronavirus associated with Asian bats. Scientists have been unable to isolate and culture live bat coronaviruses, and little is known about the prevalence and taxonomy of coronaviruses in bats. Virus isolation is essential for researching virus biology and transmission, particularly as they relate to SARS. FORT biologists are collaborating with microbiologists at the University of Colorado Health Sciences Center, CSU, and University of Northern Colorado to survey North American bats for coronaviruses and to try to acquire appropriate samples for basic biomedical research. This led to the first documentation of bat coronaviruses in the Western Hemisphere and the discovery of coronaviruses in two very common species of bats from which they had never been reported. Additional sample analysis is ongoing. Results of this work will offer important information on the prevalence of coronaviruses in North American bats and potentially result in acquisition of samples of biomedical significance.

Bat Use of Coniferous Forests at Mesa Verde National Park, Colo. Because Mesa Verde National Park is dominated by piñon-juniper woodlands, bat species diversity and roosts were feared to have been affected by recent losses of these woodlands to fire. In FY08, FORT completed a study of bat diversity, reproduction, and roosting habits initiated during 2006–2007. During that period, we captured more than 2,000 bats and documented 16 species, a diverse fauna that includes all species of bats known to occur in western Colorado. We recorded sex ratios and reproductive rates for all species, and radio-tagged 74 individuals of 7 species to locate maternity colonies. The study revealed that most bats roosted in crevices in boulders and cliff faces, including the first known colony of spotted bats in Colorado. Numerous canyons and cliff faces that bisect the park's high mesas provide very favorable roosting habitat for bats. The availability of rock crevices in these cliffs and canyons likely overrides bats' extensive reliance on piñon or juniper trees and snags as roosts.



Assessing Degradation Rates of DNA Extracted from Mountain Lion Fecal Samples for Use in Capture-Recapture Studies. Capture-recapture studies are used to estimate a species' population size as well as movements of individuals between capture events. Using DNA extracted from fecal matter to uniquely and non-invasively identify individuals for capture-recapture studies is becoming increasingly feasible with the advancement of molecular techniques. In collaboration with the CDOW, FORT is attempting to determine the relationship between quantity/quality of DNA extracted from mountain lion fecal matter and abiotic factors such as temperature, humidity, and time since deposition. To do this, fecal matter from captive mountain lions is being collected and placed in various environmental settings to simulate conditions in the wild. This study is using highly variable microsatellite loci to determine the quality of the DNA extracted from feces kept at different conditions and to quantify actual amounts of mountain lion DNA using real-time polymerase chain reaction (PCR) protocol.



Investigating the Effects of Climate Change on White-tailed Ptarmigan.

Investigations of the interactions between ecological and evolutionary responses to global climate change is an important aspect of climate change studies. It is thought that alpine ecosystems will be one of the first habitats affected by climate change, and the impact on ptarmigan and other alpine-dependent species could be significant. Understanding the genetic basis of phenotypes under selection allows for the prediction and mitigation of climate change effects on the viability of populations like ptarmigan. To investigate this issue, FORT scientists are documenting changes in genetic diversity and allele frequencies in white-tailed ptarmigan from Mt. Evans, Colo., over a 40-year time span. Using these data, we are comparing current levels of diversity and patterns of allele frequencies with a northern population of this bird on Vancouver Island, B.C. In the process, we are attempting to identify genetic markers under selection and to determine whether these markers can be correlated with environmental changes associated with climate change.



Photo by Greg Wann, Colorado State University. Used with permission.

A female White-tailed Ptarmigan is banded for a USGS study to assess the possible consequences of environmental changes brought about by climate change on wildlife populations. Photograph by Greg Wann, Colorado State University. Used with permission.



Evaluation of Black Bear Population Structure in Colorado.

Understanding the population structure of a species is key to developing effective wildlife management strategies. For example, if wildlife managers apply different management strategies on each of two adjacent game management units, but a single population of black bears is represented across both management units, then it is not possible to evaluate either management strategy because the effects are on the population as a whole and are not distinguishable between unit boundaries. However, little genetic information is available to assist managers in defining workable “management units” for black bears in Colorado. In collaboration with the CDOW, FORT is seeking to ascertain population boundaries (if any exist) for black bear populations across the state. This study, begun in FY08, will determine the efficacy of using mitochondrial DNA and microsatellite markers to delineate black bear subpopulations by genotyping approximately 150 individual black bears across 7–10 nuclear microsatellite loci and sequencing a rapidly evolving portion of the control region for each bear. These data will be analyzed using standard population genetic methods.



Adverse Effects on Northern Shovelers from Exposure to Treated Wastewater.

From January to February 2007, more than 900 waterfowl died in or near wastewater treatment plants located along the central Colorado Front Range. In collaboration with the FWS, CDOW, USGS (FORT, National Wildlife Health Center, and Water Resources Discipline), Metro Wastewater Reclamation District, and Chemir Analytical Services, a study was developed to test whether prolonged exposure of waterfowl to treated wastewater plays a role in the loss of feather waterproofing. Chemical analyses were conducted for specific components of wastewater in feather rinsates, but results relating the presence of tested

surfactants to hypothermic response of experimental and control ducks were inconclusive. This work was completed in FY08.

Population Genetic Analysis of the Midget Faded Rattlesnake in Wyoming. Little is known about the biology of Midget Faded Rattlesnakes, a rare subspecies of the Western Rattlesnake. In collaboration with the University of Wyoming, the FORT conservation geneticist conducted a molecular genetic study of Midget Faded Rattlesnakes in southwestern Wyoming. The objective was to investigate population genetic structure in this area, particularly with reference to Flaming Gorge Reservoir and its associated human activities, and to document levels of genetic diversity. In this study completed in FY08, 229 snakes from 11 populations were genotyped using 9 micro-satellite loci. We found that significant levels of genetic structure among populations were better explained by geography and isolation by distance than by position relative to waterway. Populations on either side of the reservoir's widest point were not significantly different. Finally, this study showed that the populations that were the most genetically distinct were those farthest north and the most susceptible to potential impact from human activity.



Midget-faded rattlesnake. Photograph by Josh Parker, College of Southern Nevada. Photograph courtesy of Sara Oyler-McCance, USGS.

Sharing the Wealth: Access to Products

Products and Publications

During FY08, FORT scientists delivered 130 products, 111 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 FY08 by USGS program element and goal; Appendix II does the same for other types of products.

Sharing the Wealth: Access to Expertise

Workshops

 ***Invasive Species Modeling and Assessment Workshop.*** In partnership with the NASA Applied Sciences Program, FORT has made significant progress in developing various capacities for modeling and assessing invasive species. FORT hosted a workshop in March 2008 to demonstrate these tools and capacities, including those currently available and those in development, and to solicit feedback on their use from a select group of users in the Department of the Interior. Results from the workshop are being used to guide future research and development efforts.

Using River 2-D in Habitat Simulation. This 3-day workshop, given in March 2008 in South Porcupine, Manitoba, Canada, provided the Manitoba Department of Natural Resources with improved capabilities for assessing resource management alternatives. FORT developed and presented instructional material and computer modeling exercises covering the theory and practice of coupling 2-D hydrodynamic flow modeling with spatially explicit habitat modeling.



USGS River Ecosystem Modeling Work Group. The USGS River Ecosystem Modeling Work Group, organized by FORT scientists, hosted a meeting in February 2008 in Orange Beach, Ala., as part of the second USGS Modeling Conference. More than 50 participants from across USGS disciplines and regions recognized the USGS' leadership role in river ecosystem modeling and urged continuation of natural systems research, monitoring, and modeling. USGS can better utilize current human and technology resources, while remaining a leader in riverine modeling, by increasing the opportunity for communication and providing a national infrastructure for its modeling resources. Summary sheets of 60 models currently being used for river ecosystem modeling within the USGS, along with modeler contact information, were compiled to address the need for a centralized, online menu of available models and modelers. This new source of information can be expanded, continually updated, and made accessible online to foster scientific collaboration. New models incorporating current knowledge of global climate change and increasing natural and induced hazards will provide valuable risk assessment and decision-support tools. Release of the Work Group report, produced by FORT as a USGS Science Investigations Report, is expected in early 2009.

Training



Brown Treesnake Rapid Response Team Training Workshops. Brown treesnakes 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 if the snakes were accidentally transported from Guam. Since its creation, the RRT has conducted 2 to 5 training courses annually on Guam and 19 off-Guam field operations. As of 2008, the RRT consisted of 70 members located throughout the Pacific region and the U.S. mainland. The RRT has incorporated USGS research results, including effective means for improving snake detectability at low densities, the effectiveness of control tools in rodent-rich environments, and predicting movements of snakes translocated accidentally. Two full-length (18-day) training courses were conducted for new team members in October 2007 and February 2008, and two 5-day refresher courses were conducted in November 2007 and March 2008. Cooperators include the FWS Hawaii Invasive Species Committees (Oahu and Maui), Hawaii Coordinating Group on Alien Pest Species (CGAPS), Department of Defense, Guam Division of Aquatic and Wildlife Resources, USDA Wildlife Services, Hawaii Department of Agriculture, and Hawaii Department of Forestry and Wildlife. Additional quarantine, agriculture, and natural resources cooperators include officials from the



Brown Treesnake Rapid Response Team member examines a captured brown treesnake, a destructive invasive species on Guam that can live for months in cargo being delivered to other islands and the mainland U.S. USGS photograph.

Federated States of Micronesia, the Republic of the Marshall Islands, the Commonwealth of the Northern Mariana Islands, and the Republic of Palau.

Negotiation Training for Natural Resources Professionals. Natural resource managers entrusted with responsibilities for Federal and State resources often face decisions that are complex and involve many parties. Decisionmakers are well trained in their professional fields but often lack training in negotiation processes. With increasing emphasis on collaboration and stakeholder involvement, it is essential that resource managers acquire and refine negotiation skills. The negotiation training provided by FORT researchers addresses an acknowledged need. Social scientists at FORT have conducted research about natural resource conflict resolution and negotiation since the 1980s and have provided training courses that draw in part from these findings. The courses are well grounded in classic negotiation theory but are enriched by the instructors' research. During FY 2008, two classes were held in Basic Negotiation for Natural Resource Professionals (in March and May). The March class was requested by the Montana Department of Transportation and was held in Helena. At the May class, students were from a variety of Federal agencies (USGS, FWS, NPS, BLM), State agencies (Colorado Department of Public Health and Environment, Wyoming Game and Fish Department), Colorado State University's Center for Collaborative Conservation, and Clark County, Nev. Class evaluations were very positive, and feedback from previous or returning students indicates that the skills gained in these classes are extremely valuable and help managers make informed decisions.



Participants in a negotiations course at the Fort Collins Science Center, Colo. USGS photograph by Katie Walters, ASRC Management Services.

Making a Difference (Customer Satisfaction)

Letters, Emails, Non-USGS Awards

- From Charisse Sydoriak, BLM, to FORT social scientists **Berton Lee Lamb** and **Nina Burkardt**, on the Negotiations Training course they conducted for the BLM:

“Woohoo!!! You did an outstanding job of being present and pertinent! I liked how the two of you balanced each other in the Q&A part and that the negotiations training wasn't just for natural resource managers. The internal negotiations process is very important, too...BTW--This is the first broadcast training I've participated in where the viewers asked for more.... Good job.”



Negotiations course instructors Nina Burkardt and Lee Lamb share a light moment. USGS photograph by Katie Walters, ASRC Management Services.

- From Carl Marti, Editor, *Studies in Avian Biology*, to Rodney Felix (University of Southern Mississippi) and his team (including FORT research ecologist and issue Associate Editor **Janet Ruth**) who produced issue number 37, *Birds of the US-Mexico Borderlands: Distribution, Ecology and Conservation*:

“I enjoyed working with you in producing this volume. This group was one of the most responsive and professional that I have worked with in SAB, and I am very happy to see the volume in print. I think it will be an important source of information for the ornithological and conservation communities.”

- From Ruben A. Guieb, Natural Resource Specialist, U.S. Navy, Naval Station San Diego, to FORT research wildlife biologist **Tom Stanley**, for his technical review of a monitoring report on the status of the San Clemente Island fox:

“After reading your attached review, I feel compelled to write this email to express that I was profoundly impressed (I am confident Kelly will agree with me) with the very high quality of your technical review of the draft report. Your review comments were clearly articulated, organized, easy to read and understand. Of profound importance, you provided a very comprehensive review of the technical quality of the draft report's statistical and quantitative analyses of the data, followed up with constructive suggestions on how to further improve the report's technical credibility and defensibility in estimating the population status of the island's foxes. Your review supports and further validates Kelly's concern on the importance of the technical defensibility of the Navy's

population status estimate of the island foxes at San Clemente Island. The US Navy is privileged to have officially solicited your involvement on research studies in support of the US Navy's San Clemente Island Fox Conservation Efforts Program.”

- From Rick Kaiser, biology teacher, Sterling (Colo.) High School, to FORT research wildlife biologist **Bob Reed**, who made a presentation about invasive snakes to students:



USGS scientist Bob Reed holds an invasive boa constrictor. Photograph courtesy of Bob Reed, USGS.

“Dr. Reed:

‘HE’S AWESOME!’

‘I WISH WE COULD HAVE STAYED LONGER.’

‘I HAD MORE QUESTIONS, WHY DIDN’T WE STAY?’

‘CAN WE GO BACK?’

“And, these were only a few of the comments and questions that students pummeled me with as we were moving to the second presentation of the day. In short, you had 21 SHS students mesmerized, interested, eager, and wanting more when, unfortunately, our session ended.

“Had I known how amazing a day today was to be—we’d have shipped all 120 biology students up to Ft. Collins. It was truly a special day that benefited our students tremendously. In case you’re wondering, it is not in my nature to be hyperbolic, it’s just that the students to whom you presented, (who represent the best of the best) were so pumped after being with you they still had not settled down even after arriving home. In short, you were a HIT.

“There is no way to thank you enough for what you did for our students, but please accept my thanks, nonetheless. Should you be willing, we’d like to have the opportunity to meet with you again, and perhaps, schedule a little more time. Best wishes, and thank you, again.”

- In April 2008, the U.S. Fish and Wildlife Service presented **Gordon Rodda** with a **Meritorious Service Award** for nearly 20 years of perseverance in brown treesnake control efforts.
- The Department of the Interior FY2007 Performance and Accountability Report featured two projects involving FORT research ecologists **Doug Andersen, Greg Auble, Butch Roelle, and Pat Shafroth**: “Stream/Shoreline Miles Restored: Arapaho National Wildlife Refuge, CO” and “Innovative Water Management: Bill Williams River National Wildlife Refuge, AZ.” They were selected as representative wildlife refuge achievement under “Mission Area One Resource Protection.”
- From Jennifer Shanahan, City of Fort Collins (Colo.) Natural Areas Program, to **Jonathan Friedman** for his contributions to an advisory group examining the impacts of the Northern Integrated Supply Project (NISP):



USGS research zoologist Gordon Rodda, Meritorious Service Award recipient. USGS photograph.

“We would like to thank you all for your contributions and expertise in helping us develop comments to the NISP draft EIS. It was a tremendous group effort and the comments reflect a high level of detail and professional analysis by this whole group. We very much appreciated each of your contributions and time....”

- From Katherine A. Mitchell, Natural Resources Program Coordinator and NSF TCUP Program Director, Southwestern Indian Polytechnic Institute (SIPI), to USGS museum specialist **Cindy Ramotnik**, regarding a tour she led of the Museum of Southwestern Biology at University of New Mexico for SIPI students:



USGS museum curator Cindy Ramotnik by a skin collection at the Museum of Southwestern Biology, University of New Mexico, Albuquerque. USGS photograph.

“The visit to MSB was superb. The students were really interested. I think you could tell by how attentive they were. It was an excellent lab and it will be interesting to see their lab reports. They are amazing students.... The MSB staff was

very kind to find the time. You are also very good at the outreach/education portion of your job! I was really impressed at how well you teach and how everyone related to the students. You're great at it Cindy, and you have a standing offer to come do a course lecture or lunchtime brown bag at SIPI–anytime.”

- From R. B. Pratt, California State University–Bakersfield, review in *Choice* about USGS research ecologist **Tom Stohlgren**'s book, *Measuring Plant Diversity: Lessons from the Field*:

“Measurements of plant diversity are crucial for testing many basic ecological hypotheses.... Stohlgren (US Geological Survey and Colorado State University, Fort Collins) delivers a well written “how to” book on current techniques to measure plant diversity in space and time. This well-organized book starts with a concise history of approaches and challenges to vegetation sampling. The following chapters discuss sampling techniques, and the volume finishes with an assessment of research needs. Numerous case studies illustrate the issues and techniques highlighted in the book. This is an indispensable resource for all science libraries. Summing Up: Essential....”

- From Bob Locke, Director of Publications and Grants Coordinator, Bat Conservation International (BCI), to FORT research wildlife biologist **Tom O'Shea**, in acknowledgment (along with a framed bat photo and BCI paperweight) of his service on the BCI Scholarship Review Committee:

“...More importantly, thanks for all your help with the scholarships. I’m very proud of this program, and I appreciate the wisdom you shared with me and with the applicants.”

- From David J. Stout, Designated Federal Official, U.S. Fish and Wildlife Service, to **Paul Cryan** for the presentation described:



USGS Research Biologist Paul Cryan takes a female hoary bat from a mist net in New Mexico. Photograph by Leslie Cryan.

I would like to take this opportunity to express my sincere appreciation for your time, energy, and expertise in presenting “What Is Known About Bat/Wind Power Interaction?” at the Wind Turbine Guidelines Advisory Committee technical workshop, February 26–27, 2008, in Washington, DC. This workshop was vital in providing the committee with the fundamental information and understanding they will require in order to carry out their charge, and your contribution helped to make it a success. Congratulations on an excellent presentation that benefited the Committee members as well as the members of the public who attended, and thank you again for your participation.... You were terrific!

- From James A. Allen, Interim Executive Director, Northern Arizona University (NAU) School of Forestry, to FORT research ecologist **Pat Shafroth**, for a guest lecture and seminar at NAU:

“I am writing to express my appreciation for your guest lecture yesterday in my graduate Wetland Ecology and Management class. It was great to have someone with your expertise join us and tell us about issues related to Tamarix ecology and control. Your presentation was [a] very definite enhancement to my brief overview of western riparian ecosystems and some of the issues related to their management and protection.

“As a relative newcomer to the West and to riparian systems in the region, I learned a lot from your lecture and from reading some of your publications. I will certainly be reading more of your publications in the near future, along with those of some of your colleagues from Fort Collins ... The work you have done to date has been excellent, in my humble opinion!

“In addition to your guest lecture, I also enjoyed the seminar you presented as part of our School of Forestry Seminar Series... The seminar was well attended and it was nice to see some of [the] students from my wetlands class among the audience, all the more so since it required some of them to make a second long trip down to the South Campus that day.

“I hope...your fieldwork along the Bill Williams River went well. Your lecture and publications have definitely whetted my appetite for getting down there and seeing some of the Bill Williams riparian areas for myself.

“Thanks again for taking the time to visit with us here at NAU. It was a real pleasure to meet you and I hope our paths will cross again before too long.”

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 FY08.

Appendix I: FORT Publications Delivered in FY 2008

Pub Type	Program	Goal	Citation
Biological Informatics (BIO)			
BIO #1 - Increase the availability and usefulness of biological resources data and information (Content).			
Pages in Book	BIO	1	Burns, M.R., J.G. Taylor, and J.T. Hogan. 2008. Integrative healing: The importance of community collaboration in postfire recovery and prefire planning. Pages 81-97 in W.E. Martin, C. Raish, and B. Kent (eds.). Wildfire risk: Human perceptions and management implications. Washington, DC: Resources for the Future.
Journal Article	BIO	1	Souchon, Y., C. Sabaton, R. Deibel, D. Reiser, J. Kershner, M. Gard, C. Katopodis, P. Leonard, W.J. Miller, and B.L. Lamb. 2008. Detecting biological responses to flow management: Missed opportunities; future directions. <i>River Research and Applications</i> 24(5): 506-518.
USGS Open-File Report	BIO	1	Wilson, J.T. (ed.). 2008. Fort Collins Science Center: Fiscal year 2007 accomplishments: U.S. Geological Survey Open-File Report 2008-1092. 38 p.
BIO #4 - Facilitate information science and technology research that supports the advancement of biological informatics capabilities (Research).			
Journal Article	BIO	4	Acker, S.A., T.J. Beechie, and P.B. Shafroth. 2008. Effects of a natural dam-break flood on geomorphology and vegetation on the Elwha River, Washington, U.S.A. <i>Northwest Science</i> 82: 210-223.
Journal Article	BIO	4	Christensen, L., C.L. Tague, and J.S. Baron. 2008. Spatial patterns of simulated transpiration response to climate variability in a snow dominated mountain ecosystem. <i>Hydrological Processes</i> 22(18): 3576-3588.
Journal Article	BIO	4	Lightfoot, D.C., S.L. Brantley, and C.D. Allen. 2008. Geographic patterns of ground-dwelling arthropods across an ecoregional transition in the North American Southwest. <i>Western North American Naturalist</i> 68(1): 83-102.
Journal Article	BIO	4	Margolis, E.Q., T.W. Swetnam, and C.D. Allen. 2007. A stand-replacing fire history in upper montane forests of the southern Rocky Mountains. <i>Canadian Journal of Forest Research</i> 37(11): 2227-2241.
Journal Article	BIO	4	Sanderson, J.S., N.B. Kotliar, D. Steingraeber, and C. Browne. 2008. Simulated natural hydrologic regime of an intermountain playa conservation site. <i>Wetlands</i> 28(2): 363-377.
Journal Article	BIO	4	Shafroth, P.B., V.B. Beauchamp, M.K. Briggs, K. Lair, and A.A. Sher. 2008. Planning riparian restoration in the context of <i>Tamarix</i> control in western North America. <i>Restoration Ecology</i> 16(1): 97-112.
Pages in Report	BIO	4	Spaulding, S.A., K.A. Hermann, and T. Keller. 2008. Confirmed distribution of <i>Didymosphenia germinata</i> (Lyngbe) Schmidt in North America. Pages 26-27 in M.L. Bothwell and S.A. Spaulding (eds.). Proceedings of the 2007 International Workshop on <i>Didymosphenia geminata</i> . Canadian Technical Report of Fisheries and Aquatic Sciences 2795.

Terrestrial, Freshwater, and Marine Ecosystems (ECO)

ECO #1 - Quantify and understand factors influencing patterns of temporal and spatial variability in key ecosystem components and processes.

Journal Article	ECO	1	Aldridge, C.L., S.E. Nielsen, H.L. Beyer, M.S. Boyce, J.W. Connelly, S.T. Knick, and M.A. Schroeder. 2008. Range-wide patterns of greater sage-grouse persistence. <i>Diversity and Distributions</i> 14(6): 983-994.
Journal Article	ECO	1	Allen, C.D., R.S. Anderson, R.B. Jass, J.L. Toney, and C.H. Baisan. 2008. Paired charcoal and tree-ring records of high-frequency fire from two New Mexico bog sites. <i>International Journal of Wildland Fire</i> 17(1): 115-130.
Journal Article	ECO	1	Anderson, R.S., C.D. Allen, J.L. Toney, R.B. Jass, and A. N. Bair. 2008. Holocene vegetation and fire regimes in subalpine and mixed conifer forests, southern Rocky Mountains, USA. <i>International Journal of Wildland Fire</i> 17: 96-114.
USGS Open-File Report	ECO	1	Auble, G.T. and Z.H. Bowen. 2008. Effects of a 2006 high-flow release from Tiber Dam on channel morphology at selected sites on the Marias River, Montana: U.S. Geological Survey Open-File Report 2008-1234. 44 p.
Abstract	ECO	1	Baron, J.S., T.S. Schmidt, and M.D. Hartman. 2008. Climate-induced changes in nitrogen dynamics in Loch Vale Watershed, Rocky Mountain National Park (abs). Page 7 in 2008 Research Conference, Rocky Mountain National Park. National Park Service, U.S. Department of the Interior.
Journal Article	ECO	1	Enders, S.K, M. Pagani, S. Pantoja, J.S. Baron, A.P Wolfe, N. Pedentchouk, and L. Nunez. 2008. Compound-specific stable isotopes of organic compounds from lake sediments track recent environmental changes in an alpine ecosystem, Rocky Mountain National Park, Colorado. <i>Limnology and Oceanography</i> 53(4): 1468-1478.
USGS Science Investigations Report	ECO	1	McDougal, R.R., R.G. Waltermire, C.L. Aldridge, S.S. Germaine, S.E. Nielsen, C.C. Nielsen, L. Hanson, and Z.H. Bowen. 2008. An aerial-photographic assessment of reenacted handcart treks on a section of the Mormon Pioneer National Historic Trail, Fremont County, Wyoming. U.S. Geological Survey Scientific Investigations Report 2008-5115. 70 p.
Journal Article	ECO	1	McDowell, N., W.T. Pockman, C.D. Allen, D.D. Breshears, N. Cobb, T. Kolb, J. Sperry, A. West, D. Williams, and E.A. Yezpe. 2008. Mechanisms of plant survival and mortality during drought: Why do some plants survive while others succumb to drought? <i>New Phytologist</i> 178(4): 719-739.
USGS Open-File Report	ECO	1	Zeigenfuss, L.C., D. Binkley, G.A. Tuskan, W.H. Romme, T. Yin, S. DiFazio, and F.J. Singer. 2008. Aspen ecology in Rocky Mountain National Park: Age distribution, genetics, and the effects of elk herbivory: U.S. Geological Survey Open-File Report 2008-1337. 57 p.

ECO #3 - Develop indices of ecosystem sensitivity to change and vulnerability to potential stressors, and tools to predict ecosystem responses to environmental change.

Pages in Report	ECO	3	Bothwell, M.L. and S.A. Spaulding. 2008. Synopsis: The 2007 International Workshop on <i>Didymosphenia geminata</i> . Pages xiii-xxi in Proceedings of the 2007 International Workshop on <i>Didymosphenia geminata</i> . Canadian Technical Report of Fisheries and Aquatic Sciences 2795.
Report	ECO	3	Bothwell, M.L. and S.A. Spaulding (eds.). 2008. Proceedings of the 2007 International Workshop on <i>Didymosphenia geminata</i> . Canadian Technical Report of Fisheries and Aquatic Sciences 2795. 58 p.

Abstract	ECO	3	Edlund, M.B., S.A. Spaulding, and S. Kumar. 2008. The diatom <i>Didymosphenia geminata</i> , its spread, distribution, and formation of nuisance blooms (abs). In 5th Annual International Lake of the Woods Water Quality Forum, March 12-13, 2008. Ontario, Canada: Lake of the Woods Water Sustainability Foundation.
USGS Open-File Report	ECO	3	Spaulding, S.A. and L. Elwell. 2007. Increase in nuisance blooms and geographic expansion of the freshwater diatom <i>Didymosphenia geminata</i> : U.S. Geological Survey Open-file report 2007-1425. 38 p.
Pages in Proceedings	ECO	3	Spaulding, S.A., K. Hermann, and T. Johnson. 2008. Confirmed distribution of <i>Didymosphenia geminata</i> (Lyngbye) Schmidt in North America. Pages 26-29 in M.L. Bothwell and S.A. Spaulding (eds.). Proceedings of the 2007 International <i>Didymosphenia</i> Workshop. Canadian Technical Report of Fisheries and Aquatic Sciences 2795.
Journal Article	ECO	3	Whittaker, T.E., B.L. Hall, C.H. Hendy, and S.A. Spaulding. 2008. Holocene depositional environments and surface-level changes at Lake Fryxell, Antarctica. The Holocene 18(5): 775-786.
ECO #4 - Devise restoration and adaptive management frameworks for impaired ecosystems.			
Report	ECO	4	Julius, S.H., and J.M. West (eds.); Baron, J.S., L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors). 2008. Preliminary review of adaptation options for climate-sensitive ecosystems and resources—A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Final Report, Synthesis and Assessment Product 4.4. Washington, DC: U.S. Environmental Protection Agency. 873 p.
USGS Open-File Report	ECO	4	Kotliar, N.B., Z. Bowen, D. Ouren, and A. Farmer. 2008. A regional approach to wildlife monitoring related to energy exploration and development in Colorado: U.S. Geological Survey Open-File Report 2008-1024. 73 p.
USGS Open-File Report	ECO	4	Ouren, D.S., C. Hass, C.P. Melcher, S.C. Stewart, P.D. Ponds, N.R. Sexton, L. Burris, T. Fancher, and Z.H. Bowen. 2007. Environmental effects of off-highway vehicles on Bureau of Land Management lands: A literature synthesis, annotated bibliographies, extensive bibliographies, and internet resources. U.S. Geological Survey Open-File Report 2007-1353. 250 p.
Fisheries: Aquatic and Endangered Resources (FAER)			
FAER #1 - Provide scientific information about the diversity, life history and species interactions that affect the condition and dynamics of aquatic communities.			
Abstract	FAER	1	Mueller, G. 2008. Fish introduction impacts on fisheries and water quality (abs). In: 21st Annual National Conference Enhancing the States' Lake Management Programs, Chicago, Illinois, April 29-May 2, 2008.
FAER #2 - Provide scientific information about factors and processes that affect aquatic organism health in support of survival, protection, conservation and recovery.			
USGS Open-File Report	FAER	2	Mueller, G.A. 2008. Native Fish Sanctuary Project: Sanctuary development phase, 2007 Annual Report: U.S. Geological Survey Open-File Report 2008-1126. 59 p.
Journal Article	FAER	2	O'Shea, T.J. and D.K. Odell. 2008. Large-scale marine ecosystem change and the conservation of marine mammals. Journal of Mammalogy 89(3): 529-533.

FAER #3 - Quantify and describe functional relationships among aquatic species and habitats to provide information to conserve or restore aquatic community structure and function.			
Journal Article	FAER	3	Cade, B.S., J.W. Terrell, and M.T. Porath. 2008. Estimating fish body condition with quantile regression. <i>North American Journal of Fisheries Management</i> 28: 349-359.
Abstract	FAER	3	Nakamura, K., and G. Mueller. 2008. Review of the performance of the artificial floating island as a restoration tool of aquatic environments (abs). In: <i>World Environmental and Water Resources Congress, May 13-16, 2008, Honolulu, Hawaii.</i>
Journal Article	FAER	3	Nelson, S.M. and J.S. Thullen. 2008. Aquatic macroinvertebrates associated with <i>Schoenoplectus</i> litter in a constructed wetland in California (USA). <i>Ecological Engineering</i> 33(2): 91-101.
Abstract	FAER	3	Schmidt, T.S., S.E. Church, W.H. Clements, K. Mitchell, D.L. Fey, R.B. Wanty, P.L. Verplanck, C.A. San Juan, and M. Adams. 2008. The effects of mines on aquatic communities in Central Colorado (abs). Page 2 <i>in</i> <i>Planning for an uncertain future: Monitoring, integration, and adaptation. The Third Interagency Conference on Research in Watersheds, Estes Park, Colorado, September 8-11, 2008.</i>
Journal Article	FAER	3	Thullen, J.S., S.M. Nelson, B.S. Cade, and J.J. Sartoris. 2008. Macrophyte decomposition in a surface-flow ammonia-dominated constructed wetland: Rates associated with environmental and biotic variables. <i>Ecological Engineering</i> 32: 281-290.
FAER #4 - Provide science support for natural resource managers by investigating the factors that contribute to the conservation and recovery of aquatic species at risk.			
Journal Article	FAER	4	Carpenter, J. and G.A. Mueller. 2008. Small nonnative fishes as predators of larval razorback suckers. <i>The Southwestern Naturalist</i> 53(2): 236-242.
Abstract	FAER	4	Mueller, G.A. 2008. A brief summary of USGS native fish research activities on the Colorado River (abs). <i>In</i> <i>Upper Basin Researchers Meeting, Jan 15-16, 2008, Moab UT.</i>
USGS Open File Report	FAER	4	Mueller, G.A., J. Carpenter, R. Krapfel, and C. Figiel. 2007. Preliminary testing of the role of exercise and predator recognition for bonytail and razorback sucker: U.S. Geological Survey Open-File Report 2007-1423. 37 p.
Abstract	FAER	4	Mueller, G.A., S. Hiebert, R. Wydoski, E. Best, J. Lantow, J. Millosovich, M. Santee, and B. Goettlicher. 2007. Development of monitoring techniques for razorback sucker found between Hoover and Parker Dams, 2006-2007 (abs). Page 3 <i>in</i> <i>USBR Annual Work Summary Report. U.S. Bureau of Reclamation.</i>
FAER #5 - Develop research and technology tools to provide the scientific basis for developing adaptive management strategies and evaluating their effectiveness for restoration efforts to sustain aquatic resources.			
USGS Open-File Report	FAER	5	Mueller, G.A., R. Wydoski, E. Best, S. Hiebert, J. Lantow, M. Santee, B. Goettlicher, and J. Millosovich. 2008. Techniques for monitoring Razorback Sucker in the Lower Colorado River, Hoover to Parker Dams, 2006-2007, Final Report. U.S. Geological Survey Open File Report 2008-1245. 34 p.

FAER #6 - Provide research support and technical assistance to DOI bureaus, other Federal and State government agencies, Tribes, and non-governmental groups to support natural resource management problem solving and decisionmaking.			
USGS Open-File Report	FAER	6	Bovee, K.D., T.J. Waddle, C. Talbert, J.R. Hatten, and T.R. Batt. 2008. Development and application of a decision support system for water management investigations in the Upper Yakima River, Washington. U.S. Geological Survey Open-File Report 2008-1251. 289 p.
USGS Open-File Report	FAER	6	Waddle, T. 2007. Simulation of flow and habitat conditions under ice, Cache la Poudre River, January 2006. U.S. Geological Survey Open-file report 2007-1282. 37 p.
Invasive Species (INV)			
INV #1 - Provide and coordinate the collection, synthesis, and accessibility of invasive species information (Information Management Goal)			
Abstract	INV	1	Crall, A., J. Graham, G. Newman, C. Jarnevich, T. Holcombe, T. Stohlgren, and M. Kalkhan. 2008. A national scale citizen science program for invasive species (abs). <i>In</i> 93rd Ecological Society of America Annual Meeting, August 3–9, 2008, Milwaukee, Wisconsin.
Abstract	INV	1	Graham, J., G. Newman, A. Crall, C. Jarnevich, and T. Stohlgren. 2008. Creating a cyberinfrastructure for citizen science: Proper planning can go a long way (abs). <i>In</i> 93rd Ecological Society of America Annual Meeting, August 3–9, 2008, Milwaukee, Wisconsin.
Journal	INV	1	Graham, J., A. Simpson, A. Crall, C. Jarnevich, G. Newman, and T. Stohlgren. 2008. Vision of a cyberinfrastructure for nonnative, invasive species management. <i>BioScience</i> 58(3): 263-268.
Abstract	INV	1	Newman, G., L. Stapel, D. Zimmerman, T. Stohlgren, A. Crall, J. Graham, C. Jarnevich, T. Holcombe, and M. Kalkhan. 2008. Can citizen scientists think spatially? Evaluating the public's ability to understand and use an online GIS map application for invasive species (abs). <i>In</i> : 93rd Ecological Society of America Annual Meeting: August 3–9, 2008, Milwaukee, Wisconsin.
INV #2 - Identify and report new invasions and assess risks to natural areas and waters (Early Detection & Rapid Assessment Goal)			
Pages in Proceedings	INV	2	Holcombe, T., T.J. Stohlgren, and C. Jarnevich. 2007. Invasive species management and research using GIS. Pages 108-114 <i>in</i> G.W. Witmer, W.C. Pitt, and K.A. Fagerstone (eds.). <i>Managing vertebrate invasive species: Proceedings of an international symposium</i> . Fort Collins, CO: National Wildlife Research Center.
INV #3 - Assess changes in populations and distributions of established invaders (Monitoring and Forecasting Goal)			
Journal Article	INV	3	Evangelista, P.H., S. Kumar, T.J. Stohlgren, C.S. Jarnevich, A.W. Crall, J.B. Norman III, and D.T. Barnett. 2008. Modelling invasion for a habitat generalist and a specialist plant species. <i>Diversity and Distributions</i> 14(5): 808-817.
Abstract	INV	3	Holcombe, T., P. Evangelista, T. Gass, S. Kumar, M. Li, and T. Stohlgren. 2008. Modeling white pine blister rust in the southern Rocky Mountains (abs). <i>In</i> : 93rd ESA Annual Meeting: August 3–8, 2008, The Midwest Airlines Center, Milwaukee, Wisconsin. Ecological Society of America.

Abstract	INV	3	Jarnevich, C.S. and T.J. Stohlgren. 2008. Short term climate projections for species distributions (abs). In: 93rd ESA Annual Meeting: August 3–8, 2008, The Midwest Airlines Center – Milwaukee, Wisconsin. Ecological Society of America.
Journal Article	INV	3	Li, M-Y., Y-W. Ju, S. Kumar, and T.J. Stohlgren. 2008. Modeling potential habitat for alien species of <i>Dreissena polymorpha</i> in the Continental USA. <i>Acta Ecologica Sinica</i> 28(9): 1-6.
Journal Article	INV	3	Shafroth, P.B. and M.K. Briggs. 2008. Restoration ecology and invasive riparian plants: An introduction to the special action on <i>Tamarix</i> spp. in Western North America. <i>Restoration Ecology</i> 16(1): 94-96.
Journal Article	INV	3	Stohlgren, T.J., D.T. Barnett, C.S. Jarnevich, C. Flather, and J. Kertesz. 2008. The myth of plant species saturation. <i>Ecology Letters</i> 11(4): 313-326.
INV #4 - Provide approaches to contain, reduce, and eliminate populations of invasive species and restore habitats and native species (Control and Management Goal)			
Journal Article	INV	4	Evangelista, P., S. Kumar, T.J. Stohlgren, A.W. Crall, and G.J. Newman. 2007. Modeling aboveground biomass of <i>Tamarix ramosissima</i> in the Arkansas River basin of southeastern Colorado, USA. <i>Western North American Naturalist</i> 67(4): 503-509.
Journal Article	INV	4	Rodda, G.H., K. Dean-Bradley, J.A. Savidge, M.T. Christy, and C.L. Tyrrell. 2008. Post-colonization reversal of selection pressure on dispersal behavior of the Brown Treesnake, <i>Boiga irregularis</i> , on Guam. <i>South American Journal of Herpetology</i> 3(2): 123-134.
INV #6 - Determine effects of invasive species and susceptibility of habitats to invasions (Effects Goal)			
Journal Article	INV	6	Brien, M.L., C.H. Brien, and R.N. Reed. 2008. <i>Morelia spilota spilota</i> (Diamond python). Reproduction. <i>Herpetological Review</i> 39(3): 355.
Journal Article	INV	6	Reed, R.N., K.A. Bakkegard, G.E. Desy, and S.M. Plentovich. 2007. Diet composition of the invasive cane toad (<i>Chaunus marinus</i>) on Rota, Northern Mariana Islands. <i>Pacific Conservation Biology</i> 13(3): 219-222.
Journal Article	INV	6	Stohlgren, T.J., C. Flather, C.S. Jarnevich, D.T. Barnett, and J. Kertesz. 2008. Rejoinder to Harrison (2008): "The Myth of Plant Species Saturation." <i>Ecology Letters</i> 11(4): 324-326.
Journal Article	INV	6	Todd, B.D., B.B. Rothermel, R.N. Reed, T.M. Luhring, K. Schlatter, L. Trenkamp, and J. Whitfield Gibbons. 2008. Habitat alteration increases invasive fire ant abundance to the detriment of amphibians and reptiles. <i>Biological Invasions</i> 10(4): 539-546.
Status and Trends of Biological Resources (ST)			
ST #1 - Develop a conceptual model and the required infrastructure (a National Framework for Monitoring Biological Resources) that facilitate the integration of information from a variety of sources, at multiple spatial and temporal scales, to describe and track the abundance, distribution, productivity, and health of the Nation's plants, animals, and ecosystems.			
Journal Article	ST	1	Sammler, J.E., D.E. Andersen, and S.K. Skagen. 2008. Population trends of tundra-nesting birds at Cape Churchill, Manitoba, in relation to increasing goose populations. <i>The Condor</i> 110(2): 325-334.
Journal Article	ST	1	Skagen, S.K., D.A. Granfors, and C.P. Melcher. 2008. On determining the significance of ephemeral continental wetlands to North American migratory birds. <i>The Auk</i> 125(1): 20-29.

Pages in Report	ST	1	Taylor, J.G., S.C. Gillette, R.W. Hodgson, J.L. Downing, D.J. Chavez, J.T. Hogan, and M.R. Burns. 2008. Quick-response research of communication between agencies and interface communities during wildland fire. Pages 119-152 <i>in</i> D.J. Chavez, J.D. Absher, and P.L. Winter (eds.). Fire social science research from the Pacific Southwest Research Station: Studies supported by National Fire Plan Funds. General Technical Report PSW-GTR-209. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.
ST #2 - Develop and evaluate inventory and monitoring methods, protocols, experimental designs, analytic tools, models, and technologies to measure biological status and trends.			
Journal Article	ST	2	Andres, B.A., S.K. Skagen, and K. Rosenberg. 2008. Assessing conservation status of poorly monitored birds. <i>All-Bird Bulletin</i> Jan 2008: 11-12.
Report	ST	2	Burkardt, N., E. Ruell, and D. Clark. 2008. Technical Memorandum No. 86-68211-09-01: An exploration of Bureau of Reclamation approaches for managing conflict over diverging science - Institutional solutions for water resource conflicts workshop, Salt Lake City, Utah, September 24-27, 2007. Reclamation Research and Development Proposal X7515. 19 p.
Journal Article	ST	2	Etterson, M.A. and T.R. Stanley. 2008. Incorporating classification uncertainty in competing-risks nest-failure analysis. <i>The Auk</i> 125(3): 687-699.
Abstract	ST	2	Lamb, B.L. 2008. Role of the environmental flow specialist in water conflicts (abs). Page 54 <i>in</i> NoWPaS Annual Meeting: Copenhagen, Denmark. NoWPaS.
Journal Article	ST	2	Lamb, B.L. and N. Burkardt. 2008. Mathematical models frame environmental dispute [Review of the article Useless arithmetic: Ten points to ponder when using mathematical models in environmental decisionmaking]. <i>Public Administration Review</i> 68(3): 55-60.
Pages in Book	ST	2	Royle, J.A., T.R. Stanley, and P.M. Lukacs. 2008. Statistical modeling and inference from carnivore survey data. <i>In</i> : Robert A. Long, Paula MacKay, William J. Zielinski, and Justina C. Ray (eds.). <i>Noninvasive survey methods for carnivores</i> . p. 293-312.
USGS Fact Sheet	ST	2	Ruth, J.M., J.J. Buler, R.H. Diehl, and R.S. Sojda. 2008. Management and research applications of long-range surveillance radar data for birds, bats, and flying insects. U.S. Geological Survey Fact Sheet 2008-3095. 4 p.
Journal Article	ST	2	Schroeder, R. 2008. Comprehensive conservation planning and ecological sustainability within the United States National Wildlife Refuge System. <i>Sustainability: Science, Practice, & Policy</i> 4(1). Available at http://ejournal.nbii.org/archives/vol4iss1/communityessay.schroeder.html
USGS Open-File Report	ST	2	Scott, M.L., and E.W. Reynolds. 2007. Field-based evaluations of sampling techniques to support long-term monitoring of riparian ecosystems along wadeable streams on the Colorado Plateau. U.S. Geological Survey Open-File Report 2007-1266. 68 p.
USGS Open-File Report	ST	2	Sexton, N.R., S.C. Steward, and L. Koontz. 2008. Community survey results for Rappahannock River Valley National Wildlife Refuge: Completion Report. U.S. Geological Survey Open-File Report 2008-1219. 91 p.
Abstract	ST	2	Sexton, N.R., E. Swann, and N. Burkardt. 2008. The virtues of Q methodology in natural resource planning and decisionmaking (abs). <i>In</i> 14th International Symposium on Society and Resource Management, June 10–14, 2008, Burlington, Vermont.

ST #4 - Produce and provide analyses and reports that synthesize information on the status and trends of our Nations flora, fauna, and ecosystems and are responsive to the needs of the scientific community, land and resource managers, policy makers, and the public.			
Journal Article	ST	4	Benson, L.V., H.E. Taylor, K.A. Peterson, B.D. Shattuck, C.A. Ramotnik, and J.R. Stein. 2008. Development and evaluation of geochemical methods for the sourcing of archaeological maize. <i>Journal of Archaeological Sciences</i> 35: 912-921.
USGS Open-File Report	ST	4	Ellison, L.E. 2008. Summary and analysis of the U.S. Government Bat Banding Program: U.S. Geological Survey Open-File Report 2008-1363. 117 p.
Journal Article	ST	4	Ruth, J.M. 2008. Distribution of breeding Arizona Grasshopper Sparrow (<i>Ammodramus savannarum ammoregus</i>) in the southwestern United States: Past, present, and future. <i>Studies in Avian Biology</i> No. 37: 113-124.
Journal Article	ST	4	Ruth, J.M., T. Brush, and D.J. Krueper (Assoc. Eds.). 2008. Birds of the US-Mexico borderlands: distribution, ecology and conservation. <i>Studies in Avian Biology</i> no. 37. 165 p.
Journal Article	ST	4	Ruth, J.M., T. Brush, and D.J. Krueper (Assoc. Eds.). 2008. Literature Cited [Birds of the US-Mexico borderlands: Distribution, ecology, and conservation]. <i>Studies in Avian Biology</i> no. 37: 146-165.
Journal Article	ST	4	Ruth, J.M., T. Brush, and D.J. Krueper. 2008. Preface [Birds of the US-Mexico borderlands: distribution, ecology and conservation]. <i>Studies in Avian Biology</i> No. 37: 1-9.
Journal Article	ST	4	Skagen, S.K. 2008. Shorebird journeys across the North American prairies. <i>Birding</i> : 48-54.
Journal Article	ST	4	Skagen, S.K., C.P. Melcher, and D.A. Haukos. 2008. Reducing sedimentation of depressional wetlands in agricultural landscapes. <i>Wetlands</i> 28(3): 594-604.
Journal Article	ST	4	Wiener, J.D., K.A. Dwire, S.K. Skagen, R.R. Crifasi, and D. Yates. 2008. Riparian ecosystem consequences of water redistribution along the Colorado Front Range. <i>Water Resources Impact</i> 10(3): 18-21.
Wildlife: Terrestrial and Endangered Resources (WTR)			
WTR #1 - Provide the Scientific Foundation for the Conservation of Terrestrial Plants, Wildlife, and Habitats by developing the basic biological information that partners need to formulate adaptive management strategies.			
Journal Article	WTR	1	Augustine, D.J., S.J. Dinsmore, M.B. Wunder, V.J. Dreitz, and F.L. Knopf. 2008. Response of mountain plovers to plague-driven dynamics of black-tailed prairie dog colonies. <i>Landscape Ecology</i> 23(9): 689-697.
Report	WTR	1	Biggins, D. 2007. Summary of black-footed ferret, prairie dog, and plague research activities, 2007. 4 p.
Journal Article	WTR	1	Cryan, P.M. 2008. Mating behavior as a possible cause of bat fatalities at wind turbines. <i>Journal of Wildlife Management</i> 72(3): 845-849.
Journal Article	WTR	1	Felix, Jr., R.K., R.H. Diehl, and J.M. Ruth. 2008. Seasonal passerine migratory movements over the arid Southwest. <i>Studies in Avian Biology</i> No. 37: 126-137.
Journal Article	WTR	1	Geluso, K., J.P. Damm, and E.W. Valdez. 2008. Late-seasonal activity and diet of the evening bat (<i>Nycticeius humeralis</i>) in Nebraska. <i>Western North American Naturalist</i> 68(1): 21-24.

Abstract	WTR	1	Gillam, E., M. Brigham, and T.J. O'Shea. 2008. Nonrandom associations and social structure in Big Brown Bats, <i>Eptesicus fuscus</i> (abs). In Animal Behavior Society 45th Annual Meeting, Snowbird Utah.
Popular Article	WTR	1	Kissel, A. 2007. Holding onto a slippery species. Fort Collins Now. 5(43): 14-18.
Popular Article	WTR	1	Muths, E. and A. Kissel. 2007. Boreal toads and the ecosystem. Fort Collins Now. 5(43): 18.
Journal Article	WTR	1	Neubaum, M.A., M.R. Douglas, M.E. Douglas, and T.J. O'Shea. 2007. Molecular ecology of the big brown bat (<i>Eptesicus fuscus</i>): Genetic and natural history variation in a hybrid zone. Journal of Mammalogy 88(5): 1230-1238.
Abstract	WTR	1	Oyler-McCance, S.J. and T.W. Quinn. 2008. When morphology matters most: Assessing the importance of morphological difference in grouse (abs). Joint meeting of the American Ornithologists' Union, the Cooper Ornithological Society, and the Society of Canadian Ornithologists, Portland, Oregon, August 4-9, 2008.
Journal Article	WTR	1	Oyler-McCance, S.J., F.A. Ransler, L.K. Berkman, and T.W. Quinn. 2007. A rangewide population genetic study of trumpeter swans. Conservation Genetics 8(6): 1339-1353.
Journal Article	WTR	1	Oyler-McCance, S.J., J. St. John, R.F. Kysela, and F.L. Knopf. 2008. Population structure of Mountain Plover as determined using nuclear microsatellites. Condor 110(3): 493-499.
Journal Article	WTR	1	Pearce, R.D., T.J. O'Shea, V. Shankar, and C.E. Rupprecht. 2007. Lack of association between ectoparasite intensities and rabies virus neutralizing antibody seroprevalence in wild big brown bats (<i>Eptesicus fuscus</i>), Fort Collins, Colorado. Vector-Borne and Zoonotic Diseases 7(4): 489-495.
Journal Article	WTR	1	Pearce, R.D., T.J. O'Shea, and B.A. Wunder. 2008. Evaluation of morphological indices and total body electrical conductivity to assess body composition in big brown bats. Acta Chiropterologica 10(1): 153-159.
Abstract	WTR	1	Ransom, J.I. and B.S. Cade. 2008. Influences of immunocontraception on intraband social behavior in free-ranging feral horses, <i>Equus caballus</i> (abs). In: Proceedings of the International Equine Science Meeting; Regensburg, Germany, October 3-5, 2008. Regensburg, Germany: Equine Behavior Team, University of Regensburg.
Journal Article	WTR	1	Scherer, R.D. 2008. Detection of wood frog egg masses and implications for monitoring amphibian populations. Copeia No. 3: 669-672.
Journal Article	WTR	1	Stanley, T.R. and S.K. Skagen. 2007. Estimating the breeding population of Long-billed Curlew in the United States. Journal of Wildlife Management 71(8): 2556-2564.
Abstract	WTR	1	White, C.S., and C.A. Ramotnik. 2008. The Scott Able Fire: Effects on select soil parameters within Sacramento Mountain salamander habitat [Presentation] (abs). Pages 96-97 in Fire in the Southwest: Integrating Fire into Management of Changing Ecosystems, regional conference. Jan. 28-31, 2008, Tucson, Arizona. The Association for Fire Ecology.
WTR #2 - Provide tools and techniques, such as predictive models, decision support, and expert systems, for science-based management of wildlife and plant populations and their habitats.			
Journal Article	WTR	2	Cade, B.S. and Q. Dong. 2008. A quantile count model of water depth constraints on Cape Sable seaside sparrows. Journal of Animal Ecology 77: 47-56.

WTR #3 - Identify the factors that contribute to and/or limit the conservation and recovery efforts for terrestrial plant and wildlife species-at-risk.

Journal Article	WTR	3	Muths, E., D.S. Pilliod, and L.J. Livo. 2008. Distribution and environmental limitations of an amphibian pathogen in the Rocky Mountains, USA. <i>Biological Conservation</i> 141(5): 1484-1492.
Journal Article	WTR	3	Scherer, R.D., E. Muths, and B.A. Lambert. 2008. Effects of weather on survival in populations of Boreal Toads in Colorado. <i>Journal of Herpetology</i> 42(3): 508-517.

WTR #4 - Institute an Adaptive Science Approach to Support the Adaptive Management of Terrestrial Plants and Wildlife and to Provide Technical Assistance to Natural Resource Managers.

USGS General Information Product	WTR	4	Cryan, P.M. 2008. Overview of issues related to bats and wind energy: Web version of presentation to the Wind Turbine Guidelines Advisory Committee Technical Workshop & Federal Advisory Committee Meeting, Washington, D.C., 26 February, 2008. General Information Product. U.S. Geological Survey. 71 p.
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WTR #5 - Enhance USGS Wildlife Research to Meet Emerging and Future Issues. Build additional capabilities, expertise, and capacity in the WTER Program to meet the emerging needs of USGS partners as wildlife issues take on new importance in todays society.

Pages in Report	WTR	5	Cryan, P. 2007. Past, present, and future uses of radar for studying bats. Page 46 <i>in</i> Ruth, J.M. (ed.). Applying radar technology to migratory bird conservation and management: strengthening and expanding a collaborative. U.S. Geological Survey Open-File Report 2007-1361.
USGS Open-File Report	WTR	5	Ruth, J.M. 2007. Applying radar technology to migratory bird conservation and management: strengthening and expanding a collaborative. U.S. Geological Survey Open-File Report 2007-1361. 175 p.

Appendix II: Other FORT Products Delivered in FY 2008

Product Type	Program	Goal	Citation
Biological Informatics (BIO)			
BIO #2 - Implement technologies and tools to integrate, analyze, visualize, and apply biological information to natural resource issue (Tools).			
Web application	BIO	2	MyUSGS, v. 3.0. October 2007. Full integration of document management system; new community portal; community control of email, free form content, and project contexts
Web application	BIO	2	MyUSGS, v. 3.1. February 2008. Role creation and management; community navigation alteration; IT service desk incorporation
Web application	BIO	2	MyUSGS, v. 3.2. April 2008. Entry query options; Web folder self-publishing; MyAccount and Subscriptions; extension of Single SignOn to external applications
Web application	BIO	2	MyUSGS, v. 3.3. June 2008. Opt in/out per Realm, Portal self-customization; MyUSGS-Help Community addition; autocomplete user search
Web application	BIO	2	MyUSGS, v. 3.4. (August 2008) Google-like UI for navigation; added reference to Lotus Notes names in addition to shortname; Public spaces for posting Internet-accessible documents and pages, per FSP workflow
Web application	BIO	2	PLOT (People, Locations, Organizations, Teams), v. 1.0. (September 2008) Data synchronization with USGS databases, user customization UI, Web service/data providers
Web application	BIO	2	SCIM (Simple Content Information Management), v. 1.0. (July 2008) Content entry and management, content tagging, Web service/data providers
Web application	BIO	2	SCIM (Simple Content Information Management), v. 1.1. (September 2008) Tag libraries and browsing, content formatting
Web application	BIO	2	WLCI (Wyoming Landscape Conservation Initiative) Project Mapper, v. 1.0. (September 2008) Data upload/edit, Web Mapping and Web Feature Services, custom mapping UI
Terrestrial, Freshwater, and Marine Ecosystems (ECO)			
ECO #1 - Quantify and understand factors influencing patterns of temporal and spatial variability in key ecosystem components and processes.			
Web science feature	ECO	1	Baron, J. 2008. Fixing nitrogen levels. http://environmentalresearchweb.org/cws/article/opinion/33501 .
ECO #4 - Devise restoration and adaptive management frameworks for impaired ecosystems.			
Web science feature	ECO	4	Wilson, J.T., C. Aldridge, and C. Melcher. 2007. Energy, land use, and sagebrush ecosystems: Finding the delicate balance. http://www.fort.usgs.gov/SageEnergy/ .

Fisheries: Aquatic and Endangered Resources (FAER)			
FAER #6 - Provide research support and technical assistance to DOI bureaus, other Federal and State government agencies, Tribes, and non-governmental groups to support natural resource management problem solving and decisionmaking.			
Software	FAER	5	Bovee, K.D. and T. Waddle. 2007. Rio Grande Habitat Time Series Model (computer software). Fort Collins, CO: Fort Collins Science Center.
Web science feature	FAER	6	Wilson, J.T. and S.G. Campbell. 2007. Publication Brief for Resource Managers: Evaluating the potential for watershed restoration to reduce nutrient loading to Upper Klamath Lake, Oregon (USGS Open-File Report 2007-1168). http://www.fort.usgs.gov/Products/Publications/22164/22164.pdf .
Web science feature	FAER	6	Hanson, L., S.C. Williamson, T.J. Waddle, C. Talbert, and J.E. Heasley. 2008. Smart River GIS for improved decisionmaking. http://www.fort.usgs.gov/smartrivergis/ .
Invasive Species (INV)			
INV #2 - Identify and report new invasions and assess risks to natural areas and waters (Early Detection & Rapid Assessment Goal)			
Web science feature	INV	2	Stanford, J. and J. Wilson. 2008. Stalking snakes: Days (and nights) in the life of a Brown Treesnake rapid responder. http://www.fort.usgs.gov/stalkingsnakes/ .
Status and Trends of Biological Resources (ST)			
ST #4 - Produce and provide analyses and reports that synthesize information on the status and trends of our Nations flora, fauna, and ecosystems and are responsive to the needs of the scientific community, land and resource managers, policy makers, and the public.			
Web site	ST	4	Ramotnik, C.A. 2008. USGS, Biological Surveys Collection, Albuquerque. http://www.msb.unm.edu/USGS/ .
Wildlife: Terrestrial and Endangered Resources (WTR)			
WTR #1 - Provide the Scientific Foundation for the Conservation of Terrestrial Plants, Wildlife, and Habitats by developing the basic biological information that partners need to formulate adaptive management strategies.			
Web science feature	WTR	1	Ransom, J.I., M.E. Swann, J.T. Wilson, and J.E. Roelle. 2007. America's wild horses and burros: Research for management. http://www.fort.usgs.gov/WildHorsePopulations/ .
WTR #4 - Institute an Adaptive Science Approach to Support the Adaptive Management of Terrestrial Plants and Wildlife and to Provide Technical Assistance to Natural Resource Managers.			
Web site	WTR	4	Stevens, P.D. and L.E. Ellison. 2008. Symposium on the ecology of plague and its effects on wildlife. http://www.fort.usgs.gov/Plague/ .
WTR #5 - Enhance USGS Wildlife Research to Meet Emerging and Future Issues. Build additional capabilities, expertise, and capacity in the WTR Program to meet the emerging needs of USGS partners as wildlife issues take on new importance in today's society.			
Web science feature	WTR	5	Ruth, J.M. 2008. Radar technology: A tool for understanding migratory "Aerofauna." http://www.fort.usgs.gov/radar/ .

Appendix III: FORT Staff Accomplishments and Activities

A. Staff Appointments and Committee Assignments

1. Douglas Andersen, **Technical Group, Bureau of Reclamation Interagency R&D Workgroup for Climate Impacts on Water**: Member.
2. Douglas Andersen, **USGS-BRD Goals and Strategic Actions Writing Team for Goal 6, Understanding Water Availability for Ecological Needs**: Member.
3. Jill Baron, **Grand Canyon Monitoring and Research Center (GCMRC), Research and Adaptive Management Program**: Advisor.
4. Jill Baron, **H.J. Andrews Long-term Ecological Research Program**: Advisor.
5. Jill Baron, **National Center for Ecological Analysis and Synthesis**: Advisor.
6. Jill Baron, *Ecological Applications*: Associate Editor.
7. Jill Baron, **Ecological Society of America**, issues in *Ecology*: Editor-in-Chief.
8. Jill Baron, **U.S. Geological Survey Global Change Program, Science Advisory Committee**: Member.
9. Dean Biggins, **APHIS Plague and Tularemia Advisory Panel**: Member.
10. Dean Biggins, **Black-footed Ferret Recovery Implementation Team**: Conservation Subcommittee 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 Member, Membership Committee chair, Conservation Committee member.
14. Brian S. Cade, *Frontiers in Ecology and the Environment*: Editorial Board.
15. Paul Cryan, **Bats and Wind Energy Cooperative Science Committee**: Chair.
16. Paul Cryan, **White Nose Syndrome Science Strategy Committee**: Member.
17. Paul Cryan, *Northwestern Naturalist*: Associate Editor.
18. Paul Cryan and Tom O'Shea, **Bat Conservation International**: International Scholarship Applicant reviewers.
19. Aaron Douglas, *Open Hydrology Journal*: Editorial Board 2008–2010.
20. Berton Lee Lamb, *Sustainability: Science, Practice, Policy*: Editorial Board 2005–2009.
21. Berton Lee Lamb, *International Journal of Sustainable Society*: Editorial Board 2007–2009.
22. Jeff Morisette, **Ph.D. Committee for Miguel Roman, Boston University**, Geography, (anticipated graduation, spring 2009), role: external member.

23. Jeff Morisette, **U.S. National Phenology Network (NPN), Member: Land Surface Phenology Working Group** (represents remote sensing and large-scale phenology interests within the U.S. NPN): Member.
24. Erin Muths, **Animal Conservation**: Associate Editor.
25. Erin Muths, **Herpetologists' League**: Board of Trustees.
26. Erin Muths, **Southwest Partners in Amphibian and Reptile Conservation**: Steering Committee and 2009 Annual Meeting Planning Committee.
27. Erin Muths, **SaveTheFrogs!**: Advisory Board.
28. Tom O'Shea, **American Society of Mammalogists**: Member of these standing committees: Marine Mammals, Conservation Awards, Legislation and Regulations.
29. Sara Oyler-McCance, *Wilson Journal of Ornithology*: Editorial Board.
30. Phadrea Ponds, Western Social Science Association: President, 2007–2008.
31. Cindy Ramotnik, **New Mexico Endemic Salamander Team**: Member.
32. Cindy Ramotnik, *Collection Forum* (Society for the Preservation of Natural History Collections): Associate Editor.
33. Cindy Ramotnik, **Society for the Preservation of Natural History Collections**: Editorial Board; member of these standing committees: Conservation, Documentation, Membership, and Publications.
34. Jason Ransom, **International Union of Conservation and Nature (IUCN) Species Survival Commission**: Appointed member.
35. Bob Reed, *Herpetological Review*: Associate Editor.
36. Bob Reed, **Interagency Committee on Invasive Terrestrial Animals and Pathogens** (ITAP, a multi-agency Federal group): Member, Vertebrate Subcommittee and ITAP.
37. Bob Reed, **PhD committee** for University of Nevada–Las Vegas student: Member
38. Bob Reed, *Biological Reviews*, *Biological Journal of the Linnean Society*, *Journal of Zoology*, *Sensors*, *Applied Herpetology*, and *Journal of Herpetology*: Invited referee.
39. Bob Reed, **World Congress of Herpetology, Manaus, Brazil, Invasive Amphibian And Reptile Symposium**: Organizer/convener.
40. Gordon Rodda, **Mariana Crow Recovery Team**: Member.
41. Gordon Rodda, **Guam Kingfisher Recovery Team**: Member.
42. Janet Ruth, **Partners in Flight**: USGS Liaison.
43. Jeff Schafer and Erik Hernandez, **USGS Information Technology Security Operations Team** (ITSOT; responsible for implementation of IT security standards and guidelines throughout the USGS and for deployment and day-to-day operations of USGS security systems): Members.
44. Kate Schoenecker, **Department of the Interior Bison Working Group**: Member.
45. Natalie Sexton, National Conservation Leadership Institute: Fellow 2007–2008.

46. Pat Shafroth, **Northern Arizona University, Graduate Committee** for Alicyn Gitlin, Ph.D. candidate: member.
47. Sarah A. Spaulding, **Research Council of the International Society of Diatom Research:** Elected member 2008–2011.
48. Sarah A. Spaulding, **Proceedings of the 2007 International Workshop on *Didymosphenia geminata***, published as the Canadian Technical Report of Fisheries and Aquatic Sciences 2795: Co-editor.
49. Sarah A. Spaulding, **Graduate student advisory committees** (1 Master’s and 3 Ph.D. candidates in Environmental Sciences, Geology, and Engineering), University of Colorado: Member/advisor.
50. Sarah A. Spaulding, **INSTAAR Weekly Science Seminar**, University of Colorado: Organizer.
51. Sarah A. Spaulding, **Research Seminar Course at Boulder High School:** Mentor for 3 students, 2007–2008. (These students won “First Place in Environmental Sciences” and “Best Team Award” at the district and state levels in Colorado for 2008; they presented their results at the 2008 Arctic Workshop at INSTAAR and the International Diatom Symposium in Croatia; their manuscript, “Historical abundance and morphology of *Didymosphenia* species in Naknek Lake, Alaska,” is currently in review for *International Proceedings for Diatom Research*.)
52. Sarah A. Spaulding, ***Journal of Ecology, Diatom Research, Journal of the North American Benthological Society, National Science Foundation proposals, International Society for Limnology Proceedings and Academy of Natural Sciences of Philadelphia Proceedings:*** Invited referee.
53. James Stanford, **Pacific Invasives Learning Network:** Member.
54. James Stanford, **Guam Invasives Species Advisory Committee:** Member.
55. Tom Stohlgren, ***Ecology and Ecological Monographs:*** Editorial Board.
56. Tom Stohlgren, **National Ecological Observation Network (NEON):** USGS Liaison.

B. Invited Presentations

1. Craig D. Allen, Invited Presentation, “**Climate-Induced Forest Dieback: Global Overview and Piñon-Juniper Woodland Mortality in the Southwestern USA.**” International Forest Health meeting, Sedona, Ariz., Oct. 17, 2007.
2. Craig D. Allen, Invited Presentation, “**Vegetation Dieback, Fire, and Erosion as Climate-Driven Ecological Disturbances: Thresholds and Interactions Across Spatial Scales.**” New Mexico Climate Change Ecology and Adaptation Workshop, Albuquerque, N.M., Oct. 22, 2007.
3. Craig D. Allen, Invited Presentation; Allen, C.D., R. Oertel, and K.L. Beeley, Invited presentation, “**Trends in Northern New Mexico Ecosystems: Long-term Monitoring, Threshold Effects, and Disturbance Interactions.**” Ninth Biennial Conference of Research on the Colorado Plateau, Flagstaff, Ariz., Oct. 30, 2007.
4. Craig D. Allen, Invited Presentation, “**Erosion as Climate-Driven Ecological Disturbances: Thresholds and Interactions Across Spatial Scales.**” Association for Fire Ecology Conference, *Fire in the Southwest*, Tucson, Ariz., Jan. 29, 2008.
5. Craig D. Allen, Invited Presentation, “**The Cerro Grande Fire: Lessons Learned, Debated, Forgotten, and Undiscussed.**” Association for Fire Ecology Conference, *Fire in the Southwest*, Tucson, Ariz., Jan. 31, 2008.
6. Craig D. Allen, Invited Presentation, “**A Landscape Perspective on Fire and ‘Restoration’ in New Mexico Mixed Conifer Forests.**” Workshop on Ecology and Management of Mixed Conifer and Aspen Forests in New Mexico, Santa Fe, N.M., Feb. 20, 2008.
7. Craig D. Allen, Invited Presentation, “**Climate-Induced Forest Dieback: A Global Overview of Emerging Risks.**” Food and Agriculture Organization of the United Nations/International Union of Forest Research Organizations (FAO/IUFRO) International Conference on Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health, Umea, Sweden, Aug. 27, 2008.
8. Craig D. Allen, Invited Presentation (presented on behalf of G.M. Blate, L. Joyce, S. Julius, J. Littell, S. McNulty, C. Millar, S. Moser, R. Nielson, K. O’Hallaran, D. Peterson, and J. West), “**Adapting to Climate Change in U.S. National Forests.**” FAO/IUFRO International Conference on Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health, Umea, Sweden, Aug. 28, 2008.
9. Jill Baron, Invited Speaker, “**Complex Patterns in Climate and Atmospheric Nitrogen Deposition Influence Rocky Mountain Ecosystems.**” American Geophysical Union Fall Meeting, San Francisco, Ca., Dec. 12, 2007.
10. Jill Baron, Invited Speaker, Symposium Organizer and Chair, “**Adaptation Options for Climate-Sensitive Ecosystems and Resources.**” American Association for the Advancement of Science Annual Meeting, Boston, Mass., Feb. 15, 2008.

11. Jill Baron, Invited Speaker, **“Climate-Induced Changes in Nitrogen Dynamics of High Elevation Streams,”** USDA Joint Agricultural Research at the Center for Russian and East European Studies team meeting, National Water Resources Research Institutes meeting (also field trip leader), Rocky Mountain National Park Lyceum public lecture, University of Denver Graduate Ecology Seminar, Colorado State University undergraduate ecology class, Joint Global Change Research Institute seminar, various dates.
12. Jill Baron, Invited Speaker, **“Adaptation Options for Climate-Sensitive Ecosystems and Resources.”** OMB Budget Examiner’s meeting (Denver), U.S. Climate Change Science Program, Department of the Interior, U.S. Forest Service Climate Change Resource Center short course on climate change (filmed), National Water Quality Management Council, U.S. Forest Service (Pacific Northwest) managers, European alpine research scientists’ meeting, various dates.
13. Nina Burkardt, **“Negotiation and Conflict Resolution,”** USGS Leadership 101 classes in Shepherdstown, W.V., February and May 2008.
14. Sharon Campbell, Organizer, **“Colorado Lake and Reservoir Management ‘Day on the Rez.’”** July 2008.
15. Paul Cryan, Invited Speaker, **“Bat Ecology.”** White Nose Syndrome Science Strategy Meeting, Albany, N.Y., June 9–11, 2008.
16. Paul Cryan, Invited Speaker, **“Overview of Issues Related to Bats and Wind Energy.”** Wind Turbine Guidelines Advisory Committee Technical Workshop and Federal Advisory Committee Meeting, Washington, D.C, Feb. 26–28, 2008.
17. Paul Cryan, Invited Speaker, **“Uncovering the Hidden Lives of Hoary Bats and Their Mysterious Deaths at Wind Turbines.”** University of Colorado–Denver, Department of Biology, Denver, Colo., Feb. 1, 2008.
18. Jonathan Friedman, Invited Speaker, **“Tamarix and Rapidly Evolving Cold Hardiness.”** 19th USDA Interagency Research Forum on Invasive Species, Annapolis, Md., Jan. 9, 2008.
19. Catherine Jarnevich, Invited speaker, **“Forecasting Species Distributions under Changing Climates.”** Natural Resource Ecology Laboratory Seminar Series, Fort Collins, CO, March 14, 2008.
20. Catherine Jarnevich, Invited speaker, **“Models of Regional Invasive Species Using Merged Datasets.”** Integrating Invasive Plant Species Data in the Midwest: Solutions for Data Collection and Management, Madison, WI, January 24–25, 2008.
21. Lynne Koontz, **“Integrating Biological and Economic Analyses for Effective Decisionmaking.”** Northern Prairie Wildlife Research Center, Jamestown, N.D., June 12, 2008.
22. Berton Lee Lamb, Keynote address, **“Use of Science in Environmental Decision-Making.”** EnviroSymp08, Roskilde University, Roskilde, Denmark, November 13–14, 2008
23. Jeff Morissette, Invited Speaker, **“Tracking the Rhythm of the Seasons in the Face of Global Change: Frontiers in Phenological Research.”** CSU, Natural Resource Ecology Lab for the fall 2008 seminar series: "Scaling Up, Across, and Over Time in Ecology," Fort Collins, CO, Sept. 12, 2008

24. Erin Muths, Invited Speaker, “**Disease, Climate Change and Amphibians in the Western United States.**” 6th World Congress of Herpetology, Manaus, Brazil, Aug. 2008.
25. Erin Muths, Invited Speaker, “**Distribution of the Amphibian Chytrid Fungus in the Rocky Mountains.**” Rocky Mountain National Park Research Conference. Estes Park, Colo., April 2008.
26. Tom O’Shea, Invited Speaker, “**Big Brown Bats and Rabies in Fort Collins: An Overview of a Deadly Disease at Our Doorsteps.**” Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, Dec. 7, 2007.
27. Tom O’Shea, Invited Speaker, “**An Introduction to the Bats, with an Overview of the Ecology of Rabies Transmission in Big Brown Bats in an Attic Near You.**” Rocky Mountain Virology Club, Pinegree Park Campus, Colorado State University, Fort Collins, Oct. 6, 2007.
28. Sara Oyler-McCance, Invited Speaker, “**Using Genetic Data to Aid in the Management of Gunnison Grouse.**” Gunnison Sage-grouse Summit, Montrose, Colo., May 14–15, 2008.
29. Sara Oyler-McCance and Tom Quinn, Invited Speakers, “**When Morphology Matters Most: Assessing the Importance of Morphological Differences in Grouse.**” Joint meeting of the AOU, SCO and COS, Portland, Ore., Aug. 4–9, 2008.
30. Bob Reed, Invited presenter, “**Motivations for Release of Exotic Reptiles.**” Sixth World Congress of Herpetology, Manaus, Brazil, Aug. 17–22, 2008.
31. Bob Reed, Invited presenter, “**Control Tools for Snakes.**” Wild Aruba 2008, Aruba, Netherlands Antilles, Aug. 25–29, 2008.
32. Bob Reed, Invited presenter, “**Why Do People Release Invasive Amphibians and Reptiles?**” Colorado State University, Ecology of Invasive Species, September 2008, and Manaus, Brazil, Sixth World Congress of Herpetology, Aug. 17, 2008.
33. Gordon Rodda, Invited presenter, “**Seven Visions for Vertebrate Recovery on Snake-Infested Guam; Under What Conditions Is Permanent Snake Control Practical at the Landscape Scale?**” Sixth World Congress of Herpetology, Manaus, Brazil, August 17–22, 2008.
34. Gordon Rodda, Invited presenter, “**How Low Can You Go? Discussion: What Does ‘Severe Snake Suppression’ Mean?**” Brown Treesnake Technical Meeting, Honolulu, Hi., April 16–18, 2008.
35. Kate Schoenecker, Invited Participant, IUCN Commission Member; Discussion participant, “**Wild Equid Knowledge Café on Modeling.**” International Union for Conservation of Nature (IUCN) World Congress, Barcelona, Spain, Oct. 5–9, 2008.
36. Kate Schoenecker, Invited Presentation, “**A Population Model for Bison in the San Luis Valley, Colorado.**” America Bison Society Conference, Rapid City, S.D., Nov. 17, 2008.
37. Kate Schoenecker, Invited Presentation. “**Status of the Stratton Project.**” Bureau of Land Management, Rawlins, Wyo., March 2008.

38. Pat Shafroth, Invited Lecturer. “**Restoration of Riparian Habitat Dominated by Alien *Tamarix* spp.**” Wetland Ecology and Management course, Northern Arizona University. March, 5, 2008.
39. Pat Shafroth, Invited Lecturer. “**Managing Regulated Streamflows for Downstream Ecosystems: Bill Williams River, Arizona.**” Department of Forestry Seminar Series, Northern Arizona University, March 5, 2008.
40. Pat Shafroth, Invited Lecturer. “**Hydrology, Fluvial Geomorphology, and Riparian Vegetation: General Concepts and a Case Study from Arizona.**” Graduate Seminar in Riparian Ecology in the Arid and Mountain West, Colorado State University, Graduate Degree Program in Ecology, Oct. 7, 2008.
41. Pat Shafroth, Invited Presentation. “**Ecology of Russian-olive (*Elaeagnus angustifolia*) in Western U.S.A.**” 2007 Tamarisk symposium, Grand Junction, Colo., October 24–26, 2007; 2008 Wyoming Weed Management Association, Commercial Pesticide Applicator Recertification, Casper, Wyo., Feb. 23, 2008.
42. Pat Shafroth, Invited Presentation. “**Predicting Potential Effects of Global Climate Change on Invasive Species Distributions.**” Aquatic Nuisance Task Force Annual Meeting, Arlington, VA, Nov. 6–8, 2007.
43. Susan Skagen, “**Migrating Shorebirds in Dynamic Prairie Landscapes.**” University of Southern Mississippi, Hattiesburg, Nov. 15, 2007.
44. Sarah A. Spaulding, “***Didymosphenia geminata*: A Diatomic Mess in Colorado,**” Colorado Watershed Assembly Annual Meeting, Breckenridge Colo., Oct. 2007.
45. Sarah A. Spaulding, Guest Lecturer and Field Leader, “**Winter Limnology.**” University of Colorado Winter Ecology course, March 2008.
46. Sarah A. Spaulding, Trainer (management topics) and Exhibitor (diatoms and live algae), “**Colorado Lake and Reservoir Management “Day on the Rez.”**” Boulder Reservoir, Colo., July 23, 2008.
47. Sarah A. Spaulding, Co-Instructor, “**Ecology and Systematics of Diatoms.**” Course at the University of Iowa field station (June 2008; her 9th year). (Through scholarship funds, Spaulding supported several international students’ participation in the course.)
48. James Stanford, Invited Presenter, “**Invasive Species, How Secure Is Your Island?**” Secretariat of the Pacific Community, US Department of Agriculture, and University of Guam 2008 Quarantine training, Manilao, Guam, March 17–21, 2008.
49. Tom Stanley, Invited Speaker, “**Occupancy Estimation for Black-footed Ferrets.**” Black-footed Ferret Conservation Subcommittee Annual Meeting, Denver, Colo., Feb. 2008.
50. Tom Stanley, Invited Speaker, “**Estimating the Breeding Population of Long-billed Curlew in the United States.**” Workshop on Bird Monitoring and Detectability: Understanding and Applying Appropriate Methods, Fort Collins, Colo., Nov. 2007.
51. Tom Stohlgren, Invited Speaker, “**Forecasting Species Invasions in the United States.**” University of Wisconsin, Madison, Wisc., January 25–26, 2008.

52. Tom Stohlgren, Invited Speaker, **“Forecasting Species Invasions in U.S. Fish and Wildlife Refuges.”** Tucson, Ariz., Jan. 31, 2008.
53. Tom Stohlgren, Invited Speaker, **“Invasion Patterns: Theory and Scale.”** NEOBiota: Towards a Synthesis 5th European Conference on Biological Invasions, Prague, Czech Republic, Sept. 26–26, 2008.
54. Mark Vandever, **“Overview of Technical Assistance to USDA Farm Service Agency on Land Management and Conservation Policies in Agriculturally Dominated Landscapes.”** USGS Workshop on Environmental Effects of Agricultural Practices, July 2008.
55. Terry Waddle, **“Instream Flow Methods and Decisions Support Systems.”** 2nd USGS Modeling Conference, Orange Beach, Ala., Feb. 11, 2008.

Appendix IV: USGS Science Strategy Directions and Programs Supported by 2008 FORT Scientific and Technical Accomplishments

In 2007, the U.S. Geological Survey (USGS) developed a science strategy outlining the major natural-science issues facing the Nation in the next decade. The science strategy consists of six primary science directions as well as two cross-cutting science directions of critical importance, focusing on areas where natural science can make a substantial contribution to the well-being of the Nation and the world. These eight science directions are listed across the top of the table. For additional information on the USGS Science Strategy, visit http://www.usgs.gov/science_strategy/.

KEY: Projects are listed by USGS Programs. Additional USGS Programs met by each project are abbreviated using: **BIO** = Biological Informatics Program; **CCSP** = U.S. Climate Change Science Program; **ECO** = Terrestrial, Freshwater, and Marine Ecosystems Program; **EIP** = Enterprise Information Program; **FAER** = Fisheries: Aquatic and Endangered Resources Program; **INV** = Invasive Species Program; **NBII** = National Biological Information Infrastructure; **ST** = Status and Trends of Biological Resources Program; **WTR** = Wildlife, Terrestrial, and Marine Resources Program. Partner USGS disciplines are abbreviated using: **GD** = Geology Discipline; **GEOG** = Geography Discipline; **GIO** = Geospatial Information Office; **WRD** = Water Resources Discipline.

Project by Program, Page # in FORT 2008 Annual Report	Science Direction Addressed						Cross-Cutting Science Directions		Additional USGS Programs Served	Partner USGS Disci- plines
	Ecosys- tems	Climate	Energy	Hazards	Human Health	Water	Data Integra- tion	Evolving Technol- ogies		
Biological Informatics										
FORT Web Applications and Services, p. 2	✓	✓	✓				✓	✓	EIP	GD, GEOG, GIO, WRD
Metadata Development and Quality Control, p. 3							✓		NBII	
USGS Scientist Serves as Liaison to the National Ecological Observatory Network, p. 3	✓	✓			✓		✓	✓	INV	
Enterprise Information										
Integrated Information Environment Support, p. 3							✓	✓		GIO

Project by Program, Page # in FORT 2008 Annual Report	Science Direction Addressed						Cross-Cutting Science Directions		Additional USGS Programs Served	Partner USGS Disci- plines
	Ecosys- tems	Climate	Energy	Hazards	Human Health	Water	Data Integra- tion	Evolving Technol- ogies		
Wireless Solutions, p. 4								✓		
Network Security, p. 4								✓		GIO
Fisheries: Aquatic and Endangered Resources										
Individual River Basin Management Decision Support Models, p. 5	✓					✓	✓	✓	ECO	WRD
Using River2D in Habitat Simulation (Workshop), p. 26	✓					✓		✓		
USGS River Ecosystem Modeling Work Group (Workshop), p. 26	✓					✓	✓	✓	ECO	
Invasive Species										
Control of Invasive Burmese Pythons in Florida, p. 6	✓			✓	✓			✓	WTR	
Considering the Impacts of Climate Change on Invasive Species, p. 6	✓	✓					✓	✓	WTR	
Reptile and Small Mammal Surveys of Tinian and Aguiguan Islands, p. 7	✓			✓	✓				WTR	
Modeling Capture Probability of the Invasive Brown Treesnake, p. 7	✓			✓	✓			✓	WTR	
The FORT Advanced Invasive Species Modeling, p. 8	✓	✓			✓		✓	✓	ST, WTR	
Invasive Species Modeling and Assessment Workshop, p. 25	✓						✓	✓	BIO	
Brown Treesnake Rapid Response Team Training Workshops, p. 26				✓	✓			✓		
Status and Trends of Biological Resources										
Integrating Agriculture and Conservation, p. 9	✓				✓					
Comparative Vegetation Mapping for Lassen Volcanic National Park, p. 9	✓							✓	BIO, EIP	
Image Analysis for Growers to Map Weed Cover in Fallow Fields with Color Digital Images, p. 10	✓							✓	BIO, EIP	

Project by Program, Page # in FORT 2008 Annual Report	Science Direction Addressed						Cross-Cutting Science Directions		Additional USGS Programs Served	Partner USGS Disci- plines
	Ecosys- tems	Climate	Energy	Hazards	Human Health	Water	Data Integra- tion	Evolving Technol- ogies		
Applications of Radar Technology to Studying, Conserving and Managing Migratory Birds, p. 10	✓	✓						✓	WTR	
Migratory Bird Response to Environmental Change, p. 11	✓	✓					✓	✓	WTR	
Birds of the US-Mexico Borderlands: Distribution, Ecology, and Conservation, p. 12	✓								WTR	
Summary and Analysis of the U.S. Government Bat Banding Files, p. 12	✓									
Assessment for Pacific Sheath-tailed Bats on Aguiguan, CNMI, p. 13	✓								WTR	
The Use of Science in Decision Making, p. 13	✓									
Socioeconomic Considerations for Public Lands Management and Planning, p. 13	✓									
Training and Technical Assistance for Public Lands Management and Planning, p. 14	✓							✓		
Program Assessment for DOI Agencies, p. 14	✓						✓			
Survey of Moderate-Resolution Imagery Users, p. 15	✓							✓		GEOG
Social and Economic Evaluation Supporting Adaptive Management for the WLCI, p. 15			✓	✓			✓			
Science Strategy for the WLCI, p. 16	✓	✓	✓	✓	✓	✓	✓	✓	ECO, WTR	GD, GEOG, GIO, WRD
Coordinating and Integrating Science for the WLCI, p. 16	✓	✓	✓	✓	✓	✓	✓	✓	ECO, WTR	GD, GEOG, GIO, WRD
Negotiation Training for Natural Resources Professionals, p. 27	✓	✓	✓	✓	✓	✓	✓			

Project by Program, Page # in FORT 2008 Annual Report	Science Direction Addressed						Cross-Cutting Science Directions		Additional USGS Programs Served	Partner USGS Disci- plines
	Ecosys- tems	Climate	Energy	Hazards	Human Health	Water	Data Integra- tion	Evolving Technol- ogies		
Terrestrial, Freshwater, and Marine Ecosystems										
Regional and Global Ecological Effects of Climate Variability and Change, p. 17	✓	✓		✓			✓	✓	ST, ECO (incl. CCSP & Global Change Research goals)	
Grazing Ecology of Elk and Bison in Great Sand Dunes National Park and Preserve, Colo., p. 18	✓							✓	WTR	
Diatom Ecology and Taxonomy, p. 19	✓	✓					✓		FAER	
Tracking and Interpreting Chemical Changes in Mountain Streams and Lakes, p. 19	✓	✓		✓			✓	✓	ST, ECO (incl. CCSP & Global Change Research goals)	WRD
Models and Tools to Assist Environmental Flow Assessment and Implementation below Reservoirs [Bill Williams River], p. 20	✓			✓			✓	✓	WTR, ST	
Decision Support System for Evaluating Effects of Gunnison River Flow Regimes in Black Canyon of the Gunnison National Park, Colo., p. 21	✓						✓	✓	WTR, ST	
Aspen Ecology in the Core Elk Range of Rocky Mountain National Park, Colo., p. 21	✓						✓		WTR, ST	
Wildlife and Terrestrial Resources										
White Nose Syndrome in Bats, p. 22	✓	✓			✓					
Wind Energy Turbines and Bat Mortality, p. 22	✓	✓	✓						ST	

Project by Program, Page # in FORT 2008 Annual Report	Science Direction Addressed						Cross-Cutting Science Directions		Additional USGS Programs Served	Partner USGS Disci- plines
	Ecosys- tems	Climate	Energy	Hazards	Human Health	Water	Data Integra- tion	Evolving Technol- ogies		
Emerging Viruses in Bats, p. 23					✓			✓		
Bat Use of Coniferous Forests at Mesa Verde National Park, p. 23	✓	✓		✓					ST	
Assessing Degradation Rates of DNA Extracted from Mountain Lion Fecal Samples for Use in Capture-Recapture Studies, p. 23	✓							✓		
Investigating the Effects of Climate Change on White-tailed Ptarmigan, p. 24	✓	✓						✓	ECO, ST	
Evaluation of Black Bear Population Structure in Colorado, p. 24	✓							✓		
Adverse Effects to Northern Shovelers from Exposure to Treated Wastewater, p. 24	✓			✓	✓					WRD
Population Genetic Analysis of the Midget Faded Rattlesnake in Wyoming, p. 25	✓		✓							

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