Research Support for BLM Mission

The Western Ecological Research Center (WERC) of the U.S. Geological Survey (USGS) has a strong and productive history of working with the Bureau of Land Management (BLM). That history started when many of our past and present research scientists were transferred from BLM into the National Biological Survey (Service) in 1993. In 1997, those scientists became part of the Biological Resources Division of the USGS, thus strengthening their capability to conduct integrated natural resources research that meets the needs of BLM. The BLM mission is to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations. WERC's 15 field stations are strategically located in California, Nevada, and Arizona, and four field stations conduct research largely in support of needs identified by BLM. Over 25 research projects are underway and focus directly on fire ecology, Habitat Conservation Plan science support, inventory and monitoring, ecosystem impacts of contaminants, threatened and endangered species, and invasive species, at a cost of over $2 million. Indirect research benefits for BLM total another $1 million. Several of these projects directly benefiting BLM are highlighted below. WERC also conducts research on natural resource issues of concern to other federal agencies such as the U.S. Fish and Wildlife Service, National Park Service, Minerals Management Service, and the Department of Defense. Many of these projects have cross-cutting application to BLM research needs.

Highlighted Projects

Threatened and Endangered Species Research

BLM is responsible for managing millions of acres of public land in the Mojave and Sonoran deserts of California, Nevada, Arizona, and Utah. Over 4.7 million acres of this land has been designated as Critical Habitat for the federally threatened desert tortoise. Scientists at the Las Vegas, San Diego, and Box Springs (Riverside, Calif.) field stations are studying the biology and habitat needs of the desert tortoise throughout this vast area. At the Box Springs Field Station, research focuses on long-term population trends and causes of ill health and high mortality rates of tortoises. Additional research projects on upper respiratory tract and shell disease in desert tortoises are being conducted with collaborators including USGS geologists. At the Las Vegas Field Station, research is focused on the effects of natural and human-induced changes to the environment, such as the effects of invasive plants and fire on native animal and plant populations, desert communities, and ecosystems. Las Vegas is the fastest-growing city in the nation, and rapid urbanization increases demands on local resources of the Mojave Desert, thus impacting habitat of threatened species

such as the desert tortoise. Additional research focuses on other plants and animals that occur at the margins of their geographic and physiological limits and are challenged by rapid urban growth. A scientist at the San Diego Field Station has been studying the impacts of raven predation on desert tortoise populations. Ravens are predators that frequent garbage dumps and urban areas in the desert, benefiting from the subsidies of water and food that humans provide in an otherwise raven-hostile landscape. However, some ravens appear to prey preferentially on juvenile tortoises with possible negative consequences for the reptiles. The results of this research were incorporated into a raven management plan developed by BLM. Additional studies focus on the impacts of roads to desert tortoises and other

wildlife, and testing the effectiveness of fencing along roads to prevent animal mortality. WERC staff meet regularly with the Management Oversight Group (MOG) for the desert tortoise and the MOG's Technical Advisory Committee to provide technical assistance and information transfer (http://www.werc.usgs.gov/cc/tacmog.htm). Other information on our Mojave Desert research is summarized at http://www.werc.usgs.gov/mojave-symposium/. WERC scientists are also involved in an interagency project to study the marbled murrelet in northern California, in which BLM and the National Park Service are major partners.

Desert Fire Ecology

Fire was not an important factor in shaping the prehistoric structure and dynamics of plant communities in the Southwestern deserts. The low density and wide spacing of perennial shrubs, coupled with sparse groundcover to support and propagate flames, protected desert plant communities from frequent or intense fires. The invasion of highly combustible exotic annual grasses has allowed fire to become a prominent force in shaping the modern desert. Native perennial plants are poorly adapted to frequent or intense fires and are often replaced with fire-adapted exotic annual grasses. The effects of such dramatic and widespread habitat change on native plants and animals are poorly understood and the focus of research at the Las Vegas Field Station. One study, conducted in collaboration with BLM, involves large experimental manipulations in the Mojave Desert of northwestern Arizona. Experimentally burned and unburned sites, where granivorous ants and rodents, and herbivorous rabbits are allowed or denied access to plots, are being evaluated to determine the ecological interactions in community change subsequent to desert fires. Other studies at our Las Vegas and

Sonoran Desert field stations examine the survival and recovery of Joshua trees and giant saguaro cacti after fires. Additional information on our fire ecology research can be found at http://www.werc.usgs.gov/fire/.

Invasive Species

During the past century, non-indigenous plants, animals, and pathogens have been introduced at increasing rates into all U.S. ecosystems. A growing number of these species are becoming invasive, and contribute to declines in native species, changes in ecosystem functions, and cumulative economic impacts currently estimated at more than $138 billion annually. Much of the research WERC conducts on invasive species is coupled with the fire research discussed above because of the relationship between exotic annual grasses and fire. However, WERC scientists conduct additional research on invasive species. In the southern San Joaquin Valley, not far from the edge of the Mojave Desert, WERC is investigating the effectiveness of cattle grazing in improving habitat for several species of threatened and endangered plants and animals (http://www.werc.usgs.gov/kern/lokern.htm). Much of the remaining wildlands in the San Joaquin Valley have been converted to landscapes dominated by exotic annual grasslands, to the detriment of native plants and animals. Properly timed grazing shows promise as a tool for improving habitat of sensitive species. Past and continuing research has examined the relationship between roads and proliferation of invasive plant species in the desert. Elsewhere in the desert, one of our scientists is studying the effects of increased atmospheric CO_2 on the interaction between native and exotic grasses. Collectively, our research on the topic of invasive species is geared toward helping BLM, and other natural resource managers, better understand the environmental conse-

quences of invasive species so that natural resources can be more effectively protected or restored. Additional information on our invasive species research can be found at http://www.werc.usgs.gov/invasivespecies/.

Habitat Conservation Planning Science Support

Southern California is a region characterized by both unparalleled natural biodiversity and an enormous human population whose continued growth and expansion threaten many native species and habitats. As a result, this region has more endangered and threat-

ened species than any other area in the continental United States, and once extensive natural communities have been reduced to mere remnants. Las Vegas and Washington County, Utah are also experiencing rapid growth and development, and much of the associated mitigation involves public land administered by BLM. It is thus essential to manage biodiversity in remaining habitats while providing opportunities for other appropriate uses of the land. Our San Diego and Las Vegas field stations are actively involved in providing data and technical assistance to a variety of Habitat Conservation Planning efforts administered by the U.S. Fish and Wildlife Service. Historically, wildlife protection has taken the form of single-species management as provided for under the Endangered Species Act (ESA). Growing recognition that the single-species approach is not justifiable on either ecological or socioeconomic grounds has promoted a shift towards multi-species and habitat-based planning in the form of Habitat Conservation Plans (HCP's), legal agreements that afford protection under the ESA to multiple species and/or habitats. A significant HCP process emerged with the incorporation into California law of the Natural Communities Conservation Planning (NCCP) program in 1991. The pilot project of this ambitious program focuses on protection of coastal sage scrub communities within a 6,000-square-mile planning area spanning five southern California counties. It is this planning effort that is the subject of our investigations in southern California, where BLM administers 129,000 acres of biologically diverse public land outside of the desert area described above (http://www.werc.usgs.gov/sandiego/nccp.html). Similar technical assistance is being provided within the framework of the West Mojave Coordinated Management Plan of BLM. BLM, working with 28 federal, state, and local governments, is developing the plan for managing lands in the western Mojave Desert. To incorporate rigorous, objective science into the development of a strong regional management plan, BLM requested WERC scientist participation on the planning team to provide expertise in desert tortoise biology and management. Activities include analyzing the threats to desert tortoise populations, coordinating the compilation of technical information for 98 plant and animal species of concern found within the planning area and providing input into

development of alternative planning strategies (http://www.werc.usgs.gov/cc/tort2.htm). Additional information on our activities in southern California is summarized at http://www.werc.usgs.gov/socal/ and http://www.werc.usgs.gov/hcp/.

Inventory and Monitoring

Properly designed inventory and monitoring is critical in determining the presence and abundance of plant and animal populations, and in assessing the effectiveness of Habitat Conservation Plans and reserve design. WERC scientists were heavily involved in the development and testing of survey protocols for the desert tortoise on BLM and other public lands. These protocols are now accepted as the standard to determine recovery of the threatened tortoise in parts of California, Nevada, Arizona, and Utah. Scientists at our San

Diego Field Station are developing a regional ecological monitoring plan for southern California through collaboration with regulatory agencies, resource managers in BLM, university scientists, and other technical advisory committees. The goal is to develop a plan that focuses attention of the resource management agencies on the conservation conditions of the region as a whole. Recognizing that ecological monitoring is more than a simple exercise in tracking a particular feature of interest, our goal is to design a plan that will detect changes in ecological conditions that exceed acceptable limits, identify the specific threats affecting covered species and habitats, and help prioritize management and research needs in response to what is learned from the monitoring data. WERC scientists were requested by BLM to develop and test a biological and physical monitoring program to assess the impacts of off-highway-vehicle (OHV) activity on 500,000 acres of OHV recreation areas administered by BLM throughout California. That program is under development and will be implemented shortly. Additional details on our research can be found at http://www.werc.usgs.gov/hcp/monitoring.html.

Ecosystem Impacts of Contaminants

Mercury contamination is an issue of concern at the Cache Creek Management Area, administered by BLM. California has abundant geologic sources of mercury and a long history of mercury contamination associated with mercury mining, particularly in the Coast Ranges. Since 1976, California's Toxic Substances Monitoring Program has consistently reported high mercury concentrations in Cache Creek. The effects of these elevated mercury concentrations upon Cache Creek biota are not well known. Very high mercury concentrations were measured in water samples in lower Cache Creek, the Yolo Bypass, and the Sacramento Delta during recent flood events. These data suggest that large-scale, downstream movements of mercury are occurring in the Cache Creek watershed and imply that resources in the Sacramento River Delta and San Francisco Bay Area may be threatened by mercury transport or deposition. Although the Cache Creek watershed has been identified as a primary source of mercury to the Sacramento River Delta, the contributing sources of mercury within the watershed have not all been identified. Abandoned mines and active springs and vents are present in the watershed and drain into Cache Creek from several tributaries. Analyses of mercury residues in benthic macroinvertebrates collected in the watershed indicate that some tributaries are heavily contaminated. Elevated mercury concentrations in a water body or its sediments do not necessarily result in excessive accumulations in the biota inhabiting these environments, or their associated riparian areas. However, where environmental conditions favor conversions of inorganic mercury to organometallic forms, which more easily pass biological membranes and accumulate, high residue concentrations in biota are observed. Although organometallic mercury, primarily methyl mercury, may be taken up directly from water, evidence from studies of fish indicates that the diet is the primary route of uptake. Upon entering food webs, methyl mercury is biomagnified through trophic levels. Human exposure to methyl mercury, a neurotoxin, is almost entirely due to consumption of contaminated fish. Other research is examining the possible role of contaminants in diseases of desert tortoises.

Current Research Projects

Threatened and Endangered Species

- Anthropogenic effects on desert tortoise populations and habitat in California
- Desert tortoise health profiles and reference ranges
- Declining species and grazing in the San Joaquin Valley, California
- Causes of shell disease in desert tortoises
- Status and trends in desert tortoise populations in California; demography of 15 populations
- Causes of death in desert tortoises: necropsies
- Epidemiology of upper respiratory tract disease in desert tortoises
- Demography and status of desert tortoise populations at Fort Irwin; feasibility of relocation at selected sites
- Desert tortoise translocation study
- Geographic variation and environmental determinants of reproductive output in the desert tortoise

Fire Ecology

- Fire behavior and ecological effects in blackbrush *(Coleogyne ramosissima)* shrublands and invasive annual grasslands of the Mojave Desert
- Fire and Invasive Annual Grasses in Western Ecosystems
- Fire research in forested and shrubland ecosystems

Habitat Conservation Plan Science Support

- Autecology and reserve design parameters for reptiles and amphibians of coastal southern California
- Ecological research to support the Natural Community Conservation Planning program in coastal sage scrub in southern California
- Biological support for BLM's West Mojave Plan

Inventory and Monitoring

- Focal Herpetofaunal Survey for Mojave Desert Ecoregion
- Development and testing of ecological monitoring plan for off-highway-vehicle recreation areas in California
- Mojave desert ecosystem program: vegetation mapping program

Ecosystem Impacts of Contaminants

- The effects of roads and potential toxicants from roads on desert tortoise *(Gopherus agassizii)* populations and on ecosystem health in the Mojave and Colorado deserts of California
- Contamination associated with abandoned mine lands, Bear River, South Fork Yuba, and Trinity River watersheds: Mercury contamination of biota
- Cache Creek mercury study

Invasive Species

- Status of introduced plants in southern Arizona parks and refuges
- The effects of alien plant invasions and fire on native plants and animals in Mojave Desert scrub and Sonoran Desert scrub communities.
- The competitive effect of the introduced annual grass *Bromus madritensis* ssp. *rubens* on native Mojave Desert perennials after wildfire

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