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Western Ecological Research Center http://www.werc.usgs.gov

Research Support for NPS Mission

The Western Ecological Research Center (WERC) of the U.S. Geological Survey (USGS) has a strong and productive history of working with the National Park Service (NPS). That history started when many of our past and present research scientists were transferred from the NPS 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 resource research that meets the needs of NPS. The NPS mission is to protect and preserve natural and cultural resources for the use and enjoyment of present and future generations. WERC's 12 field stations are strategically located in California and Nevada. Five of WERC's field stations are co-located within California's national parks and WERC scientists at ten field stations conduct research in support of needs identified by NPS. Nearly 20 research projects are underway that focus directly on NPS needs at a cost of approximately $2 million. Indirect research benefits for NPS total nearly another $1 million. Several of the projects directly benefiting NPS are highlighted below. WERC also conducts research on natural resource issues of concern to other federal agencies such as the Fish and Wildlife Service, Bureau of Land Management, Minerals Management Service, Department of Agriculture (U.S. Forest Service) and the Department of Defense (Army, Navy, Marine Corps). Many of these projects have cross-cutting application to NPS research needs.

Highlighted Projects

Western Mountain Initiative (WMI): Climate Change Impacts to Western Mountain Forests

Mountain ecosystems of the western U.S., many of which are located within national parks, provide irreplaceable goods and services such as water, timber, biodiversity, and recreational opportunities, but their responses to climatic changes are complex and not well understood. Moreover, other ecological disturbances such as wildfire, insect outbreaks, and the spread of invasive species interact synergistically with warmer temperatures and accelerate ecosystem changes. The rate and magnitude of ecosystem responses to changes in the global atmospheric environment are variable and uncertain, ranging from gradual to abrupt and from moderate to profound. The responses of greatest importance to policy makers and land managers are also the least understood and least predictable: responses that are both abrupt and profound. Scientists from WERC, along with those from other USGS biology centers, NPS, U.S. Forest Service, and academic partners, are studying climate change and ecological interactions to better understand and predict likely outcomes in the mountainous American West. As part of the USGS Global Change Science program, the WMI seeks to understand and predict the responses—emphasizing sensitivities, thresholds, resistance, and resilience—of western mountain ecosystems to climatic variability and change. WMI catalyzes assessment and synthesis of the effects of disturbance and climate change across western mountain areas, focusing on national parks and surrounding national forests. WMI scientists nurture close working relationships with each other, the larger science community, and land and resource managers with whom they have cooperated for many years. They take an ecosystem approach to science, integrating research across science disciplines at scales ranging from field studies to global trends.

USGS field crew monitors forest dynamics at Sequoia National Park, California. Photo: USGS.

In this photo, a traditional radio telemetry device is affixed to the left forward area of the shell. RFID technology will dramatically reduce the size of a tracking device for use on juvenile tortoises. Photo: T. Esque, USGS.

Tracking Juvenile Desert Tortoises Using Innovative RFID Responder Chip Technology

The desert tortoise *(Gopherus agassizii)* is a "threatened species" under both the California and federal Endangered Species Acts. To understand the dynamics of desert tortoise population trends, it is important to quantify the survivorship, behavior, and habitat needs of tortoises at all life stages. Although relatively abundant data exist for adult desert tortoises, there is very little information available about hatchling and juvenile tortoises, where considerable mortality may occur. This problem stems from our inability to locate and conduct long-term studies with current technology on tortoises ranging from the smallest tortoise hatchling size classes (40–50 mm length), to sub-adult sizes (to about 100 mm). Conventional VHF telemetry is mostly ineffective at tracking small tortoises over long durations due to limitations in battery capacity relative to the small size required for application on these small size classes of animals. However, radio-frequency identification (RFID), a new technology that is used widely to track inventory in retail businesses, has the potential to help solve these limitations. This technology has been used on some animal species (e.g., polar bears), but has not yet been used to successfully track small desert tortoises. The system consists of two devices: a handheld or backpack receiver and a responder chip. The receiver energizes the RFID chip and uses the return signal from the chip and a directional antenna to estimate the location of an object being inventoried (e.g., a book, a roll of wire, a tortoise). One advantage for marking juvenile tortoises is that the chips are extremely light weight, and small in size, ranging from roughly the size of a dime to the size of a small "post-it note." Our goal when the product is finished is that the reception range of the smallest devices will be 10–30 m, depending on terrain. NPS is helping to coordinate funding for WERC scientists to conduct this experiment with the goal of increasing the range substantially by increasing the performance of the power source or creating a hybrid between passive (no battery on the chip) and active (battery-assisted) chip technology. This will provide an invaluable resource to assist resource managers in evaluating factors that control desert tortoise populations.

Roundup on Santa Rosa Island, (ca. 1990). Cattle ranching ended in 1998; remaining non-native elk and mule deer will be removed after hunting ends in 2011. Photo: NPS.

Ecological and Hydrological Recovery Following Removal of Non-native Ungulates

The California Channel Islands span an ecological gradient off the coast of southern California where cold waters from the north mix with warmer waters from the south. Each of the eight Channel Islands, which were never connected to the mainland, developed

unique floras as colonizing plants adapted to their new island homes. This part of California is one of only five Mediterranean climate regions in the world, characterized by hot, dry summers and cool, wet winters. Thus the islands support a truly unusual assemblage of plants and animals found nowhere else, either regionally or globally. The northern five islands comprise Channel Islands National Park, authorized for the preservation of their unique ecosystems. Park islands support 75 endemic plant taxa; 14 are listed as threatened or endangered. For about 150 years these islands were used for ranching, and large areas of native scrub and woodland were destroyed and converted to alien annual grasslands. The challenge before the NPS and its partners is to recover native communities and the endemic plants they support. Now, feral animals are nearly eliminated from the islands in a major step toward island ecosystem recovery. WERC researchers are working closely with NPS scientists to evaluate the status of this compromised ecosystem and preserve the remnants of threatened and endangered species. One innovative approach is being designed to assist the recovery of native vegetation and the hydrologic cycle by enhancing the capture of moisture from fog—which will then recharge the hydrologic regime—by constructing artificial structures and replanting natural vegetation on the landscape. The hope is that this will further enhance soil moisture to rejuvenate native vegetation.

Global Amphibian Decline—Factors and Drivers

Compelling evidence from many areas around the world indicate that amphibians are declining on a global scale. Potential causes of amphibian declines have included non-native species (e.g., fish and bullfrogs as predators), estrogenic effects, disease, and contaminants. This decline may be one of the most serious conservation problems in the U.S. today because it is occurring in our largest park and wilderness areas where healthy and seemingly well-protected populations have disappeared for no obvious reason. These losses are important both because of the reduction in biodiversity and because amphibians are sensitive biological indicators of the health of the environment. This has led to the establishment of a Declining Amphibian Task Force, sponsored by the International Union for the Conservation of Nature (IUCN) Species Survival Commission in Lund, Sweden. WERC scientists were instrumental in developing a U.S. national program, the Amphibian Research and Monitoring Initiative (ARMI), to monitor changes in amphibian populations across Department of Interior lands and to address research needs to understand amphibian declines. WERC is evaluating the status of amphibians in California and elsewhere, identifying potential causes of the decline, and conducting experimental reintroductions of selected species. The primary fieldwork is being conducted in the Sierra Nevada, in Yosemite and Sequoia-Kings Canyon national parks, and in the California Coast range, including Point Reyes National Seashore.

Mountain (or Northern) yellow-legged frog *(Rana aurora),* one of the most rapidly declining amphibians in California's Sierra Nevada. Photo: G. Fellers, USGS.

Current Research Projects

Fire Ecology

- Fire ecology and management of grassland, shrubland, and woodland ecosystems of western North America
- Effects of fire on shrub, riparian and forest ecosystems on public lands in the Great Basin and Mojave Desert
- Fire effects on seedbanks and vegetation in the Eastern Mojave Desert national park units
- Evaluate treatments to reduce hazardous fine fuels created by non-native plants in Zion Canyon National Park
- 2008 Desert Fire Conference
- Assessing patterns of pine mortality, recruitment, and density in NPS prescribed burn units
- Evaluating wildfire and drought-related animal damage on Joshua tree recruitment in Joshua Tree National Park
- Effects of fire and fire management practices on California ecosystems

Status and Trends, Inventory and Monitoring

- Inventory and monitoring techniques for terrestrial amphibians, reptiles, small mammals, and carnivores in national parks
- Using acoustic sampling of bat assemblages to monitor ecosystem trends—Point Reyes National Seashore
- Population status and monitoring of declining amphibians in southern California
- Kelp forest biodiversity and community dynamics in the Channel Islands National Park
- Long-term Prototype Monitoring program data analysis and guidance for Channel Islands National Park
- Point Reyes National Seashore bird surveys

Threatened and Endangered Species

- Evaluating long-term changes in Mojave Desert landscapes using repeat photography
- Developing RFID technology to track juvenile desert tortoise survivorship in national park units
- Distribution, population status, and causes for decline of California amphibians
- Ecology and distribution of big-eared bats in coastal California
- Nutritional ecology and physiology of desert tortoises in the Mojave Desert
- Responses of desert tortoises to post-wildfire habitat
- Desert tortoise survivorship and dispersal on the Lake Mead National Recreation Area
- Desert tortoise ecology in the Mojave Desert
- Validation and development of a certification program for using K9s to survey desert tortoises
- Rare plant research in the Northern Channel Islands

Invasive Species

- Effects of invasive species on shrub, riparian and forest ecosystems on public lands in the Great Basin and Mojave Desert
- Invasive *Brassica* weed removal and habitat restoration—Lake Mead National Recreation Area
- Management and control of exotic vegetation to restore natural conditions and enhance visitor experience at Death Valley National Park
- Monitoring the effects of invasive species on desert plant community dynamics to aid restoration in national park units
- Controlling Italian thistle in national parks
- Influence of land management practices on invasive species
- Rare plant population viability in invaded national park habitats: California, Great Lakes, Mojave Desert
- Invasive plant modeling and early detection protocol development in national parks

Human/Wildlife Interactions

- Mountain meadow ecology: impacts of pack stock grazing on mountain meadows—Sequoia-Kings Canyon National Parks
- Reproduction by black-crowned night-herons and snowy egrets on Alcatraz Island, California—Golden Gate National Park
- Population status and reproductive ecology of the western burrowing owl in the eastern Mojave Desert—Lake Mead National Recreation Area
- Geographic variation and behavioral plasticity: vigilance behavior in desert bighorn sheep populations
- Genetic variability of translocated desert bighorn sheep in Nevada
- A habitat management plan to maintain viability of the desert bighorn sheep population in the River Mountains, Nevada

Climate Change

- Interdisciplinary research on climate change effects on plant communities in the Channel Islands National Park
- Sierra Nevada forest dynamics: pattern, pace, and mechanisms of change
- Influence of climate change on western forests
- Carbon sequestration in the Redwood National Park

Other Research

- Border traffic impacts to soils and vegetation in national parks
- Sediment dynamics in the Redwood National Park watershed
- Effects of suspended load on stream biota—Redwoods National Park
- Watershed stream recovery following watershed restoration in Northwest national parks

For more information, contact:
USGS Western Ecological Research Center
3020 State University Drive East
Modoc Hall, 3rd Floor, Room 3006
Sacramento, CA 95819
Phone: 916.278.9485 Fax: 916.278.9475
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