



# U.S. Forest Service

## Pacific Southwest Research Station

*Serving California, Hawai'i, and the Pacific Islands*

# 2013 Accomplishments Report





## Vision and Mission

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The Pacific Southwest Research Station is a world leader in natural resources research through our scientific excellence and responsiveness to the needs of current and future generations. Our mission is to develop and communicate science needed to sustain forest ecosystems and their benefits to society.

## About Us

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The Pacific Southwest Research Station (PSW) represents Forest Service Research and Development in California, Hawai'i, and the U.S.-affiliated Pacific Islands. Our region has the lowest, driest desert in the country, the highest elevations within the 48 contiguous States, and the wettest tropical forests. An abundant diversity of native plants and animals and nearly half of the nation's threatened and endangered species live in this region. At PSW, we develop and deliver science to help inform decisions about natural resource management, conservation, and environmental protection. Much of our work is accomplished in cooperation with other research and development institutions, such as universities, and state and other federal agencies.

# Science that makes a difference.

Sherri Eng, U.S. Forest Service



I am proud to present the Pacific Southwest Research Station's 2013 Accomplishments Report. As part of U.S. Forest Service Research and Development, the Station provides reliable research to address contemporary questions about

trees, forests, ecosystems and their relationship to people now and into the future.

America's forests and grasslands are integral to the well-being of the Nation. We can no longer take for granted the values and benefits that people get from healthy, resilient forests and grasslands—including clean air, drinking water, jobs, forest products, wildlife and fish habitat, and places to recreate. This is especially true in California, Hawai'i, and the Pacific Islands. Due to changes in land use, conflicting societal values, and environmental stresses, many treasured lands are degraded or vulnerable to loss. The sound management, restoration, and sustainability of these lands depend on conducting rigorous science, and sharing it effectively with a diversity of people.

More than 50 percent of California's fresh water

comes from National Forest lands. In addition to supplying clean water for residential and industrial use, forests are vital to California's economy. Comprising nearly 20 percent of California's land mass, National Forest lands support 38,000 jobs.

PSW supports the National Forest System in our region by investing in research that will help land managers develop and sustain healthy forests. Our research informs land managers in developing resilient forests, furthering accelerated restoration of our forests and grasslands, and providing clean, reliable water and other environmental services that sustain and enhance quality of life. PSW also helps inform private landowners, State forestry organizations, tribes and communities throughout California, Hawai'i and the Pacific Islands.

PSW is organized into five research units that work with an emphasis on safety and inclusivity to address ecological restoration, wildfire management, and community connections to the land. Our work in these areas is directed toward four overarching outcomes: clean and reliable water resources from forests; restoration rather than devastation from wildfire; enhanced benefits to urban communities from forests; and sustained ecological resources and services from forests and grasslands.

To accomplish our goals, we must be mindful of the interactions among people, ecosystems, and myriad environmental changes. Human activities have an increasing impact on the functioning of our

ecosystems and understanding the interplay between social dynamics and natural resources will be an increasing part of our work. We appreciate the unique and rich diversity of the people of California, Hawai'i, and the Pacific Islands, and embrace the perspectives of the public as we shape our research programs to best serve their needs through inclusion and outreach.

We remain committed to serving the public through community involvement. Six examples that I am particularly proud of are mentioned in the pages that follow. Many of them receive financial support through grant programs. But equally important are the dedicated volunteers from PSW and their families who regularly give their time and energy to support these initiatives.

The coming year offers exciting prospects of leveraging our work with collaborators within and outside of the public sector. I believe that by focusing on collaboration and communication, the impact of our research will be amplified. At the same time, our core of rigorous peer-reviewed science will remain the foundation of the contributions we make to natural resources stewardship. We plan to respond to events and circumstances, such as the aftermath of the Rim Fire, to capture unique opportunities to learn while sustaining important, long-standing research activities. These are dynamic and challenging times, but we are up for the challenge and committed to deliver innovative research information and tools to benefit environmental health and community livelihood throughout California, Hawai'i, and beyond.

*Alex*

**Alexander L. Friend, Ph.D.**

Station Director, Pacific Southwest Research Station

# Forest Service at a Glance

The mission of the U.S. Forest Service, a federal agency under the U.S. Department of Agriculture, is to sustain the health, diversity and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. Established in 1905, the Forest Service:

- Manages 193 million acres of national forests and grasslands.
- Shares responsibility, working in concert with state and local agents, for the stewardship of about 500 million acres of non-Federal rural and urban forests.

The Forest Service has several major branches that work together to manage the nation's forests and protect global forest resources:

- The **National Forest System** sustains healthy terrestrial and aquatic ecosystems while addressing the need for resources, commodities, and services. This system is divided into nine regions. California and Hawai'i are located in Region 5.
- **State and Private Forestry** helps private landowners, State forestry organizations, tribes, and communities achieve forest management, protection, and utilization objectives through a wide range of cooperative programs in the State and Private Forestry mission area.
- **Research and Development** provides long-term research, scientific knowledge, and tools that are used to manage forests and rangelands across the United States and overseas.
- **International Programs** promotes sustainable forest management and biodiversity conservation internationally.
- **Law Enforcement and Investigations** enforces Federal laws and regulations governing national forest lands and resources.

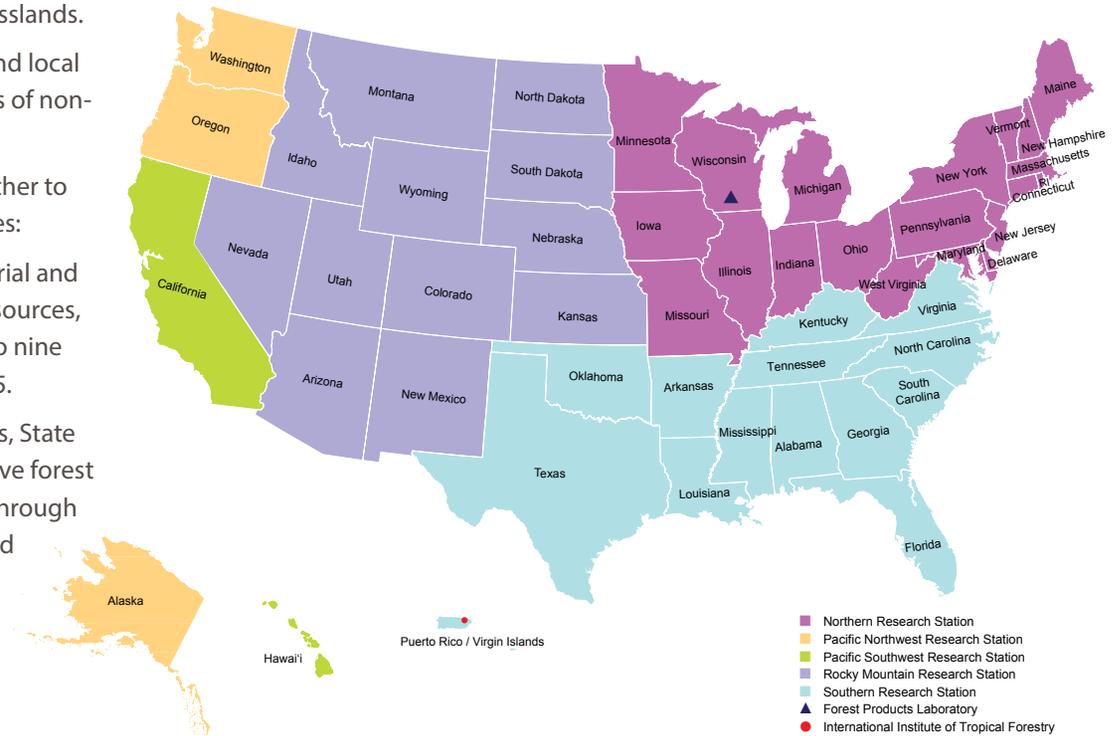


Fig. 1

The Forest Service has research units located throughout the United States, Puerto Rico, and the Pacific (Fig. 1).



Fig. 2

The Pacific Southwest Research Station partners with 18 National Forests in California (Fig. 2), and with State and Private Forestry programs throughout California, Hawai'i, and the Pacific Islands.

Leaders of the Pacific Southwest Region and the Pacific Southwest Research Station have established a goal of retaining and restoring ecological resilience of the National Forest lands to achieve sustainable ecosystems that provide a broad range of services to humans and other organisms. Combined effects of changing climate and hydrologic patterns, unhealthy forests, and rapidly growing human populations are resulting in increasingly over-allocated and undervalued ecosystem services (especially water); a dramatic increase in large wildfires, floods, and insect and disease outbreaks; threats from terrestrial and aquatic invasive species; and a growing need to revitalize rural economies in California, Hawai'i and the Pacific Islands. The Region and the Research Station are facing these challenges together and through collaboration with external partners around watershed restoration and forest resiliency.



# U.S. Forest Service Pacific Southwest Research Station Overview

Research is organized into five research units:

## 1. Institute of Pacific Islands Forestry

Station scientists conduct tropical ecosystem research and technology transfer. Research furthers sound management, conservation, and restoration of grassland, forest, and wetland ecosystems and landscapes in Hawai'i, Guam, American Samoa, Northern Mariana Islands, Marshall Islands, Micronesia, and Palau.

## 2. Conservation of Biodiversity

Station scientists conduct research on genes, species, habitats, landscapes, and the biological processes necessary to maintain diversity of organisms and functioning ecosystems. Research focuses on enhancing the conservation, ecology, and evolution of species and habitats, and the restoration and maintenance of degraded ecosystems.

## 3. Ecosystem Function and Health

Station scientists examine forest function and conduct research to protect and preserve water, air, and soil resources while considering the effects of a changing climate, unpredictable precipitation, air pollution, and growing threats from pests and pathogens.

## 4. Fire and Fuels

Station scientists conduct research on how fire behavior affects fuel types and conditions and how physical properties of fuels influence fire severity and intensity. Research includes decision-support models that analyze risk, resource allocation economics, and fire danger forecasting.

## 5. Urban Ecosystems and Social Dynamics

Station scientists examine the interconnections of people and natural resources. Research focuses on developing knowledge and tools in natural resource management to better serve the public, and to connect urban dwellers with public lands through urban forestry and social science research.



## Pacific Southwest Research Station

- Headquarters in Albany, Calif.
- Eight laboratories in California and Hawai'i
- 12 Experimental Forests and Ranges; two Research Watersheds
- Research is also conducted in more than 90 research natural areas (RNAs)
- Pacific Southwest Research Station is one of five research stations in the U.S. Forest Service
- 236 employees
- Conterminous with Region 5 of the National Forest System.

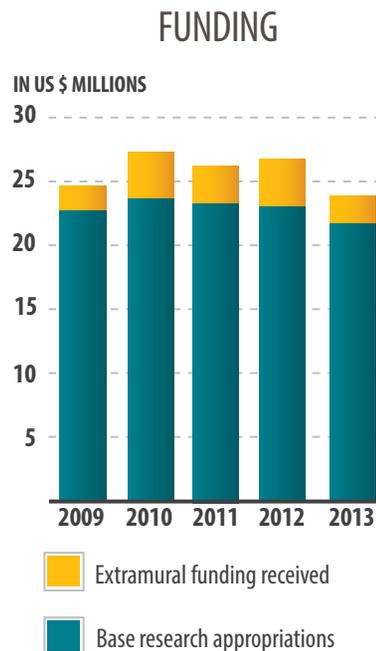
# Pacific Southwest Research Station at a Glance

## WORKFORCE

- Total station workforce: **236**
- Research: **171**
- Leadership and administration: **65**

## FUNDING

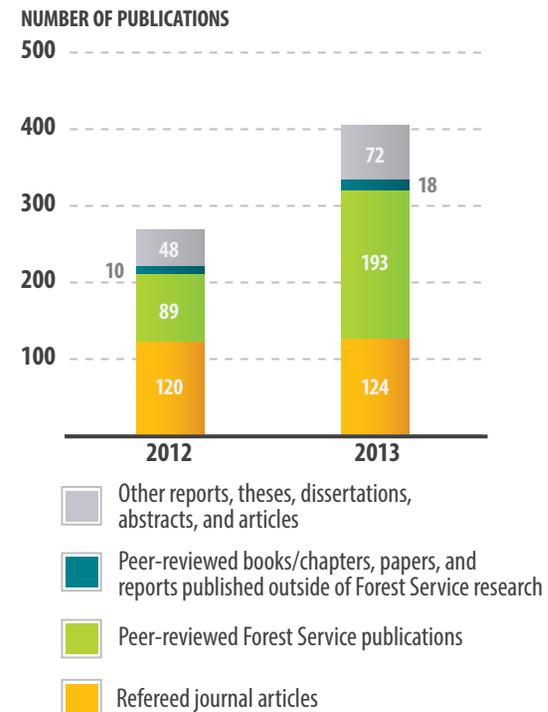
- Base research appropriations: **\$21.6 million**
- Extramural funding received: **\$2.2 million**
- Total funding: **\$23.8 million**



## WEB METRICS

- Number of visits to the PSW website: **103,729**
- Number of visitors to the PSW website: **68,787**
- Source countries or territories visits originated from: **199**
- Page views of PSW publications through Treearch: **19,645**
- Followers on Twitter(@usfs\_psw): **700**

## PUBLICATIONS



# Research Partners

PSW depends on its many partners and collaborators to develop and deliver cutting-edge, practical science to the public. The Station would like to thank the following organizations for their support and cooperation:

2<sup>ND</sup> Nature, LLC  
Alison E. Stanton  
Bat Conservation International  
Cal Poly, San Luis Obispo  
California Conservation Corps  
California Department of Fish and Game  
California Department of Forestry and Fire Protection (CalFIRE)  
California Energy Commission  
Carnegie Institute  
City and County of Denver  
City of Oakland  
Claremont Graduate University  
Colorado State University  
Coral Reef Research Foundation  
California State University, Fresno  
Desert Research Institute  
Eco-ascension Research and Consulting  
EcoLayers, Inc.  
Federal Occupational Health  
Forest Research and Management Institute, Romania  
Fundacao Universidade Regional de Blumenau  
Great Basin Institute  
Hawaii Agriculture Research Center  
Hawaii Department of Land and Natural Resources  
Hawaii Wildfire Management Organization  
Hercon Environmental  
Humboldt State University  
Hydroikos, Ltd.  
Integral Ecology Research Center  
Klamath Bird Observatory  
KUPU

Lang, Railsback & Associates  
Mazana Wind LLC  
Mendocino Land Trust  
Mississippi State University  
Montana State University  
National Fish & Wildlife Foundation  
North Arizona University  
Oregon State University  
Portland State University  
PRBO Conservation Science  
Riverside Municipal Museum  
Riverside-Corona Resource Conservation District  
San Diego Science Alliance  
San Francisco State University  
Save the Redwoods League  
Sonoma Technology, Inc.  
Spatial Informatics Group, LLC  
Stanford University  
Student Conservation Association  
The Nature Conservancy  
University Corporation for Atmospheric Research  
University of Alabama, Huntsville  
University of California, Division of Agriculture and Natural Resources  
University of California, Berkeley  
University of California, Davis  
University of California, Los Angeles  
University of California, Merced  
University of California, Riverside  
University of California, San Diego  
University of California, Santa Barbara  
University of California Cooperative Extension  
University of Hamburg

University of Hawaii, Hilo  
University of Hawaii, Manoa  
University of Maryland, College Park  
University of Montana  
University of Nevada, Reno  
University of Tuscia  
University of Washington  
University of Wisconsin, Milwaukee  
Urban Tilth  
U.S. Department of Agriculture – Agricultural Research Service  
U.S. Department of Agriculture – Animal and Plant Health Inspection Service  
U.S. Department of Defense – Strategic Environmental and Development Program  
U.S. Department of Energy  
U.S. Department of the Interior – Bureau of Land Management  
U.S. Department of the Interior – Fish and Wildlife Service  
U.S. Department of the Interior – National Park Service  
U.S. Department of the Interior – U.S. Geological Survey  
U.S. Environmental Protection Agency  
Utah State University  
Washington State University  
Watershed Professionals  
Wood Buffalo Environmental Association  
Yurok Tribe

# Awards

## USDA Secretary's Honor Award

Research Entomologist **Dr. Tracy Johnson** received the prestigious USDA Secretary's Honor Award in the category of protecting natural resources. Johnson led the Forest Service's international search to identify insect species for use as host-specific biological control agents against invasive plants in Hawai'i. His 13-year effort culminated in the release by the state of Hawai'i of leaf gall-forming scale insects to help regulate the strawberry guava invasive plant species.

## Chief's Honor Award

Research Ecologist **Dr. Connie Millar** received the 2013 Chief's Honor Award for excellence in science and technology. Millar, along with other climate change scientists, was recognized for pioneering the Forest Service's strategic framework for conducting climate change vulnerability assessments and for developing climate change adaptation options in wildland settings.

## R.W. Harris Award

Research Forester **Dr. Greg McPherson** received the 2013 R.W. Harris Award for Excellence in Education from the Western Chapter International Society of Arboriculture for his outstanding contribution to the education of Western Chapter members.

## Eagle Feather Award

Research Ecologist **Dr. Frank K. Lake** received the Eagle Feather Award, presented by the U.S. Fish and Wildlife Service, for his work with basin tribes on climate change research, and his support and efforts with the Klamath Basin Tribal Youth Program research project, a developmental project for tribal students.

## Batefuegos de Oro Golden Fire Swatter Award

Research Economist **Dr. Armando González-Cabán** received the 2013 Batefuegos de Oro Golden Fire Swatter Award in the Best International Cooperation category for his work with Spain's Ministry of the Environment Fire Management and Protection Program. The award recognizes significant contributions to the reduction of forest fire risk and forest fire prevention in Spain.

## Partners in Conservation Award

Research Ecologist **Dr. Frank K. Lake**, along with others involved with the Klamath Leadership Development summer 2013 pilot project, received the U.S. Department of the Interior's Partners in Conservation Award, presented by Secretary of the Interior Sally Jewell. The pilot 10-week summer youth internship strived to develop future tribal leaders in conservation. Lake received special recognition for providing an approach for incorporating Traditional Ecological Knowledge in conservation and scientific methodology.

## Kupu Site of the Year Award

PSW's **Institute of Pacific Islands Forestry** received the 2013 Kupu Site of the Year Award for its conservation education work with Hawaiian youth from Kupu, a nonprofit community organization that administers AmeriCorps programs in Hawai'i. Youth participated in ongoing restoration and invasive species control projects within the Hawaii Experimental Tropical Forest and surrounding lands.

## Human Diversity Award

The **Hawaii Experimental Tropical Forest** received the 2013 Human Diversity Award from the Organization of Biological Field Stations for unique activities, programs, and approaches that increase the involvement, engagement, and sustainability of underrepresented groups in field science.



## Community Service

### Bay Area Science Festival, PSW-Albany

Station scientists hosted an educational urban forestry booth at the second annual Bay Area Science Festival at San Francisco's AT&T Park. Children and parents visiting PSW's booth learned about the importance of trees in urban areas, created cards with drawing materials, and took home enlightening forest information, stamps, and stickers using the theme, "Trees for You and Me." The event provided interactive science and nature exhibits, experiments, and games to more than 20,000 people of different ages.

The Bay Area Science Festival was created by The Science & Health Education Partnership at the University of California–San Francisco, and seeks to provide an outlet for young minds to explore. The objective of the annual festival is to engage young people in the excitement, fun and wonder of science, in order to inspire and lead them toward careers in science and technology.

### Richmond Edible Forest, PSW-Albany

Employees volunteered during the Martin Luther King, Jr. National Day of Service by planting fruit trees, herbs and vegetables in the Richmond Edible Forest in Richmond, Calif. The edible forest serves as an environmental education site where station scientists and Forest Service land managers teach youth about the benefits of trees and forested landscapes.

The Richmond Edible Forest project is sponsored yearly by Urban Tilth, a community organization that helps build sustainable, healthy, and accessible food systems in urban neighborhoods. Urban Tilth has 13 school and community gardens, all uniquely rooted in the community where they are located. The mission of the initiative is to help local communities grow their own food; train and employ young people to grow food; and teach local residents about the relationships between food, health, poverty, and justice.

### **Kupu, PSW-Institute of Pacific Islands Forestry**

PSW's Institute of Pacific Islands Forestry worked with Hawaiian youth from Kupu, a nonprofit community organization that administers AmeriCorps programs in Hawai'i. Station staff took part in the long-term conservation education project, helping youth understand and learn hands-on approaches toward the conservation of forestlands. Throughout the program, youth participated in ongoing restoration and invasive species control projects within the Hawaii Experimental Tropical Forest and surrounding lands.

Kupu is a growing community organization which was developed to address Hawaii's need to train the next generation of natural resource management, renewable energy, energy conservation, and other green job skill sets. Kupu seeks to provide experiential education, job training, leadership, teamwork, and life skills development opportunities to help youth and young adults succeed in life and to serve their communities.

### **The Klamath Basin Tribal Youth Program, PSW-redding**

Research Ecologist Dr. Frank K. Lake worked with the Klamath Basin Tribal Youth Program (KBTYP), and mentored tribal students in the incorporation of traditional ecological knowledge and western science methodologies through a 10-week educational program. Over the course of the program, which launched last summer, students and scientists worked on habitat restoration projects, developed models and collected data in the Sycan River in Oregon and Shasta Big Springs Creek in California – two important tributaries in the Klamath watershed that support tribal fisheries.

The project, "Klamath Basin Traditional Ecological Knowledge and Climate Change Science Internship," is funded by the North Pacific Landscape Conservation Cooperative, and includes tribes of the Klamath Basin, federal agencies, and several academic institutions. The internship program runs throughout the summer, and selects tribal students from each of the six federally recognized tribes in the Klamath Basin. They are placed with professional mentors from tribes and federal agencies to gain experience in local and regional environmental monitoring, analysis, management and policy. This experience helps facilitate a better understanding of climate change impacts on ecological processes and natural and cultural resources valued by Tribes.

### **Veteran's Job fair, PSW-Institute of Pacific Islands Forestry**

Several members of PSW's Institute of Pacific Islands Forestry participated in the Hiring Our Heroes job fair in Honolulu, Hawai'i. More than 130 veterans visited the booth and 48 individuals completed job interest worksheets.

Hiring Our Heroes is a program of the U.S. Chamber of Commerce Foundation, and is a nationwide initiative to help veterans, military spouses, and transitioning service members find meaningful employment.

### **Centro de Niños, PSW-Riverside**

Research station staff collected school supplies, food for the Thanksgiving holiday, and holiday gifts for Centro de Niños child care center, which serves disadvantaged families of preschool-age children in the Riverside, Calif. area. Centro de Niños is a nonprofit bilingual-bicultural children's center established to provide free and low cost quality child care and development, education, and social welfare services to the families in a safe and secure learning environment. The center's goal is to teach children, and provide them the necessary tools to have a successful educational career. PSW-Riverside has been supporting Centro de Niños for nearly 25 years.



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# Recent activities and achievements on PSW's Experimental Areas:

## **Stanislaus-Tuolumne Experimental Forest**

Scientists published results of a 79-year research study on how long-term changes to forests affect biodiversity and how future fires burn. Conducted on the Stanislaus-Tuolumne Experimental Forest, the study found dramatic differences in forests today compared to historic conditions prior to logging and fire suppression. Scientists re-measured three large historical plots established in 1929 to evaluate the effects of logging methods, and collected fire scar samples to pinpoint dates of previous fires. The forest currently contains 2.4 times more trees than it did in 1929; the excess density suggests that long-term changes exert an influence on forests' susceptibility to uncharacteristically severe fire.

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## **Redwood Experimental Forest**

Scientists installed a climate monitoring plot on the Redwood Experimental Forest, which joined 15 plots established throughout California's redwood region. Sets of cover boards with motion-sensitive video cameras and sound equipment were also installed inside the canopies of two large old-growth redwood trees to track movements and behavior of canopy-dwelling salamanders and to detect the calls of marbled murrelets and high-frequency emissions of forest bats.

## **Hawaii Experimental Tropical Forest**

U.S. Forest Service



The Hawaii Experimental Tropical Forest (HEFT) provides landscapes, facilities, and data/information to support research and education activities contributing to a better understanding of how to conserve and manage the biological diversity and functioning of tropical forest and stream ecosystems. The HETF began its first five-year re-census of the Forest Dynamics Plot, as part of the Center for Tropical Forest Science global plot network. The plot was also established as part of the Hawaii-Ecosystem Climate Observatory, which has eight climate stations equipped with state-of-the-art micrometeorology equipment and complementary vegetation plots that represent different forest types on the windward and leeward sides of the Hawaiian Island.

## **Kings River Experimental Watersheds**

The Kings River Experimental Watersheds (KREW) is a watershed-level, integrated ecosystem project for headwater streams in the Sierra Nevada, which aids research efforts on the impacts of climate change and fire on the forest ecosystem. Eight sub-watersheds were chosen and fully instrumented to monitor ecosystem changes. Each watershed

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receives one of three management treatments or serves as a control. A prescribed burn was conducted on an area that

hadn't seen fire in more than 100 years, as part of a study comparing the effects of forest restoration approaches on Sierra Nevada headwaters.

## **Blacks Mountain Experimental Forest**

Scientists initiated the 15-year re-measurement of the Blacks Mountain Experimental Forest Ecological Research Project, which evaluated the effects of structural diversity and prescribed fire on community development and fuels.

## **Teakettle Experimental Forest**

Scientists followed the long-term dynamics of forest carbon on the Teakettle Experimental Forest in response to fuels reduction treatments. Researchers published the fifth paper in a series examining carbon recovery now, 10 years after prescribed burning and mechanical thinning treatments.

# Research in action: Responding to extreme fire

*On the morning of Aug. 17, 2013, a hunter's fire raced up a canyon slope in the Stanislaus National Forest and subsequently into the adjoining Yosemite National Park, burning more than 250,000 acres, and costing more than \$125 million to finally contain. What became known as the Rim Fire, the blaze exploded during unprecedented weather conditions producing thousands of acres of continuously blackened trees, an example of what may become the new norm for fire behavior under changing climatic conditions. Habitat for many species, including listed or proposed for listing species, such as the California spotted owl, great gray owl, and Pacific fisher, was drastically altered. Impacts to the watershed feeding Hetch Hetchy Reservoir, San Francisco's water supply, have already been significant, and long-term effects are still unknown.*

Each time there is a major fire season we all ask the same questions: why do we have so many fires, how destructive were they, and was there something we could have done to prevent them? We have learned much about the phenomenon of fire over the past 30 to 40 years. PSW has gathered a group of scientists from diverse research disciplines to form a Fire Research Advisory Group to encapsulate this large body of scientific knowledge into a brief set of summaries that tell the story of fire in the West with a focus on the Sierra Nevada. This information will be presented in a succinct and easy-to-read format on the PSW website. The content is intended to provide a scientifically defensible overview of all facets of the story around fire in Sierra conifer forests.

Fire is an inherent process in most Sierra Nevada, southern Cascade Range, and montane Modoc Plateau forest types. It is a regulating mechanism and

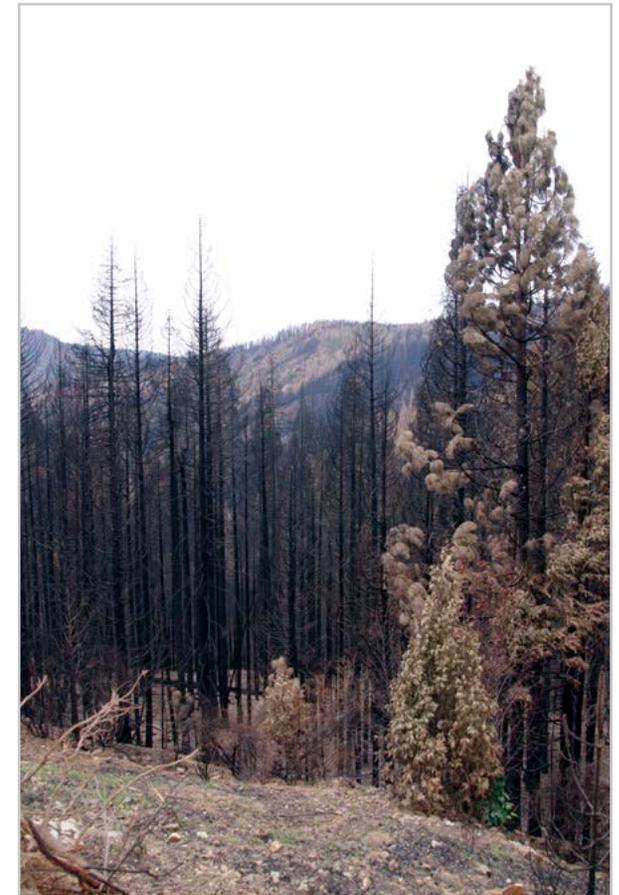


Sherri Eng, U.S. Forest Service

the dominant force in shaping forest structure. Recent studies of historical fire regimes indicate that fires occurring prior to Euro-American settlement were characterized by a high degree of spatial complexity driven by heterogeneity in vegetation/fuels and topography and influenced by variability in climate, which mediates the timing, effects, and extents of fires over time.

Ecological effects within an extreme fire like the Rim Fire vary greatly as areas burn at different severities. Areas that burn at moderate severity may experience shifts in forest fuels, tree density, and stand structure toward desired conditions. Iconic forest trees including giant sequoia, sugar pines, yellow pines, and California black oak need recurring, moderate fire to become dominant and provide food and habitat for wildlife. Patches of fire-killed trees can become a short-term haven for many wildlife species, including deer, woodpeckers and other birds, as well as fire-following grasses, forbs, shrubs, and young trees. Wildfires can also rejuvenate aquatic systems by

reforming in-stream habitat and increasing the supply of light, water, and nutrients. Current management objectives involve restoring the forest stand and landscape conditions that would allow fires to function in what is generally believed to be a more natural way.



Sherri Eng, U.S. Forest Service

# Institute of Pacific Islands Forestry

A center of research and technology transfer since 1967, the Institute of Pacific Islands Forestry addresses information needs to support the management, conservation, and restoration of natural forest and wetland ecosystems and landscapes throughout the Pacific. The Institute's area of responsibility includes the State of Hawai'i and six U.S.-affiliated Pacific Islands: the Territory of Guam, the Territory of American Samoa, the Commonwealth of the Northern Mariana Islands, the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau.

The focus of research and technological assistance centers on Hawai'i and other islands of the Pacific, but results are applicable to many tropical and temperate ecosystems of the world, including the U.S. Mainland. The research conducted through the Institute encompasses PSW's four program areas.

The Hawaii Experimental Tropical Forest (HETF) is the first experimental forest in the Pacific Islands and directly contributes to a better understanding and conveyance of information about climate change, biological diversity, and ecosystem processes in the Pacific region and tropical ecosystems worldwide. HETF encompasses remarkable gradients of climate, forests, soils, and resource history that allow PSW researchers and collaborators to address critical natural resource and conservation questions fundamental to effectively managing tropical forests to maintain and enhance important ecosystem services in a changing climate.



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## Research focuses on the following areas:

- Work to better understand invasive species interactions with factors including fire, disturbance, watershed management, and recreation; and
- Assess water quality, food web structure, and fish and invertebrate assemblages in a number of watersheds to improve protection, management, and restoration of forested wetlands and water resources in the Pacific Islands.

## 2013 Research Highlights

### Passive restoration of forest cover on abandoned pastureland

Actively re-establishing forest cover across large tracts of abandoned agricultural lands is cost prohibitive. In Hawai'i, *Acacia koa* root suckering has been shown to be a no-cost, passive option to augment high-cost planting efforts on deforested landscapes. Conversion of natural forests to grasslands for cattle pasture and other agricultural uses is a worldwide phenomenon. While the world's natural forest area continues to decline, the rate has slowed: losses are being partially offset by reforestation. Research in Hawai'i has shown that planted stands of *Acacia koa* established by active restoration are passively expanding beyond their initial boundaries by means of root suckering. An extensive network of koa tree corridors was established over a 20-year period in abandoned pasturelands of Hakalau Forest National Wildlife Refuge, on the Island of Hawai'i. Based on observed rates of expansion, gaps between planted koa corridors will close naturally simply by continuing to protect the area from ungulates and wildfires.



Susan Cordell, U.S. Forest Service



Paul Scowcroft, U.S. Forest Service

### Invasive tree species in Hawai'i store more carbon but reduce biodiversity

A team led by a PSW researcher has identified an important trade-off in the management of forests on the island of Hawai'i. The team studied above-ground carbon density (ACD) in two types of forest, and discovered that forests dominated by non-native species had higher ACD than forests composed of native Hawaiian species. However, this increased ability to store carbon comes at the cost of dramatically reduced biodiversity of native species. These results illustrate that further spread of two invasive tree species could constitute a significant erosion of the invaluable contribution of Hawaii's native ecosystems to global biodiversity.

### Addressing the threat of fire in Palau

PSW scientists developed a three-pronged approach to addressing a growing and serious fire threat to natural resources in the Republic of Palau. The three components of this approach include developing and delivering a cost-effective and low technology restoration treatment for increasing forest cover and biodiversity recovery in fire-prone savanna; a process and associated training for systematically mapping the incidence and amount of human-caused fire; and educational materials and an outreach strategy for fire prevention to communities of Babeldaob Island — the largest island of Palau and a global biodiversity hot spot.

### Watershed decision support tool enhances tropical forest management

In partnership with the Pacific Northwest Research Station, and in collaboration with local community partners, PSW scientists have developed a Watershed Decision Support Tool (WDST), which specifically addresses climate change, biological diversity, and hydrologic functions in forests and near-shore environments of the Hawaiian Islands. The tool helps decision makers in Hawai'i to better prioritize management actions, such as where to focus invasive plant species control, and where to implement native plantings.

# Conservation of Biodiversity



Jessica Wright, U.S. Forest Service

Our geographic area includes oceanic islands, elevational clines from coastal to alpine ecosystems in temperate and tropical ecosystems, and species and communities that occur nowhere else in the world. The area faces significant species extirpations and extinctions, with remaining natural areas continuing to be threatened.

**The Conservation of Biodiversity Program** provides high-quality, relevant information across the conservation continuum: status, threats, vulnerable components, response of organisms and ecosystems to threats, trade-offs in desired management outcomes, efficacy of management approaches through adaptive management, restoration and recovery techniques and tools, and effectiveness monitoring and evaluation techniques.

## Research focuses on the following areas:

- Determine environmental conditions needed for terrestrial species persistence;
- Identify conditions that can support aquatic biodiversity and ecosystem services;
- Determine the genetic origins of traits that can enhance tree adaptability and utility; and
- Develop innovative approaches to reduce ecological impacts of non-native species.



Zane Miller, U.S. Forest Service

## 2013 Research Highlights

### New insights into the evolution of forest trees

Understanding the evolutionary history of forest trees is an important step in optimizing the application of new genomic technologies that can guide forest biology research and applications. Recent large investments by federal agencies in forest genomics include the sequencing of poplar, eucalyptus, and conifer genomes. Strategies must be developed for best utilizing and exploiting these resources, including how to identify genes regulating traits, such as wood formation, underpinning characteristics of ecological and economic importance, which could then be exploited in applications for forest management. A PSW researcher authored a paper in the book "Challenges and opportunities for the world's forests in the 21<sup>st</sup> Century," which outlines the practical importance of maximizing research outcomes by considering and exploiting knowledge of the evolutionary history of trees.

### Woodland salamanders as indicators of forest ecosystem recovery: A case study from California's redwoods

A PSW researcher and collaborators have found that two common salamander species provide a way of measuring the recovery of previously harvested redwood forests, a unique forest type that contains the world's largest standing terrestrial carbon stocks. Abundance and body condition of the salamanders in a given location corresponded closely with a number of measures of forest recovery, including stand age, tree size, ambient moisture, canopy closure, and litter depth. These results suggest that sampling for salamanders could be a quick and cost-effective method for determining whether a harvested redwood forest is recovering.



Garth Hodgson, U.S. Forest Service

### Climate and habitat change effects on the avifauna of old-growth redwood forests

Long-term research is critical to understanding the effects of climate and habitat change on redwood forests, which are essential California nesting habitat of the threatened marbled murrelet (*Brachyramphus marmoratus*), as well as many landbird species. This research brings together historical data from two decades of research with new studies conducted in the Redwood Experimental Forest. Making these historical and current research data available for analysts and researchers is an important part of this project. This includes incorporating these census data into files available to data visualization tools on the web through the California Avian Data Center, making them available to a wide audience. Current analyses are in progress to compare current and historical murrelet and landbird populations.



U.S. Forest Service

### A promising beginning: Early measurements of a long-term experiment reveal differences between populations of valley oaks are associated with climate

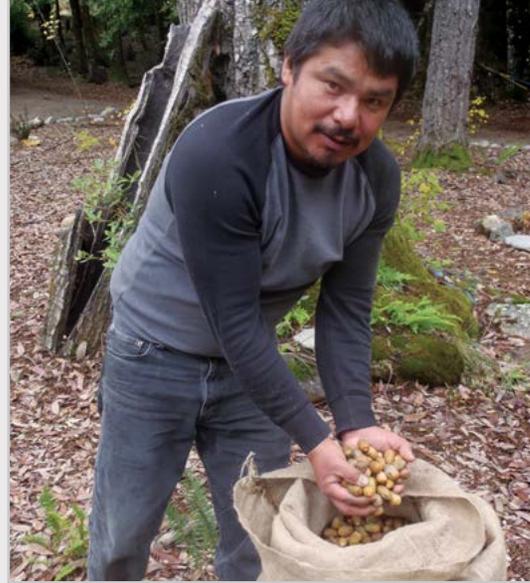
Valley oak (*Quercus lobata* Neé), a majestic California native oak, found throughout the state's foothills, valleys and flood plains is threatened by habitat loss, low seedling survivorship and climate change. Currently, there is limited information for land managers regarding where to obtain their acorns for ecological restoration projects in oaks. In order to learn about local adaptation, seed transfer and responses to climate change in valley oak, PSW and collaborators initiated a provenance test where acorns from across the range are planted into a common set of environments. Acorns from across the range of the species were collected and planted in early December at PSW's Institute of Forest Genetics (IFG) greenhouses. Nearly 12,000 acorns were weighed and planted in two days with help from Station staff, as well as staff from the Regional Genetic Resources program. Germination was monitored throughout the winter. Findings revealed that seedlings from different sites were noticeably different in the greenhouse, and in a way that was often associated with climate. For example, acorns from higher elevations germinated later. Analyses of the germination and subsequent growth data are ongoing. Future plans include outplanting the resulting seedlings into two field locations (PSW-IFG and the Genetic Resource and Conservation Center in Chico, Calif.). By planting trees into two environments, researchers will be able to look at how the different sources of trees grow in different environments, and will be able to better advise land managers about potential tree responses to a changing climate.

# Ecosystem Function and Health

Our forests and wildland ecosystems are exceedingly diverse and provide a wide array of societal goods and services. From clean water, timber and non-timber products, and carbon sequestration to recreational use, aesthetic beauty, and native biodiversity, these ecosystems are national treasures that contribute to the prosperity of current and future generations. A growing list of environmental pressures, including climate and land-use change, water scarcity, and an increasing human population, threaten the health and integrity of these ecosystems.

**The Ecosystem Function and Health Program** focuses on the interactions among changes in or brought about by biotic and abiotic factors, such as temperature and precipitation, invasive species, air pollution, insects, pathogens, and past and current land management actions. Station scientists conduct research that provides an integrated understanding of the biophysical conditions that threaten ecosystem resilience, including how environmental changes are initiated and progress, what thresholds are associated with these changes, and what the consequences are of crossing identified thresholds.

Chris Peters



Chris Fetting, U.S. Forest Service



Matt Busse, U.S. Forest Service



Luna Latimer

## Research focuses on the following areas:

- Determine how biophysical factors influence the function and productivity of tropical, subtropical and temperate ecosystems;
- Quantify and predict ecosystem responses and adaptation to environmental stressors;
- Define and measure the impacts of biotic and abiotic stresses on hydrological and atmospheric systems; and
- Develop models and tools, and evaluate management options for restoring, sustaining and enhancing ecosystem function and productivity.

## 2013 Research Highlights

### Development of SPLAT® Verb

After several years of study in the laboratory and field, PSW scientists and cooperators have developed a highly effective biochemical lure for the control of mountain pine beetles in lodgepole pine forests. SPLAT® Verb is a new formulation of a pheromone produced by male mountain pine beetles that warns other beetles away from an individual tree. This control mechanism is preferable to either removing whole infested trees or spraying insecticides. SPLAT® Verb was registered as a biopesticide by U.S. Environmental Protection Agency for use on pines in August 2013.

### New cost-effective methods for measuring atmospheric pollution effects in remote forest sites

Determining the effects of air pollution on forests and ecosystems requires that data be collected widely, including at remote sites. PSW scientists developed and deployed ion exchange resin (IER) atmospheric deposition samplers as a cost-effective method of measuring cumulative air pollution inputs in remote sites. The IER samplers can be collected only twice per year allowing for widespread deployment. Data from these studies demonstrated that nitrogen concentrations in tree-dwelling lichens are strongly correlated with IER deposition rates. This finding will allow for atmospheric nitrogen deposition to be estimated in remote regions such as Wilderness areas by simply measuring nitrogen levels in lichen tissues collected from the forest canopy.

### Detecting the walnut twig beetle, a potential threat to international walnut culture and timber production

In response to the threat posed by the walnut twig beetle (*Pityophthorus juglandis*), which spreads thousand cankers disease in walnut trees, PSW led the development of a new highly effective lure. This synthetic form of a pheromone created by the male beetles will allow for much faster detection and mapping of this invasive insect, which has already expanded its known distribution from four U.S. counties in 1960 to 100 counties by September 2013.



Steven Seybold, U.S. Forest Service and Stacy M. Hishinuma

### Effects of climate change on tribal and indigenous people of North America

Indigenous people are often the first to observe and experience the effects of how natural resources are responding to a changing climate. Closer examination of climate change impacts on indigenous peoples and their homelands, and their proposed strategies of adaptation can be of great benefit to society. Indigenous peoples and marginalized populations are particularly vulnerable and sensitive to climate change impacts due to their resource-based livelihoods and dependency on different environments. They have been able to draw on a long multi-generational transmission of traditional ecological knowledge to demonstrate actions to respond and adapt in the face of climate change. American Indian and Alaska Native cultural diversity can be informative of our human responses to climate change and what diverse strategies may be required.

### New recommendations for managing sudden oak death in tanoak ecosystems

Sudden oak death is a fungal disease caused by an invasive pathogen that has been particularly impactful to coastal ecosystems dominated by tanoak. A current management tactic is to repeatedly clear-cut forest stands where the pathogen is present; however, this approach has been shown to be unsuccessful at eradicating this pathogen. PSW has contributed to the first published biodiversity conservation strategy for these ecosystems that incorporates knowledge of pathogen behavior and stand growth characteristics to demonstrate that healthy tanoak can be maintained at low levels in infested stands. This work provides land owners and managers actions to improve stand or landscape resilience so that tanoak survives despite the presence of the pathogen.

# Fire and Fuels

Sherri Eng, U.S. Forest Service



Managing fire and the vegetation conditions that fuel fire is a paramount challenge to land managers throughout most of California, Hawai'i and the U.S.-affiliated Pacific Islands. The mission of the **Fire and Fuels Program** is to provide scientific findings that will improve management actions intended to enhance resiliency and sustainability of wildland ecosystems affected by fire, and reduce the potential for adverse effects resulting from wildland fire, including loss of life and property.

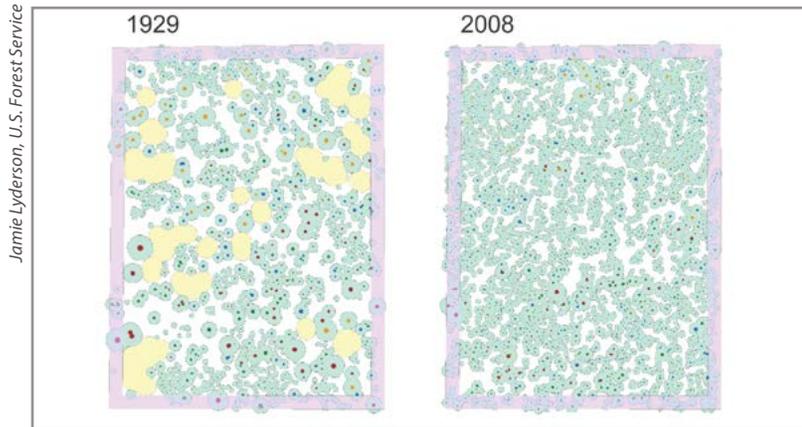
## Research focuses on the following areas:

- Improve measurement, modeling, and prediction of wildland fire and weather phenomena in complex landscapes and fuels;
- Determine the ecological effects of fire and fire removal on landscapes throughout California, Hawai'i, and the U.S.-affiliated Pacific Islands;
- Evaluate the short- and long-term outcomes of fuels, fire, and post-fire management strategies;
- Determine and quantify the interactions between climate, vegetation, and fire in the face of a changing climate and improve our understanding and predictability of these interactions in order to manage forests and wildlands more effectively; and
- Describe and quantify uncertainty and risk in a science-based decision-making framework for fire and land management planning.

## 2013 Research Highlights

### Changes to the structure of Sierran mixed-conifer forests due to fire suppression and logging make them less resilient to disturbances

Understanding the historical structure of natural forests may be useful to land managers who wish to restore forests to these conditions. A team led by PSW scientists has determined the ways in which the arrangement and size of trees in Sierran mixed-conifer forests have changed as a result of timber harvest and subsequent fire suppression. The team compared a rare dataset consisting of mapped tree locations in 1929 (pre-logging) to the current forest structure and arrangement



Jamie Lyderson, U.S. Forest Service

in those same locations. The historical forest had a greater diversity of tree arrangements and sizes, including gaps between trees, than the present structure dominated by large, dense tree groups. The present-day forest is likely less able to recover from major disturbances, such as fire or insect outbreaks as a result of these changes.

### New satellite data lead to improved tools for monitoring, management and prediction of wildland fire behavior

PSW, in association with multiple partners, has developed methods based on new sources of satellite data to provide near real-time fire mapping and measurement. These data have also been incorporated in a simulation model that includes weather forecasts to provide more realistic short-term predictions of fire spread and activity. These advances will greatly enhance the ability of firefighting agencies to identify and respond to wildland fires quickly, as well as to plan for upcoming fire seasons.

### International symposium discusses the effect of climate change and wildfires on fire economics, planning, and policy

PSW sponsored an international symposium on fire economics, planning, and policy, which focused on climate change and wildfires. More than 125 scientists, academicians, fire and fuel managers, natural resource managers, and policymakers exchanged ideas and shared mutual concerns and experiences. The symposium was a response to numerous reports in the U.S. and abroad recognizing the importance of optimizing fire management costs and the need to better understand the relationship between climate change and wildfires, and their potential impacts on community fire safety, reduction of costs to society, and reduction in fire risks. Providing information on current and potential future conditions help communities to be better prepared to respond to these events.

### Carbon dynamics in the future forest: The importance of long-term successional legacy and climate-fire interactions

Understanding how climate change may influence forest carbon budgets requires knowledge of forest growth relationships with regional climate, long-term forest succession, and past and future disturbances, such as wildfires and timber harvesting events. A landscape-scale model of forest succession, wildfire, and carbon dynamics was used to evaluate the effects of a changing climate on total forest carbon storage, tree species composition, and wildfire dynamics in the Lake Tahoe Basin, California and Nevada. The independent effects of temperature and precipitation were assessed within and among climate models. Results highlight the importance of modeling forest succession and stand development processes at the landscape-scale for understanding the carbon cycle. The future of forest ecosystem carbon cycling in many forested systems worldwide may depend more on major disturbances and landscape legacies related to land use than on projected climate change alone.



Carl Skinner, U.S. Forest Service

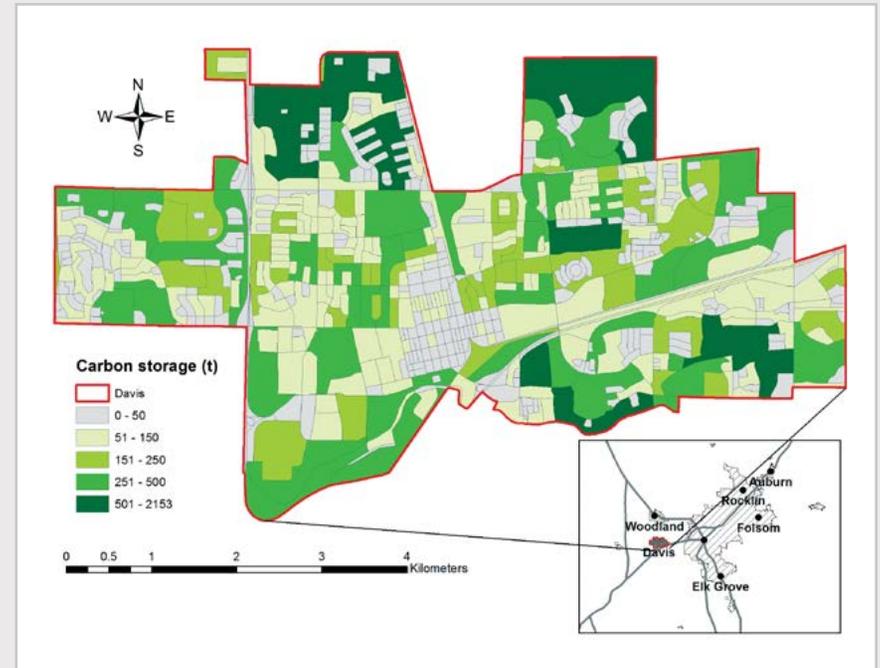
# Urban Ecosystems and Social Dynamics

The interconnection between humans and nature is complex and enduring. People need and yearn for the resources that only nature can provide: clean water, clean air, natural scenic beauty, and a connection to the land and wildlife. The Pacific Southwest Research Station strives to maintain forests, sustain functioning ecosystems in urban and wildland areas, enhance and protect quality of life, and ensure benefits to society through interdisciplinary research that examines urban ecosystems and social dynamics of natural resources conservation, management, and restoration.

**The Urban Ecosystems and Social Dynamics Program** conducts research and communicates science needed to understand and enhance the interconnections among ecosystems, people, and societies.

## Research focuses on the following areas:

- Determine the relationships among human uses, human values, ecosystem services, and management;
- Ascertain the roles of changing demographics, urbanization, socioeconomics, and technology on use and sustainability of natural resources; and
- Examine the impacts of public policies on ecological and social patterns and processes along rural-to-urban gradients.



## 2013 Research Highlights

### Barriers to Firewise actions

Community Firewise programs encourage the public to take actions that can reduce the likelihood of wildfire damage or injury, such as creating defensible space or making structural improvements to homes and other buildings. A PSW researcher and cooperators surveyed residents of the wildland-urban interface areas of Colorado to better

Kari Greer, National Interagency Fire Center



understand individual and community actions that homeowners take to protect their home or property. The survey also aimed to determine the barriers that impede homeowners from completing recommended and effective Firewise treatments. Results suggest that Firewise messaging is setting-dependent; Firewise construction issues are more difficult to enact than defensible space ones; community context and social aspects are important; and Firewise actions are more likely to be adopted if their effectiveness is communicated and residents understand the roles and responsibilities of all involved.

### Healthy pursuits or health risk? Recreation and ozone levels in Los Angeles parks

Recreation affords important benefits to urban populations and public parks are among the venues essential to city-based opportunities. A team of PSW researchers compared the areas, activities, individuals and ozone levels in two Los Angeles parks: one in a relatively affluent community, the other in a community of social and economic concern. Their findings offer important considerations surrounding recreation opportunities and use of urban parks, especially among vulnerable populations within communities at risk.



William Winter

### The urban proximate wilderness visit offers myriad benefits

Urban proximate recreation wilderness visitors derive physical, psychological, spiritual, and social benefits from their recreation visits, affirming the emphasis on getting Americans outdoors, and pointing to the value of providing for these outdoor recreation opportunities. Understanding these benefits may aid wilderness protection efforts, of particular importance in the face of ongoing population and environmental change. Consideration of these benefits may aid public well-being by increasing awareness of the beneficial outcomes from outdoor recreation. Findings suggest wilderness visits provide opportunity for physical challenge and exercise contributing to physical health and suggest important benefits can be derived from visiting the urban proximate wilderness.

### A new approach to map urban forests and determine how much carbon they store

Urbanized areas account for 3 percent of total land area and 81 percent of the total population in the U.S. Trees in cities represent about 14 percent of the carbon sequestered by U.S. forests. Carbon stored in urban forests is not typically included in national, statewide, or regional inventories of greenhouse gas emissions and sinks. Accurate quantification and mapping of these stocks is fundamental to the inclusion of urban forests in local climate action plans and carbon offset markets. A team of Forest Service researchers along with collaborators developed a novel approach for addressing these information needs by combining field surveys, biometric information for urban tree species, GIS data sets, and mapping of the urban tree canopies using satellite imagery. This approach allowed the team to accurately map and estimate carbon stored and emissions avoided by urban forests in Los Angeles and Sacramento.

### Ethnic- and gender-neutral messages about sustainability may be ineffective

Sustainability in the face of societal and environmental change requires effective messaging to address environmental attitudes and behaviors. Research by a PSW scientist revealed that ethnic identification and variations in culture and gender were important influences on the level to which an individual expressed environmental concern. These results suggested that cultural and gender environmental value differences may be relevant when framing environmental messages and developing interventions. They also point to the importance of considering degree of ethnic identification when cultural variations in environmental attitudes are examined.

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## May 2014

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