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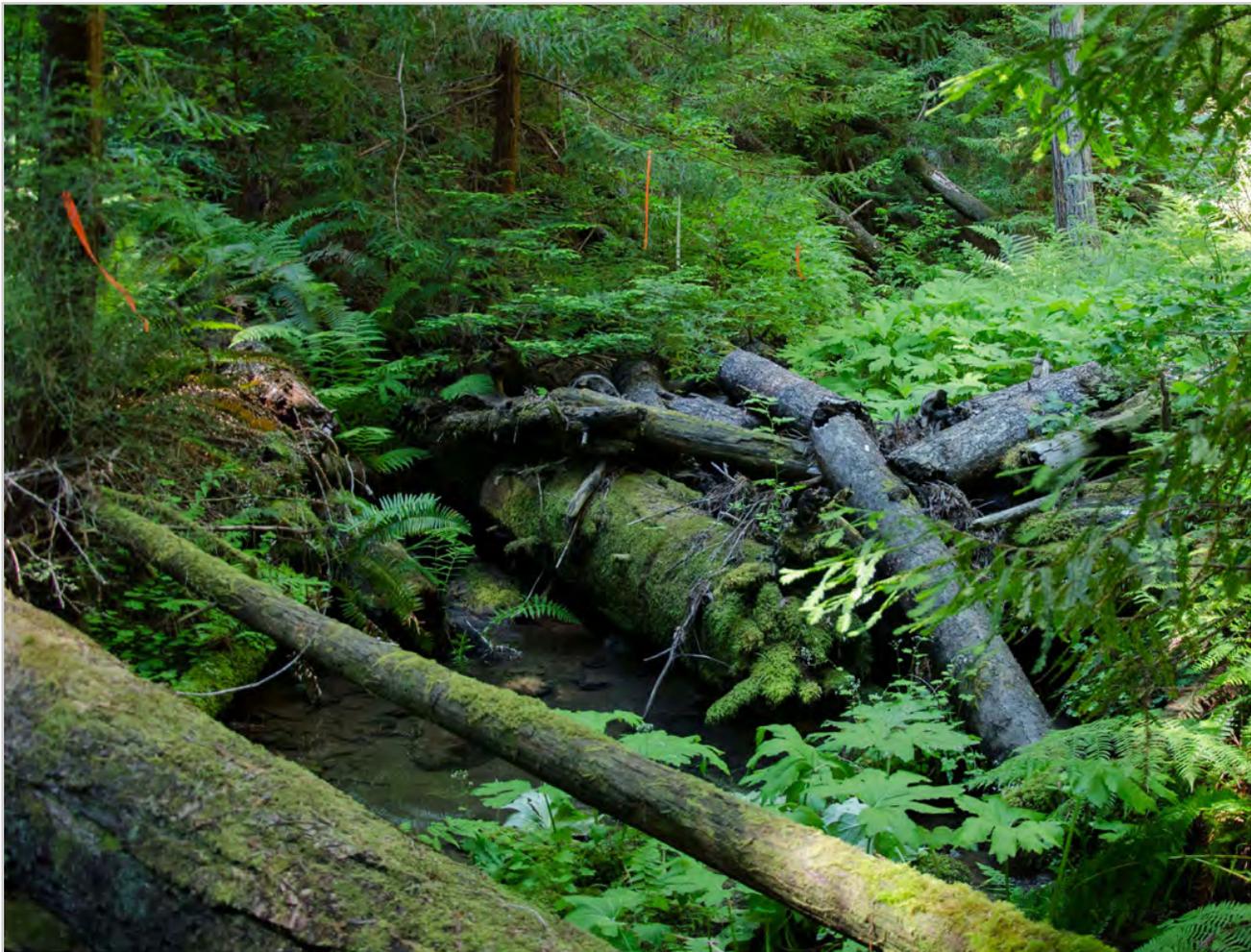
Forest  
Service

# Pacific Southwest Research Station 2014 Accomplishments Report

*Serving California, Hawaii, and the Pacific Islands*

Cover photo: U.S. Forest Service/Sherri Eng

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Caspar Creek Experimental Watershed. (U.S. Forest Service/Sherri Eng)

## **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, Hawaii, 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 resources management, and conservation. Much of our work is accomplished in cooperation with other research institutions, such as universities, and state and other federal agencies.

# Station Director's Message



PSW Station Director,  
Dr. Alexander Friend

I am proud to present the Pacific Southwest Research Station's 2014 Accomplishments Report. As part of the U.S. Forest Service, the Station provides reliable research to address contemporary questions about trees, forests, and 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 value and benefits that we 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, Hawaii, and the Pacific Islands. Changes in land use, conflicting societal values, and environmental stresses have caused many treasured lands to become degraded or vulnerable. Rigorous science is necessary to help guide the sound management, restoration, and sustainability of these lands.

As part of the nation's largest forest land management agency, our research station, along with similar units throughout the United States and the U.S.-affiliated Pacific Islands and Puerto Rico, plays an integral role in providing information and tools that help deliver and sustain benefits from forests and grasslands to all people. Benefits from forested lands and urban forests are valued in the tens of billions of dollars annually in California alone. These benefits include water from national forests for agricultural use and municipal consumption, forest recreation, street trees that reduce energy consumption and enhance home value, and sustainably harvested wood for building and bioenergy. In addition to supporting the land that provides these very tangible benefits, our research guides the conservation and management of land that supports native traditions and priceless ecological communities.

## Science that makes a difference.

The Pacific Southwest Research Station (PSW) is organized into five research units and an operations unit 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 achieving 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 resilient functioning of our ecosystems. Understanding the interplay between social dynamics and natural resources will be an increasing part of

our work. Because most of us live in cities, we are becoming more engaged in urban areas. We appreciate the unique and rich diversity of the people of California, Hawaii, 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. Several outstanding examples 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 years ahead offer immense opportunities for using rigorous science to solve contemporary natural resources problems while sustaining the basic science capacity that enables us to anticipate future challenges.

Of comparable importance to what we do is how we do it. We embrace collaborative problem solving within and outside of PSW. We intend to create a culture of inclusion that awakens and strengthens all people's connection to the land. And we are dedicated to using our work to enhance the resilience of ecosystems, communities, and organizations throughout California, Hawaii, 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 is comprised of 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.
- 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. The Forest Service has seven research stations with research units located throughout the United States, Puerto Rico, and the Pacific (Fig. 1).
- 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.

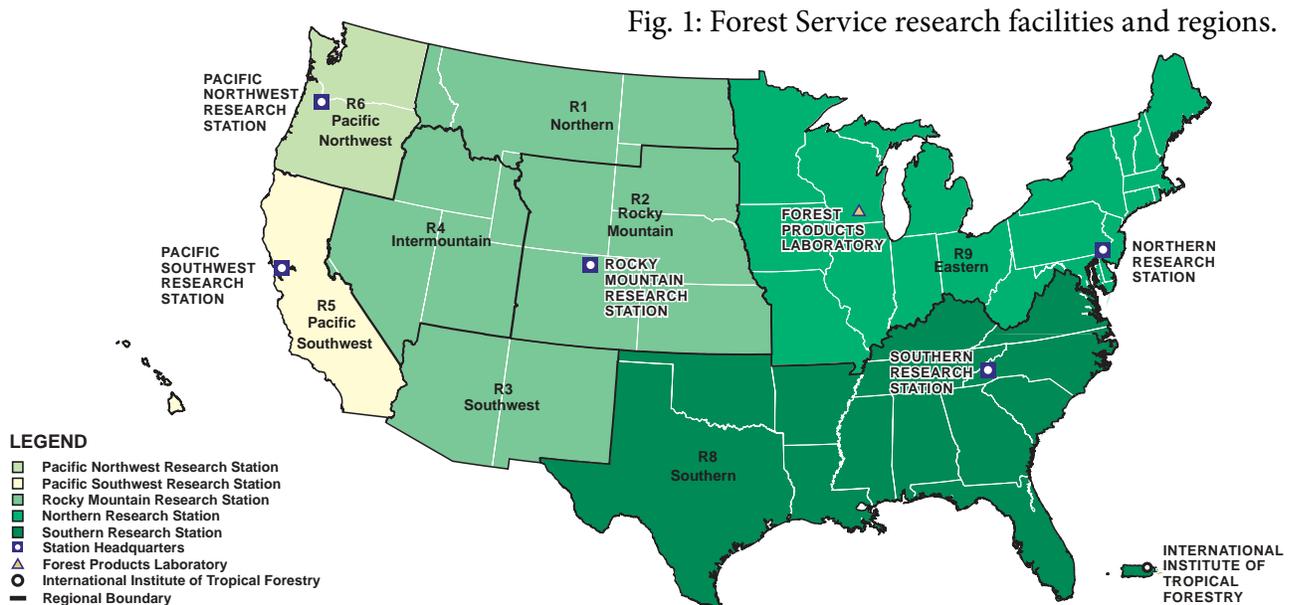




Fig. 2: The Pacific Southwest Region (Region 5) includes 18 national forests in California.

## The Forest Service at Work in the Pacific Southwest Region

California and Hawaii are located in the Pacific Southwest Region (Region 5) of the Forest Service. The Pacific Southwest Research Station (PSW), headquartered in Albany, California, partners with 18 national forests in California (Fig. 2), and with State and Private Forestry programs throughout California, Hawaii, 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 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, Hawaii and the Pacific Islands. Region 5 and PSW are facing these challenges together and through collaboration with external partners around watershed restoration and forest resiliency.

# Pacific Southwest Research Station at a Glance

Scientists and staff of the Pacific Southwest Research Station work across eight laboratories, 12 experimental forests and ranges, and two research watersheds comprising the Pacific Southwest Research Station's facilities in California and Hawaii (Fig. 3). Research is also conducted in more than 90 research natural areas linked to a nationwide system of non-manipulative research, monitoring, and educational opportunities. Research is organized into five research units:

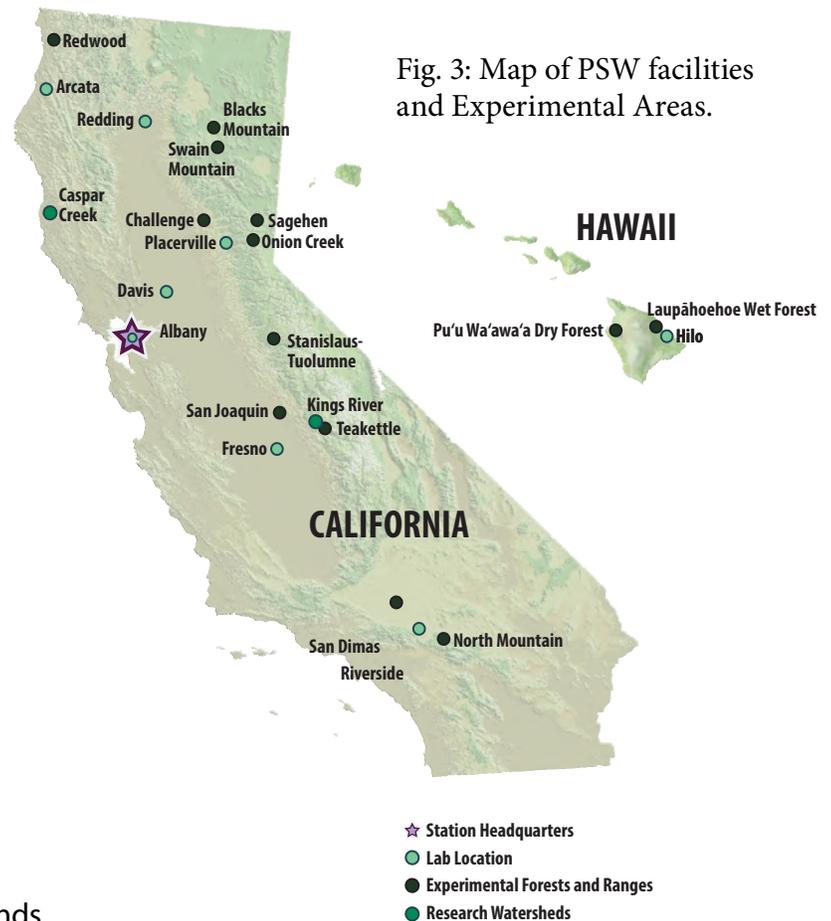


Fig. 3: Map of PSW facilities and Experimental Areas.

## 1) Institute of Pacific Islands Forestry

Scientists conduct tropical ecosystem research and technology transfer. Research furthers sound management, conservation, and restoration of grassland, forest, and wetland ecosystems and landscapes in Hawaii, Guam, American Samoa, Northern Mariana Islands, Marshall Islands, Micronesia, and Palau (Fig. 4).

## 2) Conservation of Biodiversity Program

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 of plant and animal species and habitats, and the restoration and maintenance of native ecosystems.

## 3) Ecosystem Function and Health Program

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 Program

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 Program

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

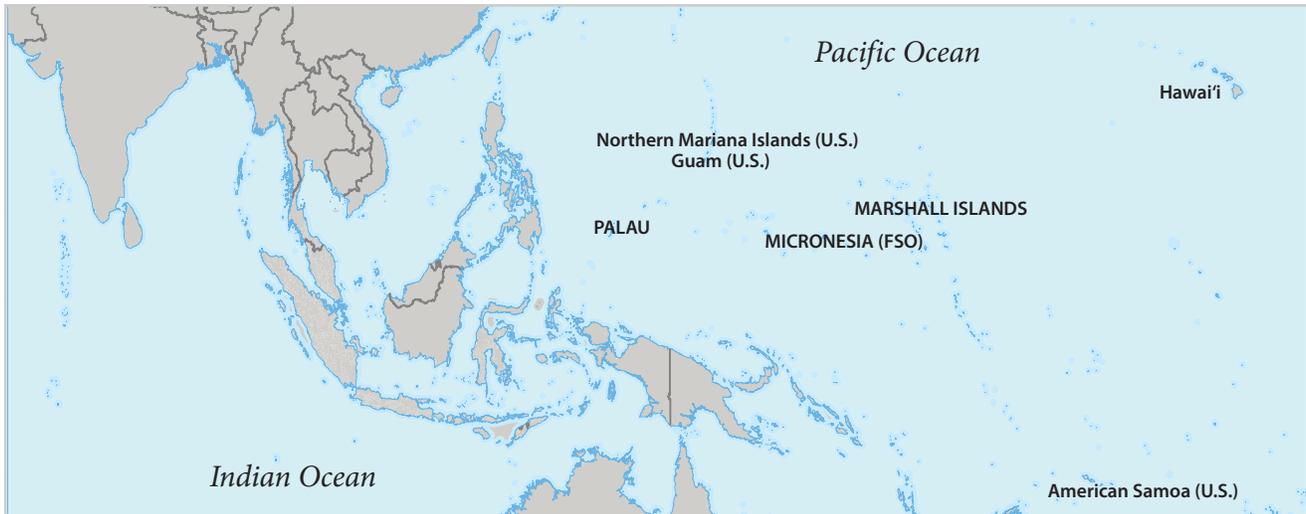


Fig. 4: PSW’s area of responsibility also includes six U.S.-affiliated Pacific Islands.

### WORKFORCE

- Total station workforce: **284 employees**
- Permanent workforce: **155 employees**
- Of the permanent workforce, **40 employees (25.8%)** are research scientists.
- In addition to the permanent workforce, **9 employees** are postdoctoral researchers.
- Temporary workforce: **129 employees**

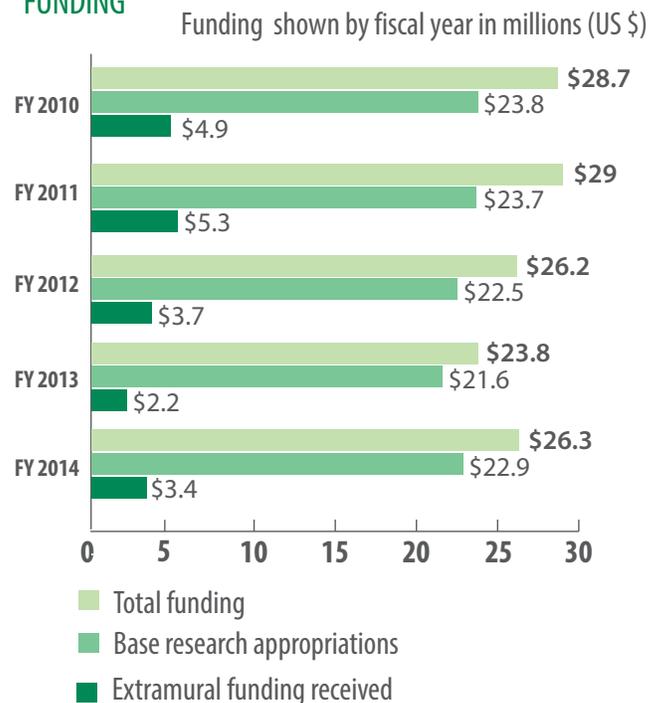
### WEB METRICS

- Number of visits to the PSW website: **75,693**
- Number of visitors to the PSW website: **50,118**
- Countries or territories visits originated from: **189**
- Page views of PSW publications: **8,472**
- Number of followers on Twitter (@usfs\_psw): **1,177**

### PUBLICATIONS

	FY 2012	FY 2013	FY 2014
Refereed journal articles	120	124	109
Peer-reviewed Forest Service research publications	89	193	38
Peer-reviewed books/chapters, papers, and reports published outside of Forest Service research	10	14	23
Other reports, theses, dissertations, abstracts, and articles	48	72	27
<b>Total publications</b>	<b>267</b>	<b>403</b>	<b>197</b>

### FUNDING



# Research Partners

PSW depends on its many partners and collaborators in developing and delivering cutting-edge, practical science to the public

## Partners plan the future of water resources in the southern Sierra Nevada

A major PSW ecosystem monitoring project, the Kings River Experimental Watersheds, is located in the southern Sierra Nevada. In 2014, PSW signed a Memorandum of Understanding (MOU) with the Southern Sierra Integrated Regional Water Management Plan group, a collection of agencies, stakeholders, and individuals engaged in a multiyear water planning effort. Research Ecologist **Carolyn Hunsaker** has been involved in this effort since 2008 and represents PSW through the plan's final development and approval as part of the MOU agreement. The group's work is an example of a state-mandated planning effort which will determine state funding for water issues and projects.

## Partnerships enhance urban forests and communities in the Los Angeles basin

Numerous organizations share a vision to improve and enhance urban forests, waterways, wildlife, and green infrastructure, as well as the quality of life for all individuals throughout the Los Angeles metropolitan region. To help realize this vision, PSW staff members developed an urban field station in Los Angeles and are contributing scientific expertise on environmental, urban ecosystem, urban natural resource, and socioeconomic issues to a network of collaborators. Partners include Region 5 and the Angeles National Forest, the Southern California Consortium, City Plants, CAL FIRE, California Urban Forest Council, California ReLeaf, Sacramento Tree Foundation, The Nature Conservancy, TreePeople, University of California Cooperative Extension, Los Angeles Conservation Corps, National Forest Foundation, LA River Revitalization Corporation, and many others.

## Stakeholder engagement and partnerships transform landscapes on Small Island States

PSW's **Institute of Pacific Islands Forestry** (IPIF) is collaborating to address needs for threat mitigation, native ecosystem restoration, and forest monitoring activities on Babeldaob Island, the largest island of the Republic of Palau and a hotspot of global biodiversity. With partners from Region 5, Palau Forestry, Coral Reef Research Foundation, Belau Museum, Ngardok Nature Reserve, Palau Fire, Palau Protected Area Networks, and the Smithsonian Museum, IPIF is engaging stakeholders to build capacity for forest management activities. Their work is helping to meet objectives outlined in Babeldaob Island's Statewide Assessment and Resource Strategy and the Micronesia Challenge, a conservation commitment among Small Island States.

## Key collaborators address forest restoration to reduce wildfire risk across a large landscape

Proactive management actions at a landscape level can enhance the capacity for resiliency in Sierra Nevada forests following disturbance, such as a wildfire event. Working across a large landscape and various jurisdictions is challenging, but cooperation among stakeholders enables management of multiple objectives. PSW is collaborating with Region 5, the Sierra Nevada Conservancy, and the Sierra Nevada Forest and Community Initiative, a consortium of public and private organizations, to develop a Landscape Management Demonstration Area in the Sierra Nevada. Activities at this demonstration site are intended to represent the ecological and socioeconomic considerations necessary to address forest restoration and protect communities at risk for significant damage from a large, high-severity fire.

# Awards



Andrzej Bytnerowicz (center) accepts the 2014 IUFRO Forest Health Award. (U.S. Forest Service)

## International Union of Forest Research Organizations' (IUFRO) Forest Health Award

Research Ecologist **Andrzej Bytnerowicz** received the 2014 International Union of Forest Research Organizations' Forest Health Award for research on wildfire effects on air quality, and for developing methodologies for large-scale monitoring of air pollution in remote areas.

**Sargent Fellowship at the Arnold Arboretum of Harvard University**  
Research Geneticist **Andrew Groover** was awarded the Sargent Fellowship at the Arnold Arboretum of Harvard University to help support collaborative research using the Arboretum's collections to understand how wood formation is regulated across a diverse sample of broad-leaved trees.

**Telly Award for Excellence in Nature/Wildlife and Safety**  
Wildlife Biologist **Sandra Jacobson** and Forest Service collaborators received a Telly Award for excellence in the categories of nature/wildlife and safety for "Avoiding Wildlife-Vehicle Collisions," a video aimed at training Forest Service employees who are likely to encounter large animals on rural roads.



A white-tailed deer crosses in front of a car. (Agricultural Research Service, Bugwood.org/ Charles T. Bryson)

## Urban and Community Forestry Award

Research Forester **Greg McPherson** collaborated with California ReLeaf and the California Department of Forestry and Fire Protection to secure funding for urban and community forestry research to address tree canopy distribution, enhance local program capacity, and increase urban forest resilience.

## National Atmospheric Deposition Program Service Award

Forestry Technician **Mike Oxford** was honored for 20 years of dedicated service to the National Atmospheric Deposition Program (NADP), a national network of collaborators tasked with monitoring acid rain and its environmental impacts. Plant Physiologist Pamela Padgett presented the award as an executive committee member for NADP.

## PSW celebrates first annual Station Director's Honor Awards

PSW presented its inaugural Station Director's Honor Awards in recognition of Station employees' outstanding achievements. The award recipients were:

### ***Station Director's Honor Award for Innovation and Service within the Station***

**Chris Nelson**, a Business Operations team leader of procurement located at PSW-Placerville, was recognized for commitment to staff needs in the lab and field. Her attention to detail and time sensitivity of purchasing requests has made dozens of research projects possible and successful.



2014 Station Director's Honor Award winner Chris Nelson (right) and PSW Station Director Alex Friend.

### ***Station Director's Honor Award for Promotion of a Safe and Healthy Workplace***

**David Oldenburg** is facilities manager for PSW's north zone, with facilities in California and Hawaii. He was recognized for creativity and ingenuity in solving problems and making progress on many projects simultaneously. Oldenburg is also located at PSW-Placerville.



2014 Station Director's Honor Award winner David Oldenburg (right) and PSW Station Director Alex Friend.

### ***Station Director's Honor Award for Science that Makes a Difference***

**Andrew Groover**, research geneticist at PSW-Davis, was recognized for groundbreaking research on the woody growth and developmental biology of forest trees to support generation of wood-based resources for a rapidly growing population. His research is directed at a core aspect of sustainability for U.S. and global forests.



2014 Station Director's Honor Award winner Andrew Groover (right) and PSW Station Director Alex Friend.

# Community Involvement

**Nightlife at the California Academy of Sciences, PSW-Albany**  
Scientists and staff participated in a lively forest-themed evening as part of the Nightlife series at the California Academy of Sciences in San Francisco. Nearly 2,600 people attended the event, which brings scientific adventure to adults each week. Visitors to PSW's table learned about forest research tools and the Station's role in fire research. Smokey Bear made an appearance and was a hit among attendees.

**Bay Area Science Festival, PSW-Albany**  
Scientists, support staff, Smokey Bear, and thousands of others came together at Discovery Days, the concluding event of the 4<sup>th</sup> annual Bay Area Science Festival. Held in San Francisco at AT&T Park, Discovery Days featured more than 150 interactive exhibits showcasing the fun of science for people of all ages. PSW's exhibit included forest research tool demonstrations, a forest insect collection, a display celebrating experimental forests, and more. Smokey Bear also made the rounds, posing for photographs and sharing his 70-year-old message of outdoor safety and forest protection.

**Bilingual McKinleyville Ecoclub, PSW-Arcata**  
Wildlife Biologist **Karen Pope** served as a volunteer science director for the Bilingual McKinleyville Ecoclub, a school-based club for students aged 4–16 that promotes leadership development and community problem solving through service-learning projects. For an ambitious citizen science project, students and their families monitored the presence and distribution of a fungal pathogen in local amphibians. Pope provided training on amphibian handling, identification, and sampling techniques; assisted with scientific permit processes; attended field sampling trips; and aided in analysis, interpretation, and write-up of monitoring data.



Bay Area Science Festival at AT&T Park, Nov. 1, 2014. (U.S. Forest Service/Sherri Eng)



Bay Area Science Festival at AT&T Park, Nov. 1, 2014. (U.S. Forest Service/Sherri Eng)



An EcoClub student presents a poster at the 2014 Wildlife Disease Association meeting. (Sally Botzler)



Run for the Dry Forest. (Hawaii Division of Forestry and Wildlife/Anya Tagawa)

### Ocean Day Mālama Kanaloa Festival, PSW-Institute of Pacific Islands Forestry

Institute of Pacific Islands Forestry scientists and staff participated in the 7<sup>th</sup> annual Ocean Day Mālama Kanaloa Festival, a marine and coastal resources awareness celebration hosted by the University of Hawaii in Hilo. Through hands-on activities, children and their families learned about marine and coastal research and explored opportunities for stewardship of unique island ecosystems.

### Laupāhoehoe Community Public Charter School Winter Retreat, PSW-Institute of Pacific Islands Forestry

A winter retreat at the Institute of Pacific Islands Forestry provided Laupāhoehoe Community Public Charter School teachers an opportunity to interact with Forest Service staff, Laupāhoehoe Community Advisory Council members, and local volunteers. Teachers hiked in the Laupāhoehoe Forest (the wet forest within the Hawaii Experimental Tropical Forest), toured the Laupāhoehoe Science and Education Center, and participated in trail maintenance and forest restoration activities, primarily invasive species removal.

### Run for the Dry Forest, PSW-Institute of Pacific Islands Forestry

Institute of Pacific Islands Forestry staff and partners from the State of Hawaii Department of Land and Natural Resources and the People's Advocacy for Trails Hawaii volunteered for and participated in the annual Run for the Dry Forest. Held in Pu'u Wa'awa'a, the dry forest unit of the Hawaii Experimental Tropical Forest, the 5K/10K event raises awareness about conservation and restoration of Hawaii's dry forests. Pu'u Wa'awa'a, once the most diverse dry forest in the State of Hawaii, is home to several species of endangered birds and at least 25 species of endangered plants, some of which are found in few or no other locations.

### Klamath Basin Tribal Youth Program, PSW-Redding

Scientists provided support for six Tribal college students enrolled in the Klamath Leadership Development Program for Integrated Science and Traditional Knowledge, a partnership-based, summer learning experience offered by the Klamath Basin Tribal Youth Program. As part of this experience, students assessed the ecosystem health and cultural priority of conservation and restoration sites in tributary streams of the Klamath River. They also addressed the challenge of providing a consistent and transparent decision-making framework across a diverse landscape. Their work will help all partners working in the Klamath Basin understand how resource management can reflect and sustain the vibrant cultures of native people.

San Diego Children and Nature Collaborative Curriculum Development, PSW-Riverside Research Social Scientist **Jim Absher** initiated a project to combine technology and outdoor experiences to achieve better science education results. Through an agreement with the San Diego Children and Nature Collaborative, PSW provided support for development of curriculum that meets Next Generation Science Standards. The standards, recently adopted by California, emphasize critical thinking and communication skills. A month-long, four-lesson project at Rincon Middle School taught students about ecology and biodiversity in the schoolyard through first-hand outdoor observation and further examination using microscopes and other laboratory tools.

California Minority Youth Environmental Training Institute Mentorship, PSW-Riverside Research Statistician **José Sánchez** represented the Forest Service at the California Minority Youth Environmental Training Institute, an intensive environmental education and career program for top high school and college students from California, Oregon, and Arizona. In a mentor role, he discussed the Forest Service mission, presented current PSW research, and assisted students with data collection during field studies.

### Society of American Chicano and Native American Scientists National Conference, PSW-Riverside

Research Economist **Armando González-Cabán** engaged young scientists at the Society of American Chicano and Native American Scientists (SACNAS) national conference in Los Angeles. More than 3,800 people participated in scientific research presentations, professional development activities, networking opportunities, exhibits, and cultural and community events during the four-day conference. One of the largest annual gatherings of minority scientists in the country, the interdisciplinary and interactive SACNAS national conference supports its diverse membership by showcasing cutting-edge science and offering mentoring and training sessions.



Armando González-Cabán shares Forest Service research at the SACNAS national conference. (U.S. Forest Service/Sophia Kirby)

# Recent Activities and Achievements on PSW's Experimental Areas

*For more than 100 years, research conducted throughout a network of experimental forests and ranges has provided invaluable information about forest health and change across the United States. PSW's 12 experimental forests and ranges and two research watersheds represent the diverse terrain, history, and culture of the West Coast, Hawaii and the U.S.-affiliated Pacific Islands. These living laboratories contribute a vast body of knowledge to guide land management decisions that can sustain forest ecosystem services and benefits in California, Hawaii, and beyond.*

## Hawaii Experimental Tropical Forest continues to expand research impact

Since 2007, the Hawaii Experimental Tropical Forest (HETF) has provided landscapes, facilities, and information to support a variety of research and education activities. In 2014, HETF personnel engaged with multiple agencies and universities on 15 research projects. Findings from recent and ongoing research on key topics including tropical forest structure, climate change, tropical dry forest restoration habitat suitability, and leaf litter decomposition in tropical montane wet forests were presented in 12 scientific journals. HETF education and outreach opportunities and service learning activities touched 650 people in surrounding communities. These efforts are enhancing the understanding of tropical forest and stream ecosystems and the conservation and management critical for sustaining their biological diversity and functioning.



A researcher collects data in the tree canopy on the Teakettle Experimental Forest. (U.S. Forest Service/ Malcolm North)

## Experimental forest research aids restoration in Sierra Nevada forests

With disturbance events on the rise, including uncharacteristic large-scale wildfires, floods, and insect and disease outbreaks, land managers are working to restore forests throughout California, but disturbance impacts may already be outpacing their efforts. To develop science-based restoration strategies in the face of changing conditions, researchers working on PSW's Teakettle, Stanislaus-Tuolumne, and Sagehen experimental forests investigated the ecological effects of structural variability following innovative forest thinning strategies. These novel approaches offer new, potentially superior options for managers to reduce fuels while accommodating sensitive wildlife. With information gained from their collective long-term studies, managers are mimicking the influence of site productivity and historic fire on forest ecosystems; management activities are more responsive to unique site conditions; and conflicting demands on forest resources are being addressed with emphasis areas that provide due attention to stakeholder priorities.



European Starlings are an invasive species and notorious for competing with native cavity-nesting birds for nesting cavities. (Gary Woods)



Western scrub-jay. (Gary Woods)

### San Joaquin Experimental Range celebrates 30 years of bird monitoring

In California, oak woodlands support the richest wildlife community of any habitat in the State, including more than 330 bird species. Human activities have severely impacted oak woodlands, resulting in habitat loss and degradation, yet little avian research or monitoring has been conducted to document and assess the effects of these impacts. At the San Joaquin Experimental Range, standardized bird surveys conducted each year since 1985 have resulted in a robust dataset with a wealth of information that directly benefits the management and conservation of oak woodlands and the diversity of its associated bird species. Researchers are using these long-term monitoring data to examine population trends and to explore species-specific responses to climate change. These results provide early warnings of change and help resource managers better understand biotic responses to climate change and the associated risks to biodiversity.

# Research in Action

*Communicating scientific findings for application in land and resource management is a key function of a research organization, but the ever-increasing volume and complexity of information can be overwhelming to land and resource managers. Recently published science syntheses from PSW combine information from numerous studies to provide a more coherent picture and provide useful summaries of research on a variety of topics to meet managers' information needs.*

## Report supports fuel reduction activities that complement soil health

Soils that can sustain a variety of ecosystem services are one of the cornerstones of healthy forests and terrestrial life. Although this concept is well appreciated by society, developing practical guidelines and management considerations for maintaining soil health is a challenging proposition given the complexity of soil properties and their sometimes seemingly unpredictable response to natural and managed disturbances. PSW published *Fuel Reduction Practices and Their Effects on Soil Quality (PSW-GTR-241)* to address this challenge and to offer managers options for reducing wildfire hazard while proactively managing soil integrity. Topics addressed in the synthesis include prescribed fire, pile burning, soil heating, mechanical harvesting, masticated fuelbeds, and nutrient removal by harvesting and burning.



Pile burning in the Lake Tahoe Basin results in moderate to severe soil damage on a limited area basis. (U.S. Forest Service)

### Report aids collaborative land and resource management planning in California

National forests in the Sierra Nevada and Southern Cascade regions are among the first in the nation to review and revise their land and resource management plans under the new 2012 USDA Forest Service Planning Rule, which requires forest planners to consider the best available science and encourages a more active role for research in plan development. To help planning teams in need of relevant and current science, a team of scientists from PSW and the Pacific Northwest Research Station participated in the public Sierra Cascades Dialog sessions where they met with Forest Service leadership and managers and external stakeholders to learn more about their concerns, interests, and management challenges. *Science Synthesis to Support Socioecological Resilience in the Sierra Nevada and Southern Cascade Range (PSW-GTR-247)* resulted from the scientists' collaboration in response to these engagement sessions and other input. Forest planners are using the report to assess environmental stressors and to inform science-based management strategies for sustaining forest health and ecosystem services across the landscape.



U.S. Western conifer forest.  
(U.S. Forest Service)

### Special journal issue presents current knowledge about the mountain pine beetle

Since 2000, mountain pine beetle outbreaks have occurred across more than 66 million acres of forest in western North America, resulting in extensive mortality and impacts to numerous ecosystem services. Forest Service research scientists from the Western Bark Beetle Research Group (WBBRG) contributed to a special issue of *Forest Science* titled "Mountain Pine Beetle, a Major Disturbance Agent in U.S. Western Coniferous Forests: A Synthesis of the State of Knowledge." The special issue, co-edited by research entomologists **Chris Fettig** (PSW) and José Negrón (Rocky Mountain Research Station), contains 11 summary papers on the biology, ecology, and management of mountain pine beetle. WBBRG members conducted much of this research in the last decade and contributed directly to policy decisions at regional and national levels. The group's work contributed to the Forest Service Western Bark Beetle Strategy, which charts a science-based path for responding to issues of human safety, recovery, and resiliency through 2016. Several papers are among the most frequently downloaded in *Forest Science*.

# 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 Hawaii 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 Hawaii 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.



Montane wet rain forest in the HETF. (U.S. Forest Service/Susan Cordell)



Two young stilt chicks in a wetland unit at Hanalei National Wildlife Refuge on Kauai Island. (U.S. Forest Service/Richard MacKenzie)

## Research focuses on the following areas:

- Increase understanding of 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.

## 2014 Research Highlights

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### Keeping out exotic fish improves endangered Hawaiian waterbird habitat

Exotic fish, such as tilapia and mosquito fish, were introduced to Hawaii and the western Pacific



A volunteer samples insects in a wetland managed for endangered waterbirds. (U.S. Forest Service/ Richard MacKenzie)

Islands in the early 1900s, becoming well-established and impacting native fish and waterbird habitat. A PSW scientist and collaborators monitored exotic fish

populations in the Hanalei National Wildlife Refuge and tested a prototype fish screen designed to keep these fish out of wetland units managed for threatened and endangered Hawaiian waterbirds. In these units, researchers saw a significant increase in aquatic insect production, which provides food for waterbirds. The screen's success resulted in the installation of larger fish screens in other refuge units.

### The Pacific Fire Exchange works to reverse the trend of increased fires in the region

Fire is a growing threat in the Pacific Region because of climate warming, drying, and a rapidly expanding cover of fire-prone non-native and invasive vegetation. PSW researchers and partners established the collaborative Pacific Fire Exchange (PFX) to reverse these trends and address the core drivers of the fire problem in Hawaii and the Pacific Islands. Because nearly all fire ignitions are of human origin, knowledge sharing, outreach, and public education can exert a large influence. Through a flexible and partnership-driven approach, PFX is curtailing the land area affected by fire, and reducing the threat to community and natural resources.

### A natural enemy begins to control invasive strawberry guava across Hawaii

Invasive strawberry guava has spread widely in Hawaiian rainforests, devastating native species and critical watersheds. A PSW scientist and collaborators evaluated natural enemies of strawberry guava from its Brazilian native range and selected the highly specific leaf-galling scale insect *Tectococcus ovatus* as a biocontrol agent. The State of Hawaii approved the insect for release in 2011 and delivered the biocontrol agent to partners across Hawaii in 2013 and 2014. The PSW team advised partners who have established and begun monitoring growing populations of the insect on the islands of Oahu and Hawai'i. The insect is expected to suppress strawberry guava and complement other long term management strategies.

### Hurricane damage and science-based solutions prompt action to remove invasive albizia trees

Albizia (*Falcataria moluccana*) is an invasive tree that impacts native forests and local communities in Hawaii and American Samoa. When Hurricane Iselle struck Hawai'i Island in August 2014, high winds created substantial damage, primarily due to tall albizia trees felled by the storm. In response, a coalition of Hawaii's residents, legislators, governmental agencies, and utility companies galvanized around the critical need to eliminate albizia. A PSW scientist, who has studied albizia impacts and developed effective means for management and control, provided science-based answers to help



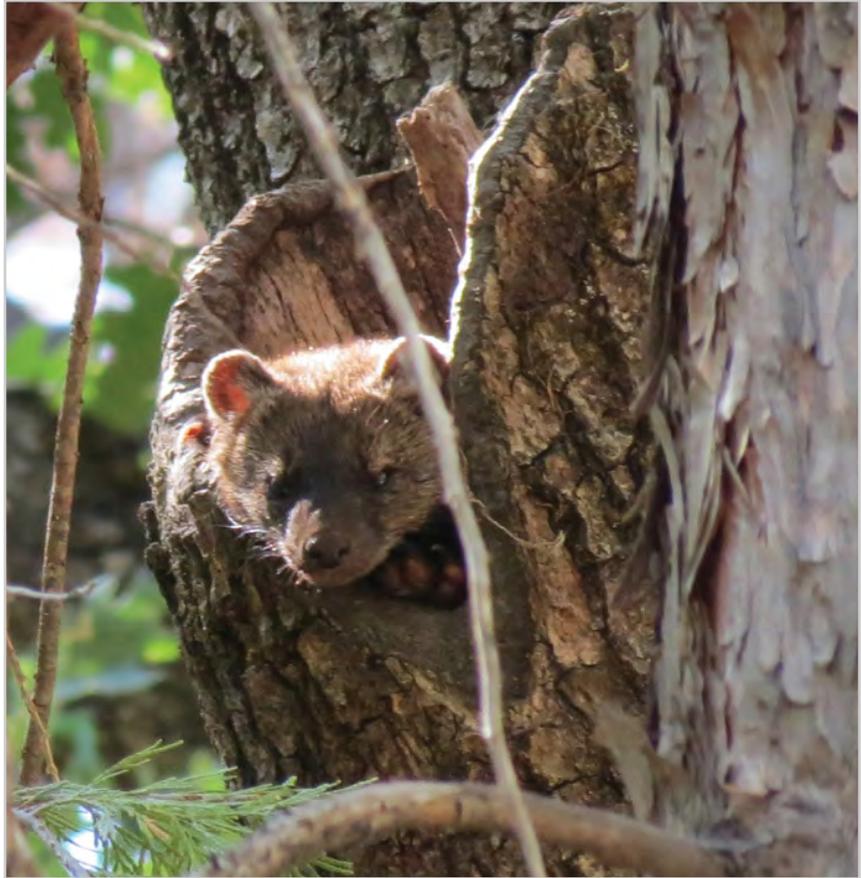
Albizia trees felled by Hurricane Iselle. (U.S. Forest Service)

guide these stakeholders in their efforts to reduce albizia's threats to Hawaii's forests and citizens.

# Conservation of Biodiversity

PSW's research 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 local extirpations and extinctions, and wildlife habitat throughout the area continues 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.



Fisher. (U.S. Forest Service/Zane Miller)

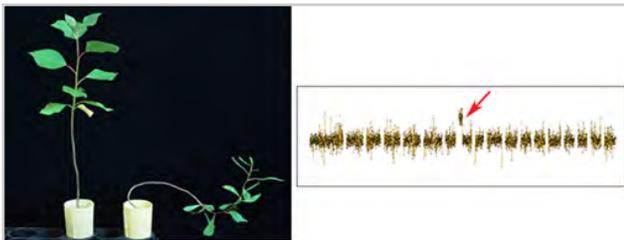
## Research focuses on the following areas:

- 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.

## 2014 Research Highlights

### Improving bioenergy feedstock options with breakthroughs in poplar genetic studies

Poplar trees are of particular interest as feedstock, or material used for producing biofuels, because they are fast-growing, have desirable wood properties, and can serve as a model for studying the genetic foundation of wood formation. A PSW scientist and collaborators developed a new process for identifying genes regulating feedstock properties, and for developing new poplar varieties (cultivars) in a single breeding cycle. To accomplish this, researchers treated pollen to mimic a natural process by which genetic variation is created in trees and then used the pollen to establish several hundred hybrid seedlings. Using laboratory processes that reveal information found in DNA, they identified chromosomal regions and genes that influence specific feedstock properties. This new research tool is a step toward the overall goal of rapidly developing cultivars with superior bioenergy feedstock traits.



Researchers identified chromosomal regions and genes responsible for wood formation. (U.S. Forest Service/Andrew Groover)



Woodland salamander. (U.S. Forest Service/Hart Welsh)

### Friends in low places: Salamanders help mitigate the impacts of climate change

Climatic changes occur when greenhouse gases, such as carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) are released into the atmosphere. A PSW scientist and collaborators investigated the role of *Ensatina*—small, seldom-seen woodland salamanders that are the most common vertebrate species in American forests—in regulating invertebrate populations and leaf litter retention in a Northern California forest. They found that these salamanders facilitate carbon capture in leaf litter by feeding on invertebrates (beetles, earthworms, snails, ants, etc.) that would otherwise release this carbon as CO<sub>2</sub> and CH<sub>4</sub> through their consumption of forest debris. These findings suggest that woodland salamanders play a significant role in regulating the capture and storage of carbon (carbon sequestration), thereby affecting the entire carbon cycle in forests and posing a provocative new perspective on the contribution of biodiversity to forest and global sustainability.

### Finding high value in low-cost surveys to estimate trends in bat populations

Broad-scale threats to bats, such as white-nose syndrome (a rapidly-spreading fungal disease) and climate change, highlight the need for reliable assessments of their populations. Few long-term, rigorously-designed assessments of bat populations exist; instead, informal efforts to survey hibernating bats (opportunistic monitoring) often provide the only data available to base population assessments. PSW scientists and a collaborator evaluated a collection of opportunistic surveys of Townsend's big-eared bats (*Corynorhinus townsendii*) recorded over a 22-year period at Lava Beds National Monument in Northern California. They used count records of hibernating bats and found that populations were stable or increasing. There was no evidence that the disturbance caused by annual surveys depressed the number of hibernating bats. This finding highlights the ability to use low-cost, informal survey options and increases the ability to link population trends to external factors, demonstrating that opportunistically collected, long-term data sets can have substantial value for establishing first approximations of population trends for bats.

### Fishers, forests, and fire: Can't we all just get along?

The fisher, a mid-sized mammalian carnivore, is currently being considered for both state and federal endangered species listing. The fisher's association with dense, structurally-diverse forests presents a conservation challenge: how do managers conserve dense habitat when fuel reduction carries the risk of short-term impacts to habitat suitability, but lack of fuel reduction carries the risk of long-term habitat loss through high-intensity fire? Using predictive models that project forest response to various fuel reduction scenarios, PSW scientists and collaborators found that, with careful consideration to location, extent, and timing, fuel reduction activities can lower the long-term risk to conserving fisher habitat and populations. This information has contributed to multiple large-scale collaborative land management projects, such as the Dinkey Collaborative involving public and private stakeholders. PSW models are providing these projects a foundation for a regional fisher conservation strategy.



Cluster of hibernating Townsend's big-eared bats, Lava Beds National Monument, California. (National Park Service/Shawn C. Thomas)

# Ecosystem Function and Health

U.S. 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 change, insect outbreaks, 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.



An adult goldspotted oak borer, an exotic insect threatening red oaks in California. (U. S. Forest Service/T.W. Coleman)

## 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.

## 2014 Research Highlights

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### Understanding the invaded range boundary of the goldspotted oak borer

A PSW scientist, working with USDA and University of California entomologists, developed an effective monitoring technique for the goldspotted oak borer, an invasive beetle that is killing coast live oak and black oak trees in Southern California. Through lab and field trials, researchers first developed a flight intercept trap for capturing the beetle, and then used the traps to survey and better define the beetle's current range. They concluded that the range of this invasive pest is currently limited to Riverside and San Diego counties.



Researchers use purple flight intercept traps to monitor goldspotted oak borers. (U.S. Forest Service/T.W. Coleman)

### Tool analyzes human-wildlife interactions

Researchers can study human-wildlife interactions on large, diverse landscapes with GPS technology and statistical models that measure behavioral responses to recreation and other human-caused disturbances. A PSW scientist and collaborators developed a statistical modeling framework and analyzed wildlife movement data from a long-term controlled experiment. They evaluated the responses of free-ranging Rocky Mountain elk to human-caused disturbances that vary in time and space. Results demonstrated the elk's strong avoidance of all-terrain vehicles up to 0.6 mile, mountain bikers up to 1,600 feet, and hikers and horseback riders up to 660 feet from the disturbances. This modeling framework is a tool that can help land managers and recreationists understand the potential impacts of various human activities on wildlife in California.

### Vulnerability of high elevation lakes of the Sierra Nevada to atmospheric acidic deposition

Large areas of California are exceeding critical loads of atmospheric nitrogen from the burning of fossil fuels, known as acidic deposition. High elevation lakes in the Sierra Nevada have a very low capacity to neutralize acid, so even low levels of nitrogen or sulfur deposition from air pollution result in vulnerability to acidification and ecological effects of excess nutrients (eutrophication responses). To determine where the most vulnerable lakes are located in the southern Sierra Nevada, a PSW scientist and a collaborator studied 208 lakes from Class I and II Wilderness areas and found that 16 percent exceeded the critical load for acidification. Atmospheric deposition inputs are projected to exceed the estimated critical loads of the more sensitive lakes and catchments in this area for the foreseeable future even though nitrogen oxide emissions from California's transportation sector have decreased dramatically in recent years.

### Variability of natural seedling distribution in conifer forests following wildfire

After wildfires, forest managers often need to regenerate many acres of burned forest and may choose to rely on natural regeneration to replenish the trees lost to fire. In a study of 10-year regeneration after wildfires in mixed-conifer forests of Northern California, a PSW scientist and collaborators found that, while stem densities were often quite high, the spatial distribution of natural regeneration was highly variable. There were large areas with no regeneration and some small areas with an overabundance of seedlings. Areas without sufficient regeneration had effectively been converted to a shrub-field condition, particularly where high-severity burns occurred leaving few surviving trees remaining to act as a seed source. Managers can use this information to prioritize planting efforts in high-severity burn areas that are least likely to regenerate naturally with sufficient coverage to produce forested conditions in the future.



Area dominated by snowbrush and mountain whitethorn 10 years after wildfire. (U.S. Forest Service/Travis Springer)



Locally abundant regeneration of true fir seedlings 10 years after wildfire. (U.S. Forest Service/Travis Springer)

# Fire and Fuels

Managing fire and the vegetation conditions that fuel fire is a paramount challenge to land managers throughout most of California, Hawaii 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.



Smoke plume from the Rim Fire as viewed from a wilderness area near Laurel Lake in Yosemite National Park on the evening of Aug. 21, 2013. (U.S. Forest Service/ Jamie Lydersen)

## 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, Hawaii, 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.

## 2014 Research Highlights

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### Factors contributing to the severity of the Rim Fire in restored forests of Yosemite National Park

The 2013 Rim Fire originated on Forest Service land and burned into old-growth forests within Yosemite National Park with relatively restored frequent-fire regimes. Park researchers had collected forest structure and fuels data three to four years before the fire, providing a rare chance to use pre-existing data to analyze fire effects. PSW and University of California, Berkeley scientists examined the influence of forest structure, fuel, fire history, topographic, and weather conditions on observed severity of the Rim Fire. They found that plots that burned on days with strong plume activity experienced moderate- to high-severity fire effects regardless of forest conditions, fire history, or topography. Study results reinforce the value of more frequent, low intensity fire, which may prevent wildfires from becoming plume-dominated.

### Composition of smoke from chaparral fires and considerations for prescribed burning on military facilities

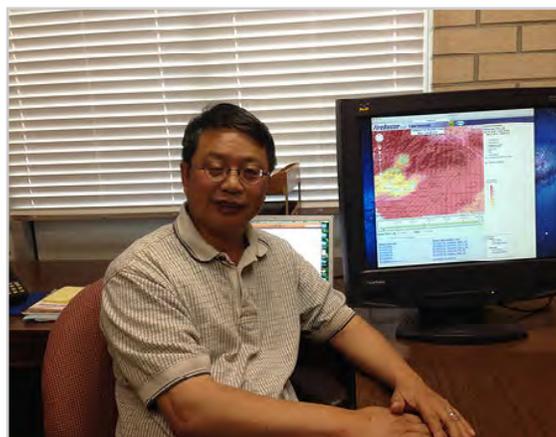
Chaparral fuels—highly flammable, woody shrubs found in some California ecosystems—can burn intensely, so land managers require information on smoke composition to use prescribed burning in chaparral. A PSW scientist and collaborators conducted a four-year laboratory and field study and found significant amounts of lead and other metallic elements in the ground-based filter samples collected at Vandenberg Air Force Base. Filters from laboratory burning of fuels did not include these elements in any significant quantity suggesting that elements found in the Air Force Base smoke are from a non-fuel source. The work provides new information about emissions from chaparral fires and specifically suggests that consideration be given at Department of Defence facilities to particles that could be carried into the smoke plume before generally conducting prescribed burns.



Prescribed burns mimic natural processes, reduce hazardous fuels and release smoke into the atmosphere. (U.S. Forest Service)

### FireBuster tool enhances fire weather forecasts

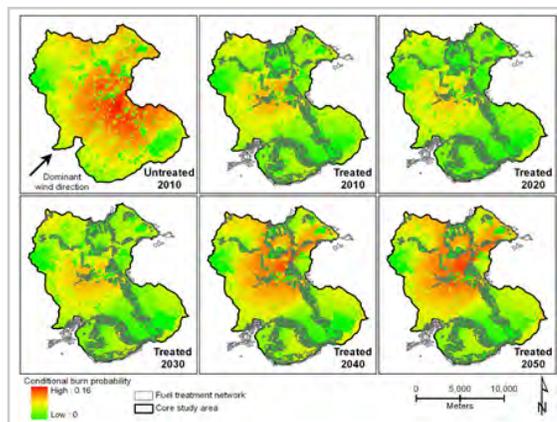
Complex terrain in mountainous areas has multifaceted impacts on wind and weather, as well as on wildland fire behavior and human communities. Because National Weather Service forecasts do not capture terrain details, regional computer models enhance official forecasts. This information is usually not available until after a severe fire event, so the benefits of high-resolution weather models for fire management have been limited. To address this limitation, a PSW scientist developed an experimental system called FireBuster to produce forecasts at ~3 mile resolution over Southern California. For even greater detail, a field forecaster can request a special ~0.6 mile resolution, 72-hour forecast with only a few clicks on a Google map. Using a web interface, firefighters can retrieve FireBuster data on location-specific, detailed weather forecasts, including wind, which they can use to better fight fires and protect communities.



Research Meteorologist Shyh-Chin Chen developed the Firebuster web tool. (U.S. Forest Service)

### Impacts on hazardous fire potential from fuel reduction across a large landscape

To assess the effectiveness of fuel treatments and their potential for reducing hazardous fire risk, PSW and University of California, Berkeley scientists and collaborators examined a completed landscape fuel treatment network. Modeling results demonstrated reductions in hazardous fire potential across much of the treated landscape, relative to the untreated condition. These reductions persisted throughout their modeling duration (2010–2050), demonstrating that a coordinated fuel treatment network using local knowledge of fire weather and likely fire behavior patterns can substantially reduce hazardous fire potential. However, even with planned maintenance of the treatment network, hazards grow in untreated areas over time, suggesting additional fuel treatments would be necessary to maintain low hazardous fire potential.



Researchers used models to assess the effectiveness of fuel treatments. (U.S. Forest Service/Brandon Collins)

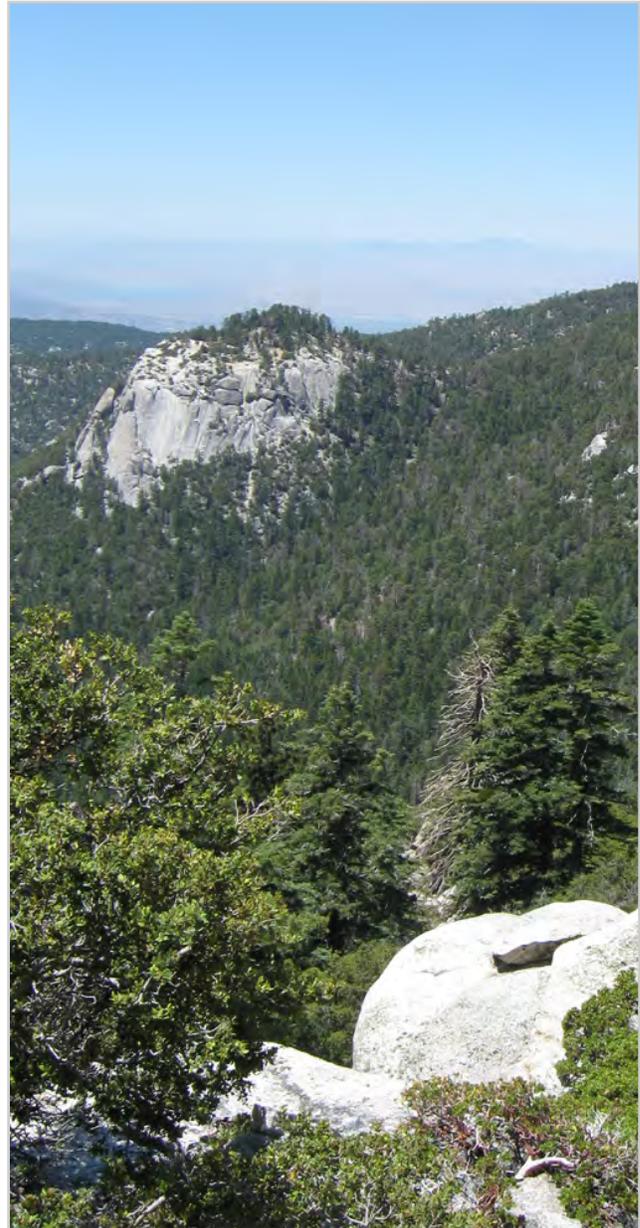
# Urban Ecosystems and Social Dynamics

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.



View from Suicide Rock from Devil's Slide Trail, located in the San Jacinto Wilderness, San Bernardino National Forest. (U.S. Forest Service/ José Sánchez)

## 2014 Research Highlights

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### Trees in Los Angeles: Carbon dioxide sink or source?

Tree planting is considered to be among the most effective approaches to cooling urban environments and mitigating climate-warming carbon dioxide emissions from a variety of sources. Los Angeles' tree program, City Plants, is one of several mayoral tree planting initiatives. The assumption behind these tree planting initiatives is that trees efficiently store carbon, providing a net long-term carbon dioxide sink. But because there has never been a full accounting of carbon dioxide emissions for a tree-planting initiative, some question their effectiveness. To address this issue, PSW researchers and collaborators analyzed information from the City Plants effort.

Researchers simulated carbon dioxide emissions and reductions from storage, as well as avoided emissions from energy savings for the 40-year City Plants period for about 100,000 trees planted from 2006 to 2010, of which approximately 34 percent were estimated to survive. Early results suggest that these plantings are achieving success in terms of survival, growth, and performance. The estimated total amount of carbon dioxide emitted (83,408 tons) from the largest sources—mulch decomposition, wood combustion, and irrigation water—was slightly more than the amount of carbon dioxide that trees were projected to store (77,942 tons). However, City Plants will be a carbon dioxide sink if 40-year projections of avoided fossil fuel carbon dioxide emissions from energy savings (101,679 tons) and biopower (1,939 tons) are realized. These findings suggest that this tree planting initiative, and possibly others, can be net carbon dioxide sinks, especially if trees are strategically located to reduce energy consumed for air conditioning and heating. There are also opportunities to further reduce emissions, such as selecting drought tolerant trees and utilizing wood to produce wood products or to generate electricity instead of producing mulch.



Los Angeles Conservation Corps members plant a tree for the city plants initiative. (City Plants/Elizabeth Skrzat)

### Benefits and losses of wildfires on the San Jacinto Wilderness

PSW scientists and collaborators discovered that recently burned landscapes are attractive to forest recreationists. Researchers used a non-market valuation method to investigate the recreation values of the San Jacinto Wilderness in Southern California, which burned in July 2013. The results suggest that recreationists are attracted to sites affected by recent wildfires, which they can view up-close. Societal benefits from recreational activity increased for sites that were partially affected by different types of wildfires. The most recent wildfires experienced the greatest societal gains. However, wildfires causing trail closures created societal losses, which were estimated to range from \$29,600 to \$2.9 million for the closure of the five trails studied. This information can help fire managers understand recreational use and to strategically place existing resources to help protect high-value areas.

### New tool for prioritizing wildfire prevention and suppression activities

Increasing fuel loads have had a significant effect on wildland fire severity. The increase in fire severity leads to short- and long-term socioeconomic and ecological consequences. Because of these important consequences and the high frequency of wildland fires, national, regional, and local decision makers have requested information on the potential risk and suppression difficulty of wildland fires. To address this concern, a PSW scientist developed the Fire Suppression Priority Index, a model which combines the Fire Behavior Potential Index and Suppression Difficulty Index, to provide precisely that kind of information. The Index identifies sectors in management areas with the highest degree of fire danger and the sectors with a high degree of firefighting difficulty. This information can help fire planners and fire managers strategically place firefighting resources to increase their fire protection effectiveness, minimize the consequences of fire and help planning units with their fire management programs and budget allocations. The Fire Suppression Priority Index is dynamic and applicable to any forest lands that experience wildland fire.



Wenatchee Complex, Okanogan Wenatchee National Forest, Washington, 2012. (U.S. Forest Service/Kari Greer)

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