U.S. Forest Service

Pacific Southwest Research Station

Serving California, Hawaii, and the Pacific Islands

2016 Accomplishments Report

USDA

Message from the Director

I am proud to present the Pacific Southwest Research Station's 2016 Accomplishments Report. Our station is focused on science that contributes to four key outcomes: (1) forest landscapes that are resilient to disturbance, especially fire; (2) enhanced benefits to urban communities from the natural environment; (3) clean and reliable water resources; and (4) sustained ecological resources and services. We serve people and improve lives with research that spans a diversity of disciplines and has an enormous geographical footprint. As you scan through the pages ahead, I invite you to observe the relevance and rigor of our science, the value we place on connecting with people and the end users of our work, and the care we take in stewarding the resources with which we are entrusted.

California, Hawaii, and the U.S.-affiliated Pacific Islands face substantial challenges related to forest resources. However, targeted science can inform policy and management so that the health, diversity, and productivity of these resources can be sustained, to the greatest extent possible, for the benefit of current and future generations. To name a few of these challenges:

- Recently, we have seen massive tree mortality in the Sierra Nevada.
- Wildfire suppression is using an ever-increasing share of the Forest Service budget at the expense of other mission work, including research.
- Conflicts associated with the management of public forests continue and intensify as changes in forest conditions affect biodiversity and productivity.
- Water resources remain scarce in California, making their management controversial.
- More than 90 percent of our citizens live in urban areas, with significant numbers not sharing in the significant values offered by trees and green spaces.
- Invasive species, pathogens, and changes in climate pose increasing threats to ecosystems in Hawaii and the Pacific Islands.

In the past year, we have made substantial progress toward addressing each of these by documenting the ecological, social, or economic phenomena at play, then communicating these findings to land managers and decisionmakers. The quality of accomplishments we report derives from the talent and dedication of our staff as well as our long-time collaborators and partners/supporters. Given this robust research and stakeholder community, I look forward to another successful year in 2017!

Alexander L. Friend, Ph.D.
Station Director, Pacific Southwest Research Station

Vision and Mission

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

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.

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 nonfederal rural and urban forests.

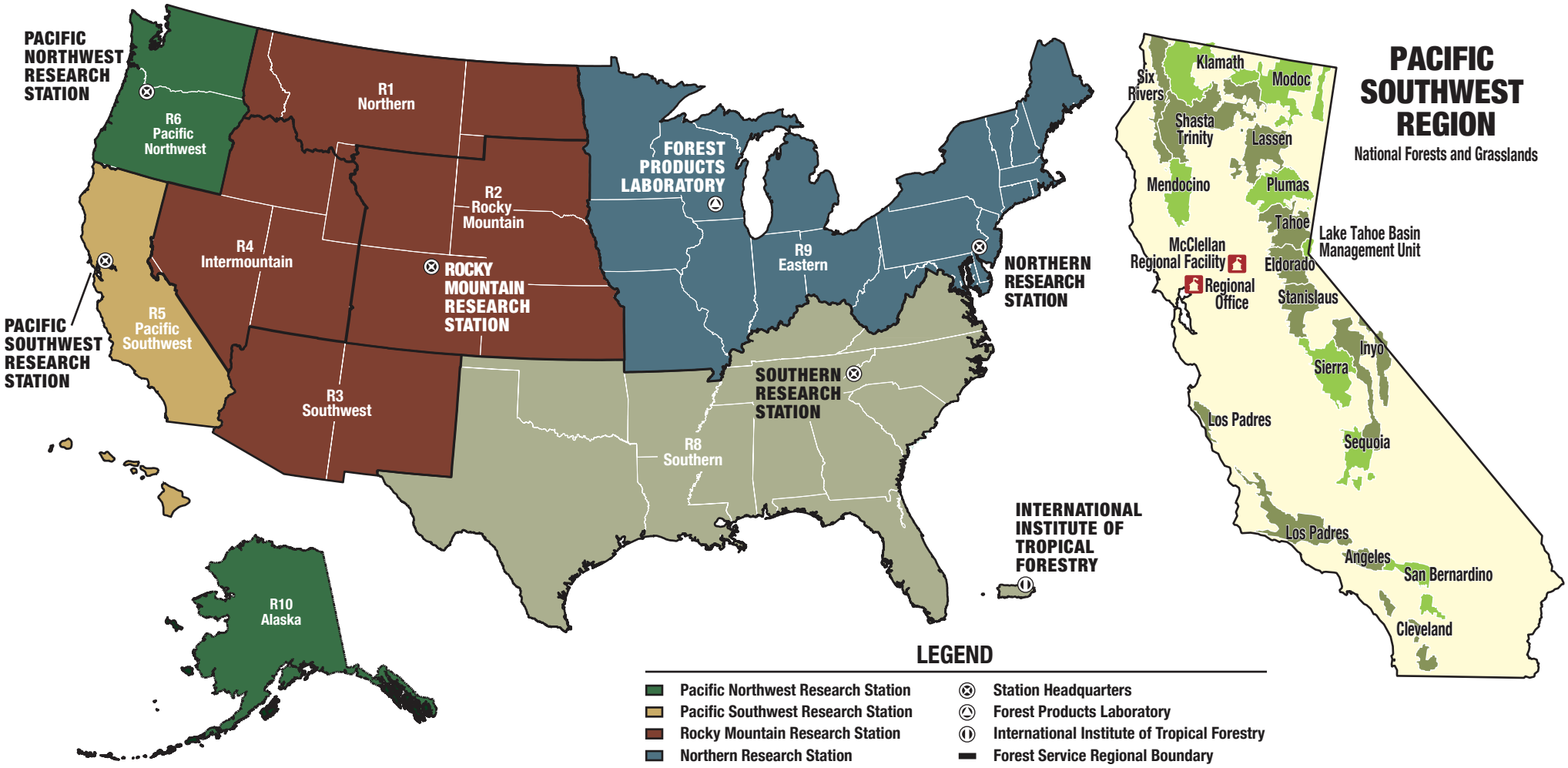
The Forest Service comprises several major branches that work together to manage the nation's forests and protect global forest resources:

- 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.
- 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.

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, and with State and Private Forestry programs throughout California, Hawaii, and the Pacific Islands.

Leaders of Region 5 and PSW have a common goal of retaining and restoring the 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 (PSW) work across 8 laboratories, 12 experimental forests and ranges, and 2 research watersheds comprising the station's facilities in California and Hawaii. Research is also conducted in more than 90 research natural areas linked to a nationwide system of nonmanipulative research, monitoring, and educational opportunities. Research is organized into five research units:

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 (see Pacific Islands map below).

2. Conservation of Biodiversity Program

Scientists conduct research on genes, species, habitats, landscapes, and the biological processes necessary to maintain a 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 constant threats from insect pests and plant pathogens.

4. Fire and Fuels Program

Scientists conduct research on how fuel types and conditions affect fire behavior 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 on connecting urban dwellers with public lands through urban forestry and social science research.

Workforce

- Total station workforce: **222 employees**
- Permanent workforce: **143 employees**
- Temporary workforce: **79 employees**
- Of the permanent workforce, **40 employees** (28%) are research scientists.
- Workforce (temporary and permanent) actively conducting research: **98 employees**

Science Delivery

- PSW website visits: **155,325**
- Twitter followers (@usfs_psw): **2,024**
- Publications: **188**
- Media mentions: **135**

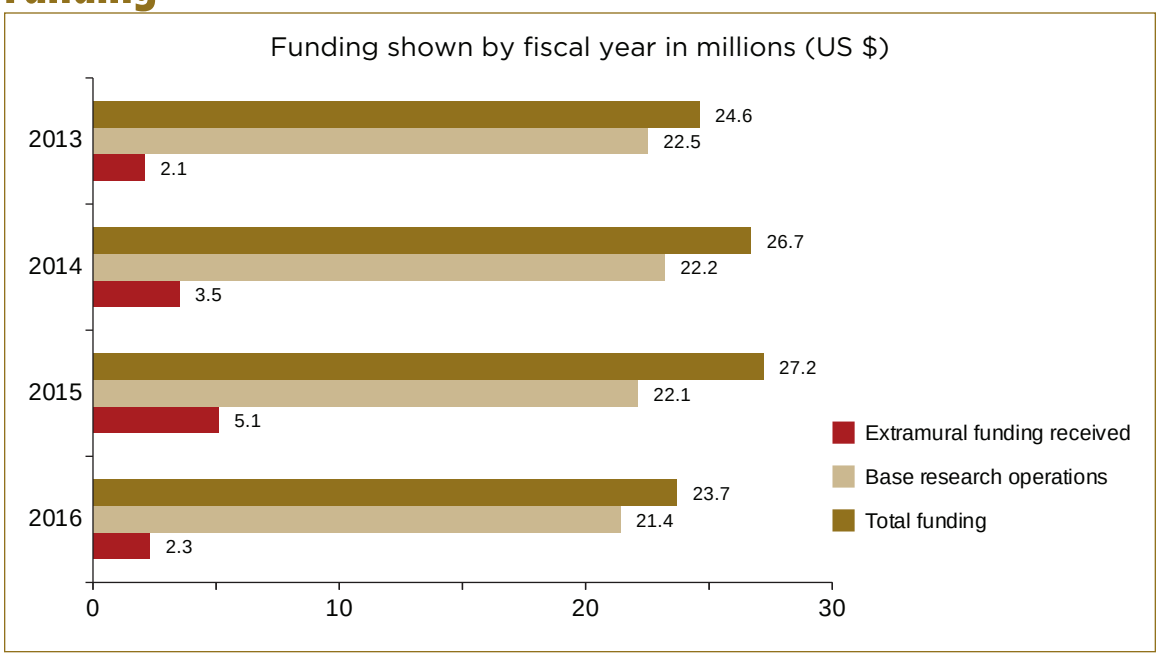
Top Website Visits

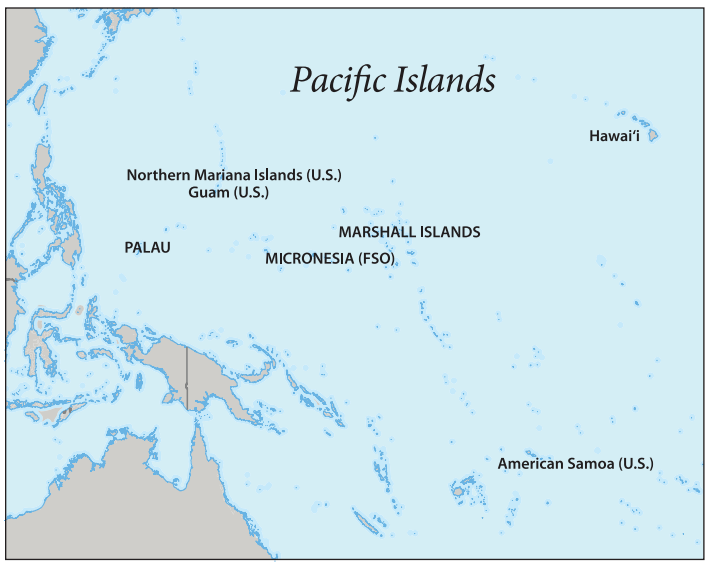
- PSW homepage: **9,663 visits**
- Biocontrol for strawberry guava: **5,777 visits**
- Urban forestry: **3,899 visits**
- Series reports: **3,296 visits**
- Publications: **3,046 visits**

Top News Stories

- Illegal marijuana farms threaten fishers
- Big-brained mammals at greatest risk of extinction
- Rapid 'Ohi'a Death: The disease that's killing native Hawaiian trees
- Weasels: Smart, fierce, and built to hunt
- California "street tree" benefits valued at $1 billion

Funding





PSW's area of responsibility also includes six Pacific Island U.S. territories and U.S.-affiliated republics.

Community Involvement

Young citizen scientists monitor deadly amphibian fungus

PSW scientists have been helping youth with the Bilingual McKinleyville Ecoclub monitor a deadly fungus that is threatening amphibian communities along California's northern coastal forests. Youths aged 4 to 16 caught frogs and salamanders, then administered a skin swab to test for *Batrachochytrium dendrobatidis*, a pathogen that has reduced populations of more than 200 amphibian species worldwide. Of the seven species and 155 amphibians tested, five species and 26 individuals tested positive for the fungus. The findings, published in the July 2016 issue of the *Journal of Wildlife Diseases*, demonstrate the ability of children to participate in meaningful citizen science projects.

Youths with the Bilingual McKinleyville Ecoclub helped PSW researchers monitor for a deadly fungus affecting amphibians around the world.

Event fosters tribal climate leaders

More than 90 students from indigenous communities across the United States gathered in early July to learn about climate change during an Inter-Tribal Youth Climate Leadership Congress in Shepherdstown, West Virginia. PSW research ecologist Frank Lake, a descendant of California's Karuk people, delivered the keynote address, led a workshop session on "Tribal Forestry as Impacted by Climate Change," and staffed a career fair to share how he incorporates traditional ecological knowledge into his profession. The congress was organized by the U.S. Forest Service, U.S. Fish and Wildlife Service, and several other federal agencies.

PSW research ecologists Frank Lake (left) discusses science- and natural resource-based careers with attendees during a career fair at the Inter-Tribal Youth Climate Leadership Congress.

BioBlitz explores Hawaiian dry forest ecology

PSW researchers, in partnership with the Hawaii Division of Forestry and Wildlife, the University of Hawaii at Manoa, and the Forest Service's National Partnership Office, hosted 250 fourth-graders in September for a "Bio-Cultural Blitz" at the Pu'u Wa'awa'a Dry Forest Unit of the Hawaii Experimental Tropical Forest. Students were traditionally welcomed by native Hawaiian descendants of Pu'u Wa'awa'a and spent the day visiting stations highlighting the biocultural significance of endangered dry forests—from botany and soils to wildlife and insects to cultural geography and indigenous resource management—while engaging in hands-on activities.

Fourth-graders learned about the biological importance and cultural significance of Hawaii's endangered dry forests during a "Bio-Cultural Blitz" in September at the Pu'u Wa'awa'a Dry Forest.

PSW forest research featured at San Francisco event

PSW was the main attraction in September during the California Academy of Sciences' NightLife event. About 1,500 people attended the after-hours event, which featured forest research. PSW researchers shared information about bark beetles, tree mortality, fire ecology, and forest resiliency. Interactive exhibits included a beanbag-toss game illustrating how cavity-dwellers make use of snags, a pine cone guessing game, a demonstration showing values of urban trees, and a beetle and butterfly display. Smokey Bear also made an appearance, spreading his wildfire prevention message.

PSW scientists shared their latest research during a forest-themed NightLife event in September at the California Academy of Sciences in San Francisco.

Ecosystem Function and Health

Shelter from the warm

Climate refugia could mitigate impacts of climate change

Once considered an icon of climate vulnerability, the American pika is now becoming a model for climate resiliency. PSW scientists studied how the pika's behaviors have changed in the face of warming temperatures. This research has highlighted the importance of climate refugia, or areas across a landscape providing climate stability. Pikas take advantage of "air conditioned" shaded rocky interiors on mountain slopes to buffer themselves from a summer day's heat. Researchers also have observed pikas adapting their behavior to be more active during cooler times of the day and less active in the midday heat. These findings give pause to climate assessments that rely solely on regional surface air temperatures to predict species vulnerability to changing climates, and point instead to the importance of microclimates, the temperatures within specific local habitats for wildlife.

Principal investigator: Connie Millar

Pikas are demonstrating how species can adapt to changing climates by finding sheltered areas to reside in or modifying their behavior to avoid the heat of the day.

Feasts from famines

Increased drought conditions a boon for attack by bark beetles, but not fungal pathogens

Current climate trends suggest that we could see higher temperatures as well as an increase in the frequency and severity of droughts in the Western United States. Such conditions are likely to bolster some forest threats, while reducing the impacts of others. A PSW scientist and colleagues from academia, the Rocky Mountain Research Station, and the National Park Service reviewed and synthesized research concerning the effects of drought on forest insects and diseases. They found that forests are able to withstand bark beetle onslaughts under moderate drought conditions, but are overwhelmed by severe drought conditions. Forest defoliators show no consistent responses to drought. At the same time, evidence suggests that pathogens whose life cycle depends directly on moisture will have less impact during droughts, while those that depend on the availability of stressed hosts will have more impact. Understanding these relationships will better allow land managers to develop and implement treatments, such as thinning, that help mitigate future disturbances.

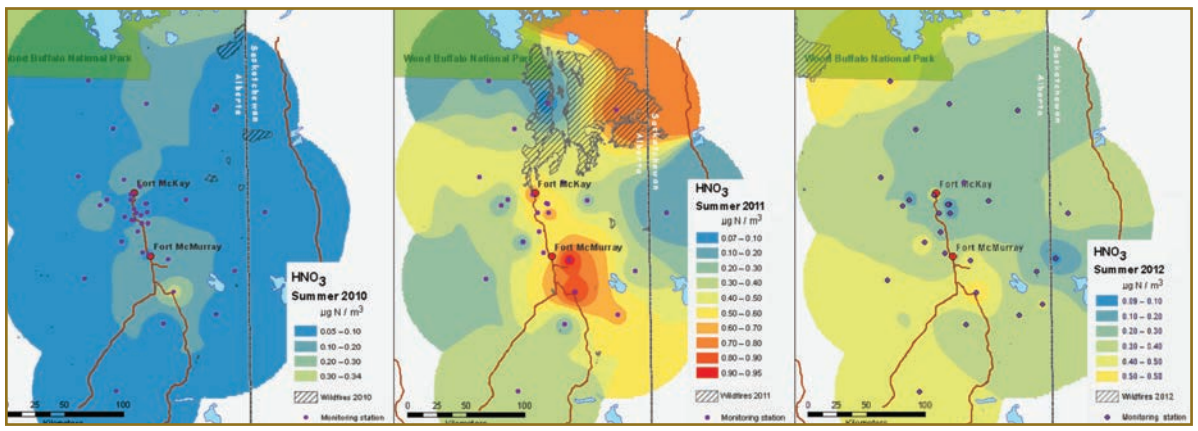
Principal investigator: Chris Fettig

Severe drought can create conditions that foster bark beetle infestations, leading to mass tree mortality, such as what is being seen in California's Sierra Nevada.

Air quality up in smoke

Air pollutants and fine particulate matter measured, tracked during mega-fire

When a 1.7-million-acre wildfire burned within the vicinity of a Canadian oil field, preexisting air monitoring devices detected a seven- to eightfold increase in nitrogenous pollutants in the air. PSW researchers tracked the output of pollutants throughout the three-and-a-half-month course of the 2011 Richardson Fire in northern Alberta. After the first month or so of burning, levels returned closer to normal as the fire moved farther from the sensors. Little change was detected in sulfuric pollutants from prefire levels. The amount of nitrous pollutants on the landscape increased by two to four times the amount from any of the previous three summers, but never reached toxic levels. The study provides public health officials with new insights into the types and amounts of pollutants that can affect an area during severe wildfires.



Corrosive nitric acid vapor spiked during the Richardson Fire in 2011. Concentrations of the pollutant decreased a year following the fire, but not to the same levels preceding the fire.

Principal investigator: Mark Fenn

Fire and Fuels

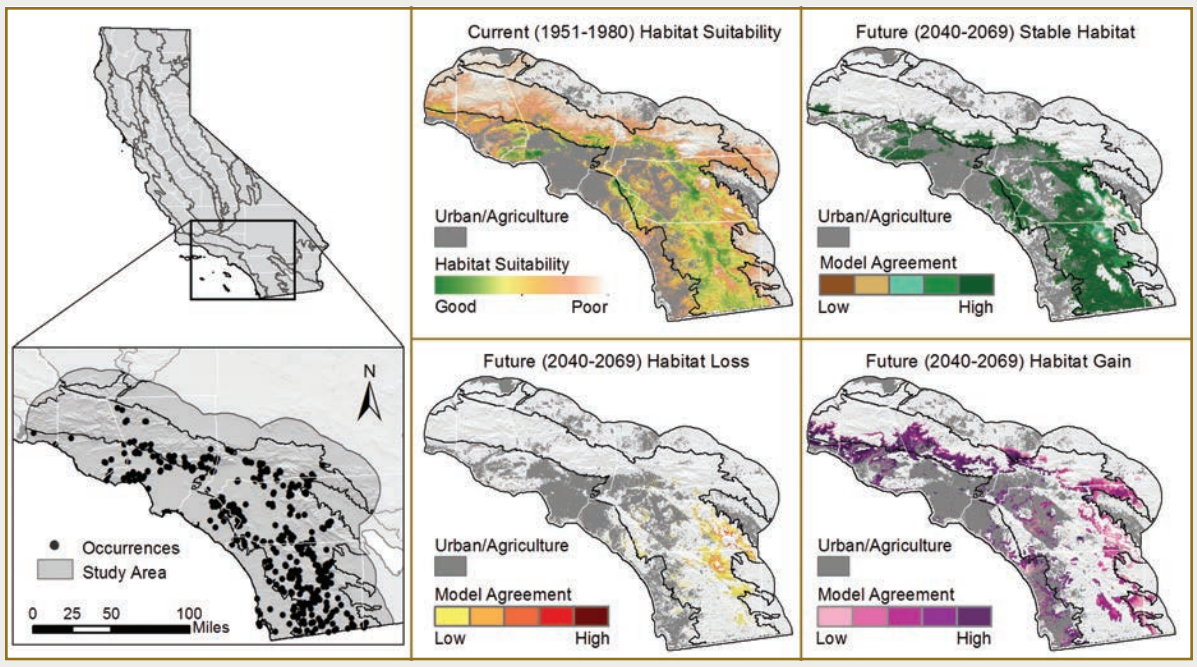
Suitable shrubs for future climates

Research identifies native plants ideal for changing climatic conditions

PSW researchers and collaborators have created an inventory of native chaparral and coastal shrub species for southern California that identifies habitat preferences, growth characteristics, and possible restoration uses. Their work includes maps of possible changes to habitat suitability under future climate conditions to guide plant selections for long-term survival. Whether replanting a landscape affected by wildfire or restoring a tract of land to its natural state, establishing native shrub communities suitable to current and future climates is paramount. Shrubs play an important role in nature by providing habitat for wildlife and stabilizing soils and slopes, as well as storing carbon and producing oxygen.

Principal investigator: Jan Beyers

Arlee Montalvo, Riverside-Corona Resource Conservation District



Sugar bush (*Rhus ovata*) is a useful shrub for southern California restoration projects because it grows fairly easily and resprouts after wildfire.

Second-hand choke

Plants exposed to air pollution re-release pollutants when burned

Vegetation exposed to high levels of nitrogen oxide pollutants later released smoke containing up to 30 percent more of the pollutant when burned than does vegetation from areas low in nitrogen deposition. The effects of nitrogen oxides from air pollution on the environment are well documented, from a reduction in water quality to acidification of soil, which reduces plant vigor and vitality. But the effects of nitrogen deposition don't stop on the forest floor, according to PSW research. The findings indicate that regional air quality also should be taken into account when considering the atmospheric emissions from wildfires.

Principal investigator: David Weise

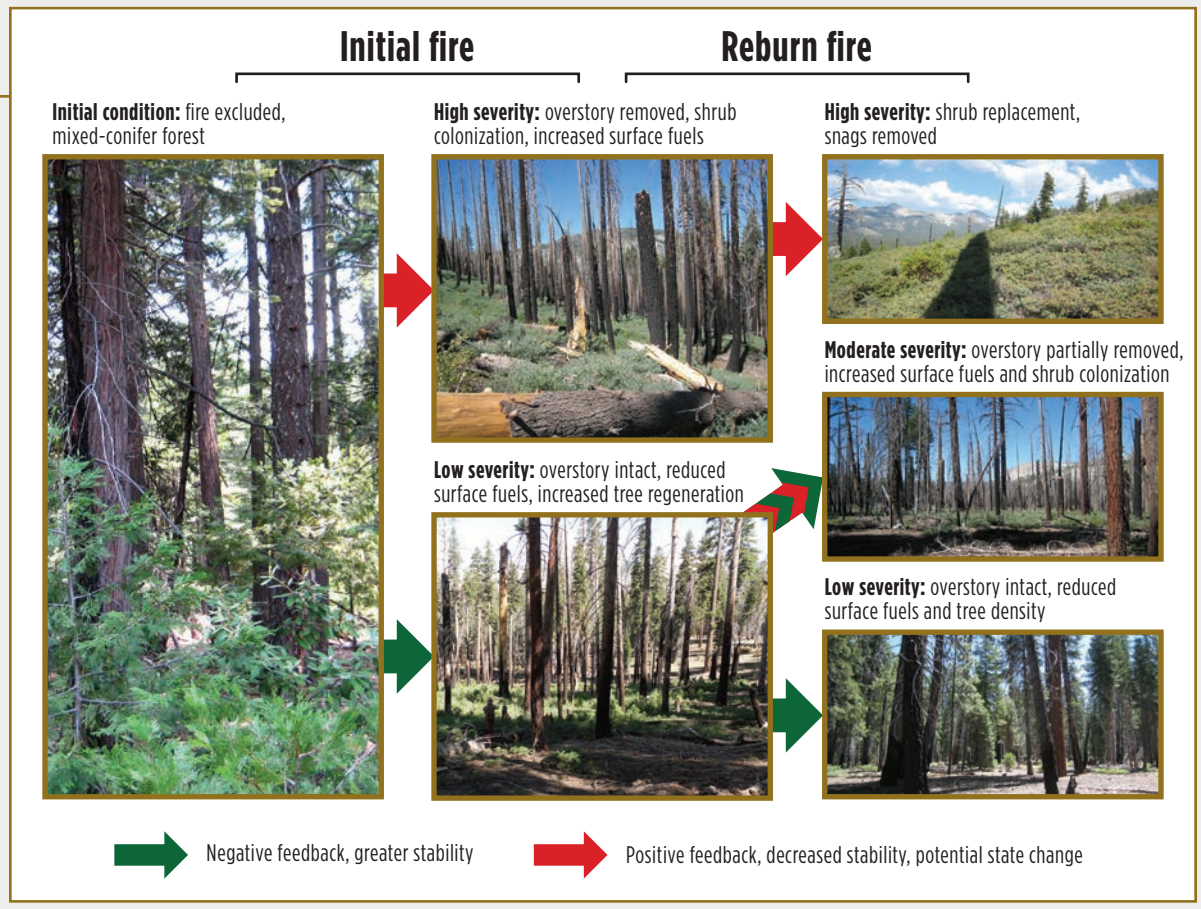
Smoke from vegetation exposed to high levels of nitrogen oxide pollutants contained up to 30 percent more of the pollutant than smoke from vegetation in less polluted areas.

Refueling the fire

Severe wildfires creating conditions that promote future extreme fires

After decades of wildfire suppression, current environmental conditions are resulting in fires burning at a greater intensity across a greater expanse of landscape than historical levels. But instead of putting ecosystems back into equilibrium, new research suggests that the aftermath of some fires is paving the way for even greater fires in the future. Moderate- to high-severity wildfires are leaving behind a greater amount of dead standing trees and an influx of fast-growing invasive shrubs in their wake, which, when exposed to wildfire several years later, are again producing severe fires with repeatable effects. Knowing the postfire conditions fueling severe reburns can guide land managers in implementing strategies that disrupt the cycle.

Principal investigator: Brandon Collins



Long-Range Research

Spotty results

California spotted owl numbers decreasing in some areas, rising in others

California spotted owl populations in and around the Sierra Nevada have declined within two study sites, but rose at a third. For the past 25 years, PSW researchers have been monitoring spotted owl population changes. On two study sites located across a mixture of national forest and private lands, researchers saw a decline in population from the previous year. However, spotted owl numbers on a third site within a national park had increased. The mixed results highlight the challenges of using a single species to evaluate or formulate land management plans, while shedding some light on potential implications of land management strategies.

Field studies tracking spotted owl populations have found the bird's numbers increasing in some areas, decreasing in others.

Principal investigator: John Keane

Steady tune

Songbird populations have periodic ups and downs, but long-term stability

Long-term research into population trends of 35 woodland bird species has found that while some species are experiencing sustained growth or decline, the majority have maintained stable populations despite temporary dips or rises. Using 27 years of data, PSW scientists tracked bird populations within the San Joaquin Experimental Range in the Sierra Nevada foothills. Long-term monitoring provides valuable insights into population dynamics and can help put short-term observations into better context. For example, an observed 3- or 5-year decline in a species could merely be the result of a short-term disturbance. Or, if that decline fits within a long-term decline spanning 20 to 30 years, it could indicate the need for concerted conservation efforts. The long-range stability exhibited by the majority of species monitored also showed that species can persist even after a series of bad years.

Woodland song birds, such as the western scrub-jay, have periodic shifts in population, but overall they exhibit long-term stability.

Principal investigator: Kathryn Purcell

Climate comforts

Ponderosa pines thrive when planted in climates matching their original seed source

More than elevation or geography, transplanting a seedling of a ponderosa pine (*Pinus ponderosa*) to an area matching the climate of its seed source best determines how well it will grow. Since 1976, PSW researchers have been monitoring the growth of ponderosa pines in three gardens across California. Although they did find that trees grown from seeds collected at lower elevations grew taller than trees from higher elevation seed sources, matching the climate from a pine's seed source to its transplant location produced the best growth results across all conditions. Knowing which conditions best promote tree growth can help land managers more selectively choose seeds for reforestation efforts.

Ponderosa pine seedlings grew best when planted at elevations similar to where they were first collected as seeds.

Principal investigator: Jessica Wright

Sturdy soil

Soil function, quality resilient to damage from logging

PSW researchers, along with a consortium of U.S. and Canadian scientists, have been tracking the short- and long-term responses of soils to disturbance. Twenty years after logging, across more than 60 study sites, affected soils showed little to no difference compared to tracts of land without any disturbances. Bacterial and fungal diversity remained robust in soils compacted or experiencing partial or complete loss of nutrient-rich top cover resulting from logging operations. Roots also continued to grow amid compacted soil. Only the complete removal of surface materials caused a momentary dip in microbial diversity, which was attributed to a change in surface temperature and exposure to moisture. Understanding effects below the surface can help land managers better evaluate the ramifications of actions above it.

Despite growing in soil compacted by logging equipment, tree roots showed little difference 20 years after disturbance to roots of trees in areas not affected by logging.

Principal investigator: Matt Busse

Urban Ecosystems and Social Dynamics


Lance Cheung

Damages, not dollars

Fuel treatments reduce property loss to wildfires, not suppression costs

In a study of wildfires across the country, PSW researchers discovered that fuel reduction treatments, such as prescribed burning or mechanically thinning forest densities and underbrush, were largely ineffective at reducing the cost of suppression efforts when wildfires did occur. Only in California did mechanical treatments result in such savings. However, all areas receiving prescribed fire treatments sustained fewer losses of public property, building structures, or residences from wildfires than areas left untreated or treated with only mechanical methods. Although both treatment mechanisms have their merits, information about how these treatments related to suppression costs allows for a more comprehensive cost-benefit analysis of treatment options.

Principal investigator: José Sánchez


Prescribed burning, or the intentional burning of landscapes under controlled conditions to reducing future wildfire severity, did not appear to reduce suppression costs when wildfires occurred, but did reduce the loss of public property and buildings.

Paying for prevention

Ethnicity, perceived risk plays role in willingness to pay for wildfire risk reduction programs

PSW researchers found that a citizen's willingness to pay for wildfire risk reduction seems to be influenced not only by one's personal experience with wildfires or sense of imminent risk, but also their ethnicity. Among Florida minority homeowners, African-Americans were twice as willing to pay for activities that reduce the risk of fire occurrence than their Hispanic counterparts. Both groups expressed willingness to pay for programs administered by public agencies, but when it came to sharing funds with private citizens, most agreed that funds should go to homeowners in areas the owners perceived to be at high risk. As populations push further into natural areas—especially in Western states—thereby exposing themselves and their property to greater risk of wildfire losses, communities must grapple with ways to fund needed prevention measures.

Understanding these influences can give land managers a framework to approach communities when seeking public funds for risk-reduction programs.

Principal investigator: Armando González-Cabán


Removing or reducing the amount of trees and brush around communities is one way to reduce wildfire risk to homeowners.

Streets lined with gold

California "street trees" valued at $1 billion

Trees lining California's streets and boulevards are immensely valuable to communities—to the tune of $1 billion. PSW researchers used tree inventories from 49 cities across the Golden State and analyzed them in i-Tree, a computerized tree inventory and management tool, to create a composite picture of not only the number of California's street trees, but also their species, size, location, and associated benefits. Researchers found that street trees bolstered property values by $840 million, while also saving energy by reducing heating and cooling needs ($100 million value), intercepting rainfall ($40 million value), removing air pollutants ($20 million value), and storing carbon ($10 million value). In fact, for every $1 invested in street trees, communities receive nearly $6 worth of benefits. Despite the number of California's street trees growing from 6 million in 1988 to 9 million today, tree density has actually fallen from 105 to 75 trees per mile, nearly a 30-percent drop. Spatial analysis indicates that California cities have room to accommodate 16 million more trees along their roadways.

Principal investigator: Greg McPherson


The ecological benefits provided by the trees lining California's streets and boulevards are valued at $1 billion.

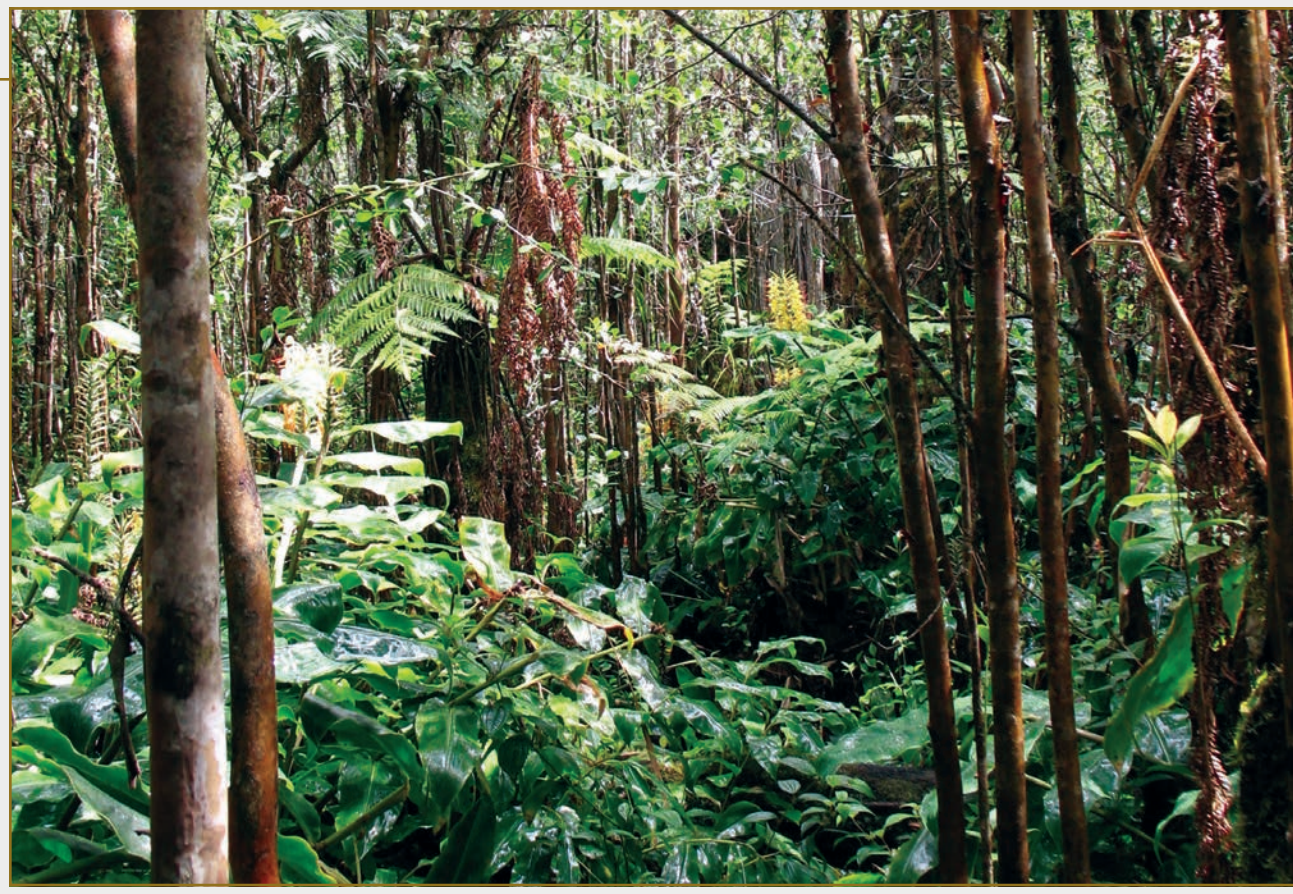
Institute of Pacific Islands Forestry

If the well runs dry

Computer modeling predicts climate change, invasive plants could cut Hawaii's fresh water supply in half

Using computer models to simulate water yield from 91 stream basins on Hawai'i Island (the Big Island), PSW researchers calculated the effects of projected climate change and invasive species growth. They found that stream flows could be reduced by as much as 50 percent from predicted drier climates, while invasive species could potentially siphon off an additional 2 percent. Tropical island watersheds are not like the slow rivers that flow across the flat plains of the continental United States. Instead, streams plunge quickly down steep montane forests from their headwaters to the coast, making flows erratic in their response to rainfall. These projections can help communities prepare contingencies for potential shortages in water supply.

Principal investigator: Christian Giardina



Invasive strawberry guava trees and ginger plants are reducing the amount of freshwater on Hawai'i Island, but not to the extent that projected drier climates are expected to have.

Tracking a killer

Hawaiian forests stalked by lethal disease

PSW researchers are studying the spread and transmission of a deadly fungus that kills up to 90 percent of the native 'ohi'a trees it infects. Since its first outbreak in 2014, Rapid 'Ohi'a Death (*Ceratocystis fimbiata*) has infected almost 80 square miles on the Big Island. Abundant across the archipelago, 'ohi'a trees are the only native trees in Hawaii that colonize lava flows. They provide habitat for several rare species of native birds and insects and are woven into Hawaiian culture through stories and songs. PSW researchers are working with a multi-agency science team to better understand Rapid 'Ohi'a Death's pathology and keep it from leaving the Big Island.

Principal investigator: Flint Hughes

Flowers from strangers

Non-native insects serve as primary pollinators for eight native Hawaiian plants

PSW researchers are studying the interactions between invasive predators, native and non-native pollinators alike, and the native plants vying for their attention to determine how these relationships are affecting plant reproduction. Of the eight plant species studied, most were visited most frequently by non-native pollinators, particularly the non-native European honeybee, *Apis mellifera*. Among the endangered plants within the study group, all were visited less frequently than their non-endangered counterparts, while the endangered mint, *Stenogyne angustifolia*, was visited least of all and by only one species, a non-native solitary bee. As non-native species become established in isolated ecosystems, such as tropical archipelagoes, it's important for land managers to understand how these new residents affect critical ecological processes.

Principal investigator: Christina Liang

Apis mellifera, a honeybee not native to Hawaii, was the most frequent pollinator of native Hawaiian plants in a recent study.

Rising to the occasion

Mangrove forests maintaining pace with rising sea levels

The majority of mangrove forests surveyed by PSW researchers are keeping pace with rising sea levels. Sediment deposited by rivers and near shore waters appears to be the primary reason the mangroves are able to accomplish this. Mangrove forests play an important role in mitigating climate change through carbon sequestration. One threat to the movement of sediment into mangrove forests is dams, often built to meet energy demands within developing countries. Dams can significantly reduce suspended sediment in rivers and negatively affect mangrove resilience to rising sea levels. Monitoring sediment loads and accumulation can help land managers know if additional restoration activities are needed to help mangrove forests.

Principal investigator: Rich MacKenzie

Sediment samples are extracted from a restored mangrove forest in Vietnam. The accumulation of sediment is helping mangroves keep pace with rising sea levels.

Conservation of Biodiversity

The key to the code

Genomic mapping opens door for advanced bioenergy research

PSW researchers have successfully sequenced the genomes of a large population of poplar trees with genetic compositions that affect attributes beneficial to bioenergy production. This sequencing identifies genetic variations correlated to specific traits pertinent to tree growth and biomass properties. It is the first functional genomics resource for a forest tree species, allowing for a better understanding of the regulation of complex traits such as size and volume, wood properties, and drought resistance to enhance bioenergy production.

Poplar trees' fast growth rates make them a popular resources for bioenergy production.

Principal investigator: Andrew Groover

In hot water

Restoring or protecting streamside vegetation can keep water cooler for trout

Land use that reduces vegetation along streams and rivers can threaten fish sensitive to water temperatures, such as California's golden trout. For six years, PSW and University of California–Berkeley researchers measured mountain stream temperatures while studying streamside vegetation. They found that areas where cattle graze typically had reduced streamside vegetation and warmer water temperatures, even to the point of being lethal to trout, despite having other in-stream conditions that are ideal for habitat. Water temperatures were cooler in areas without grazing, which had taller and denser streamside vegetation. One of the concerns with warming climate trends is warmer stream temperature. Enhancing and protecting streamside vegetation may ensure that steams have the resiliency to withstand warmer conditions in the future and provide refuge for fish.

Vegetation along stream banks helped keep water temperatures cooler, a benefit to many aquatic species, such as California's golden trout.

Principal investigator: Kathleen Matthews

The bigger picture

Fuel treatment disturbances absorbed by surrounding landscape

Northern flying squirrel populations don't diminish during logging operations to thin dense forests. Instead, they move to undisturbed neighboring habitat. PSW research showed that when broadening the scale of analysis, the animals suffered no decline in overall density. Although previous research showed that squirrel densities declined in areas where trees were removed, these new findings highlight the importance of incorporating a broader landscape context when evaluating effects of forest management on wildlife.

Principal investigator: Angela White

Northern flying squirrels might vacate areas close to logging operations, but they don't go far. Population densities didn't diminish for the species when the scale of analysis was broadened.

Traveling trouble

Deposited air pollutants carried downstream to poison estuaries

Prevailing westerly winds transport much of California's coastline auto emissions and air pollutants high into the Sierra Nevada, but the journey doesn't end there. PSW researchers found that as the pollutants deposit themselves across high-elevation landscapes, rain, wind and melting snow eventually concentrate the chemical compositions into headwater streams. From there, they are carried up to 100 miles or more back to their origins and pooled within coastal estuaries. Estuaries often serve as a transition area for younger organisms to mature into the seafaring phase of their life cycle. Excess nitrogen in these pollutants can lead to algal blooms that can kill many young species in these important coastal staging areas. The findings answer a question long puzzling the Southern California Coastal Waters Research Program, which has tracked nitrogen concentrations in estuaries for years and was unable to account for this "missing source" of pollution.

Principal investigator: Pamela Padgett

Going with the flow

Steelhead remarkably resilient to debris flows

Toppled trees and landslides tumbling into streams seemed to have few ill effects on juvenile steelhead. In fact, the species seemed to thrive from the disturbances. For three years, PSW researchers studied steelhead in six streams in northern California, some affected by debris flows and others not. They observed similar densities of steelhead in the two sets of streams at the end of the study. They also found rapid growth by steelhead in streams with debris flows immediately after the events. Scientists believe that reduced stream shading after the debris flow increased stream productivity that contributed to favorable conditions for fish, as did the fact that stream habitat complexity was not

John McMillan

Partnerships in Action

Nature and nurture

Restoring black oaks sustains environmental and cultural values

PSW scientists, along with a team of federal researchers and tribal members, produced a report to guide restoration of degraded stands of California black oak. These acorn-bearing trees provide a treasured food for many American Indians, as well as forage and habitat for numerous wildlife species, but they are threatened by high-intensity wildfires and encroachment of shade-tolerant conifer species. The report discusses how intensive thinning and fire treatments that benefit black oaks can fit within a larger landscape strategy designed to increase forest resilience to wildfire and drought.

Principal investigator: Jonathan Long

California black oaks provide forage and habitat to wildlife and also hold cultural importance to Native peoples.

Planting problems

Infected nursery stock introducing foreign diseases into native restoration sites

In the past several years, more than 40 species of the foreign pathogen *Phytophthora* have been found in California nurseries specializing in native plants, and subsequently in the restoration sites where these plants were used. PSW researchers and more than 50 partners are attempting to nip the problem in the bud by creating educational materials (http://www.calphytos.org) and a voluntary accreditation program to help nurseries adopt practices scientifically proven to reduce the spread of disease. Introducing pathogens into restoration sites is particularly insidious because it often puts rare native plants directly in harm's way. One strain of *Phytophthora* is responsible for the death of millions of oak trees along the Pacific Coast from sudden oak death.

Principal investigator: Susan Frankel

Shot hole borers are highly destructive when they lay egg galleries within the bark of trees, such as the California sycamore.

Wax on

Analysis of body wax helps researchers nationwide distinguish two similar insect species

Chemical analysis of the surface waxes of two closely related insect species have provided researchers an accurate means to tell the two species apart. Polyphagous shot hole borers (*Euwallacea* nr. *fornicatus*) and tea shot hole borers (*Euwallacea fornicatus*) are believed to hail from Asia and are nearly identical in appearance. In the United States, they have caused considerable damage to ornamental and native hardwood trees and agricultural tree crops such as almonds, avocados, and oranges. A network of entomologists are using the new knowledge to better track the beetles' movements, while also helping land managers tailor control measures specific to the species they are encountering.

Principal investigator: Steve Seybold

Reconnecting the past

Student collaboration guides land management within tribal history

The Yurok Tribe and Pacific Southwest Research Station worked with a college student to identify the historical range of native prairies within the reservation before fire suppression and shifts in land management forested the landscape. The student, a Yurok tribal member and part of an American Indian–Alaska Native undergraduate research program at Humboldt State University, sampled soils and vegetation to determine the boundary of historical grasslands and estimate the degree of forest encroachment. The research supports the Yurok Tribe's effort to quantify and map land changes while reintroducing tribal burning practices and other restoration activities to reestablish a landscape that supports tribal uses for wildlife, forage, and craftsmanship.

Principal investigator: Frank Lake

Humboldt State University student and Yurok tribal member Eldon Kinney (right) conducts a field sample of encroaching trees and shrubs with Yurok Tribe GIS specialist Shaonna Chase and PSW research ecologist Frank Lake.

For the birds

High school students learn how to band birds, design research project

High school students from the Center for Advanced Research and Technology assisted PSW researchers with a bird-banding project at the San Joaquin Experimental Range. After researchers taught the students how to capture birds using mist nets, band them, and record physical data, the students then developed a research project to determine whether a bird's foraging habits were connected to where in the mist nets they were captured. They found that birds that gleaned food from the ground were more often caught lower in the mist nets, compared to species that foraged in trees. The Center for Advanced Research and Technology provides advanced half-day classes in career-specific laboratory settings to upperclassmen in the Clovis and Fresno Unified School Districts.

Principal investigator: Kathryn Purcell

Urban sustainability

L.A. Urban Center uniting partners, connecting communities to nature

PSW scientists participated in several programs this year that brought together partners, as well as fostered stewardship within urban populations, through the Los Angeles Center for Urban Natural Resources Sustainability. They shared research on climate-resilient trees during the "Power of Trees" meeting with the California Urban Forest Council and California ReLeaf. They also participated in a panel discussion with other science organizations to discuss research projects and how groups could combine resources and efforts. Collaborative efforts are geared toward connecting urban populations with nature and fostering an environmental ethic.

Principal investigator: Pat Winter

California ReLeaf representative Cindy Blain (left), PSW urban ecologist Natalie van Doorn, and CAL FIRE urban forester John Melvin prepare to plant a tree during a spring partners' meeting focused on tree planting and care during severe drought.

Awards

Volunteer program recognized for diversity

When it comes to restoring native ecosystems, the Pu'u Wa'awa'a Dry Forest Unit of the Hawaii Experimental Forest doesn't act as an island. For collaborating with 31 organizations to restore 39,000 acres, PSW and its partner, the Hawaii Department of Land and Natural Resources' Division of Forestry and Wildlife, earned the Forest Service Chief's Volunteers and Service Cultural Diversity Award. Local schools, scout troops, youth corps, cultural practitioners, and even a housing consortium combined to design and implement service learning opportunities for students that connected their culture with their stewardship. The award recognized special efforts to coordinate with underrepresented communities to promote conservation and awareness.

Volunteers replant native vegetation within the Pu'u Wa'awa'a Dry Forest.

Scientist recognized by plant health diagnostic network

Pacific Southwest Research Station plant pathologist Susan Frankel was awarded an Outstanding TEAM Service Award at the National Plant Diagnostic Network Conference, held March 8–12 in Washington, D.C. The award recognizes public interagency and private sector coordination for a cooperative, rapid response to a new wildland pathogen, *Phytophthora tentaculata*. One aspect of the station's invasive species research strategy aims to proactively identify non-native and native organisms that pose a threat to California and Pacific Island ecosystems through potential introductions.

PSW Station Director's Honor Awards

PSW presented its third annual Station Director's Honor Awards in recognition of outstanding achievements by station employees. Award recipients were:

Distinguished Science

Connie Millar, a senior research ecologist, was recognized for her leadership and exceptional scientific productivity, particularly in the field of climate change and adaptation strategies. Millar was recently named a senior scientist by the U.S. Forest Service, the highest designation bestowed upon a researcher employed by the agency.

Science Delivery

Flint Hughes, a research ecologist located at PSW–Hilo, was recognized for his ability to communicate his research on the effects of wildfires, control of non-native species, and containment of forest pathogens to help guide natural resource policy in affected areas.

Safe and Healthy Workplace

The PSW–Riverside Safety Committee was recognized for its efforts in coordinating a highly engaging "Safety Week." Activities included guest speakers, movies, training, and group activities to address identified areas of concern.

Civil Rights

Pat Winter, a research social scientist located at PSW–Riverside, was recognized for her dedication and support of the Los Angeles Center for Urban Natural Resources Sustainability. She has helped facilitate networking among urban partners and pooling of resources, as well as furthering efforts to connect youth to the natural environment.

Innovation and Service

Ann Lindberg, an administrative support assistant located at PSW–Davis, was recognized for her exceptional customer service and skill helping new and seasonal employees navigate the federal hiring system. Her work allows new scientists and support staff to seamlessly enter the agency and assume their duties furthering forest research.

2016 Station Director's Award winners (left to right): Ann Lindberg, Flint Hughes, Station Director Alex Friend, Connie Millar, Josh Wilson on behalf of the PSW-Riverside Safety Committee, and Pat Winter.

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