United States
Department of Agriculture

Forest
Service

2017 SCIENCE SPOTLIGHT

Pacific Southwest Research Station

Science That Makes a Difference

Message From the Director

I am proud to present the Pacific Southwest Research Station's 2017 Science Spotlight. In this document, we highlight research completed during the past year related to the four outcomes that our station strives to address: (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 our research, which spans a diversity of disciplines and an enormous geographical footprint. As you scan through these pages, take note of the relevance and rigor of our science, the value we place on connecting with people, the end users of our work, and the care we take in stewarding all of the resources with which we are entrusted to conduct this work.

The forest resources-related challenges facing California, Hawaii, and the U.S.-affiliated Pacific Islands are significant. 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.

The quality of our accomplishments is the result of the talent and dedication of our staff, partners, and collaborators, as well as the enduring support for our work that has allowed relevant science to emerge and develop into impactful findings.

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

Vision and Mission

The Pacific Southwest Research Station is a leader in natural resources research through 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.

Cover: Castle Lake and Mount Shasta. Photo by Brittany Burnett.
This page: Climber on Mount Shasta. Photo by Nick Meyers.

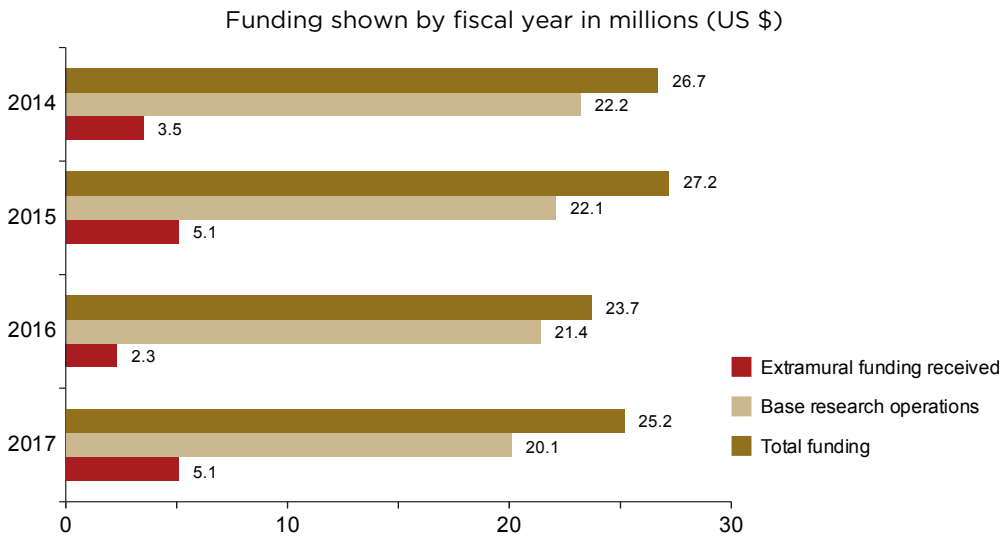
Pacific Southwest Research Station: At a Glance

Headquartered in Albany, California, the Pacific Southwest (PSW) Research Station is part of the U.S. Forest Service's Research and Development branch. Comprising 131 employees, PSW Research Station staff develop and communicate science used to sustain forest ecosystems and benefit communities. PSW Research Station scientists are engaged in research across a network of 12 experimental forests and ranges, two research watersheds, and eight research facilities throughout California, Hawaii, and the U.S.-affiliated Pacific Islands.

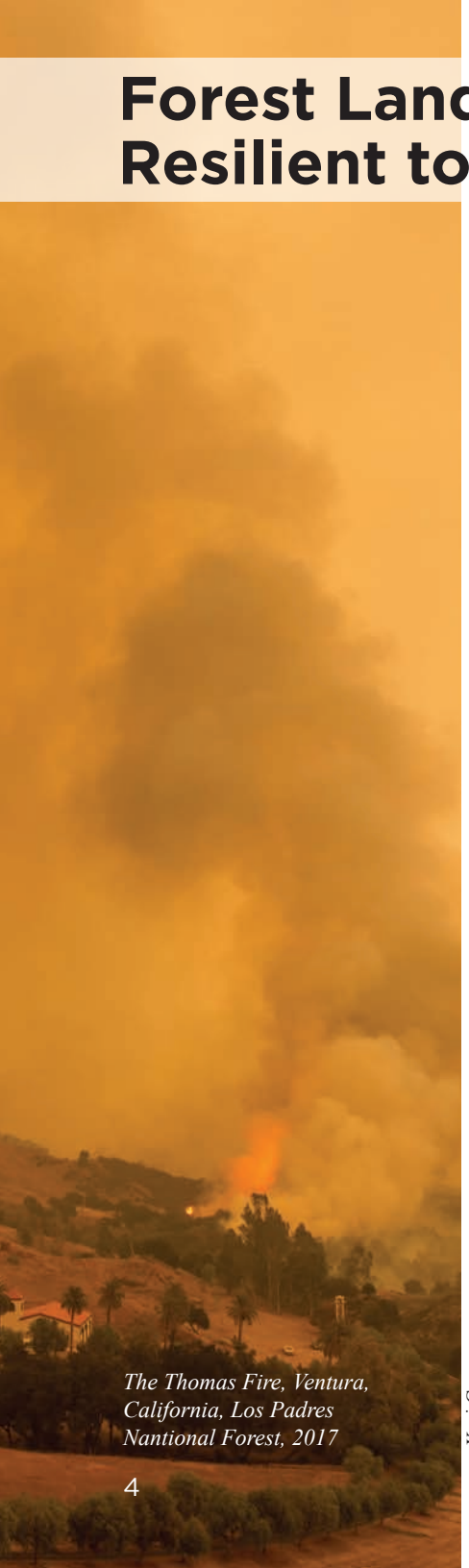
Scientific pursuits are organized into five research units:

- Conservation of Biodiversity
- Ecosystem Function and Health
- Fire and Fuels
- Urban Ecosystems and Social Dynamics
- The Institute of Pacific Islands Forestry

Funding for research comes from federal budget allocations (base research operations) and cooperating agreements with other agencies, groups, and educational institutions (extramural funding).



Forest Landscapes That Are Resilient to Disturbance



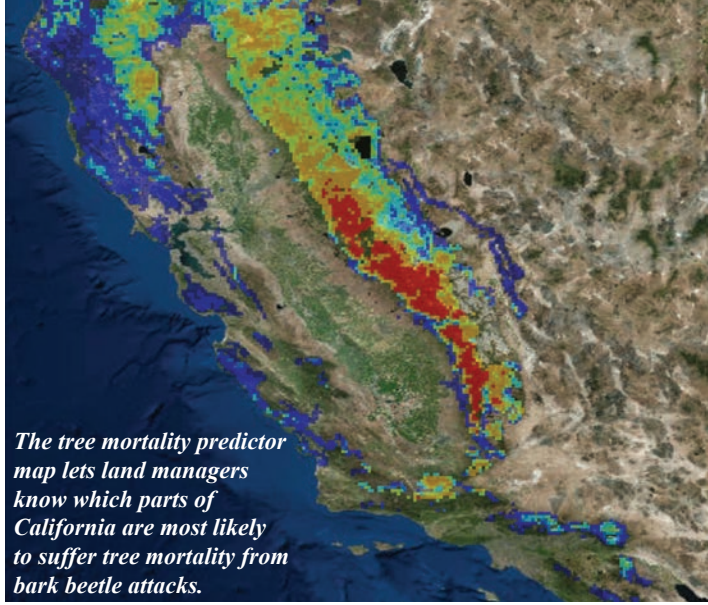
The Thomas Fire, Ventura, California, Los Padres Nantional Forest, 2017

Kari Greer

Forecasting California tree mortality

An updated map enables forest managers to adapt management strategies by predicting the likelihood of future tree mortality from bark beetles throughout California. Pacific Southwest Research Station researchers and collaborators analyzed aerial survey data and variables known to influence bark beetle success, such as precipitation and stand density, to create the map. The map can be generated to forecast the likelihood of mortality 2 years into the future, enabling land managers to prioritize treatment locations to coincide with areas most likely to experience mortality.

Principal Investigator: **Haiganoush Preisler**



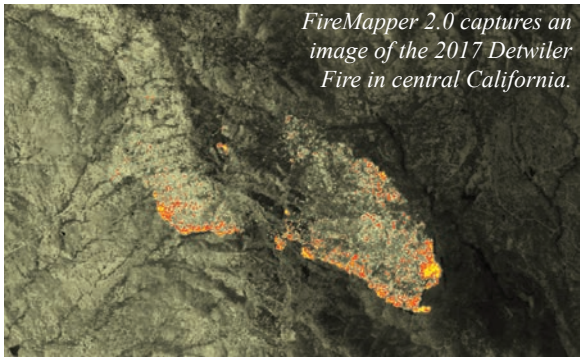
The tree mortality predictor map lets land managers know which parts of California are most likely to suffer tree mortality from bark beetle attacks.

Haiganoush Preisler

Monitoring wildfire behavior in beetle-killed forests

Researchers at the Pacific Southwest Research Station are examining how wildfire behaves in forests with high levels of tree mortality from California's prolonged drought and bark beetle epidemic. FireMapper 2.0, an airborne wildfire-mapping and remote-sensing system, uses thermal imaging technology to measure fire-spread rates, energy release or intensity, and spot-fire generation, as well as temperature gradients within the fire. These data provide valuable insights into wildfire behavior and severity in these novel environments; they also inform land managers about possible treatment strategies to mitigate these effects.

Principal Investigator: **Phil Riggan**



FireMapper 2.0 captures an image of the 2017 Detwiler Fire in central California.

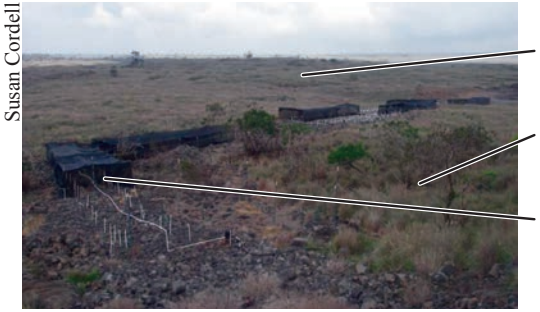
Phil Riggan

Curbing wildfire, invasive species in Hawaii with native plants

Invasive grass species are converting Hawaii's dry forest landscapes into nonnative grasslands, decreasing native biodiversity and contributing to wildfire in these ecosystems. Borrowing from techniques used in the Intermountain West, researchers are experimenting with so-called greenstrips of native Hawaiian plants to break up swaths of fire-carrying grasses, while restoring native ecosystems. *Chenopodium*, a fast-growing, flowering native shrub from the amaranth family, proved to be the most effective greenstrip species for restricting invasive grass growth; it also exhibited the fire-limiting properties of high moisture content and low heating values.

Principal Investigator: **Susan Cordell**

Susan Cordell



This "greenstrip" of native Hawaiian vegetation has the potential to restrict invasive grass growth, while acting as a fuel break against wildfires.

Sustained Ecological Services

"Snag islands" provide refuge for black-backed woodpeckers

Logging can negatively affect nesting densities for black-backed woodpeckers in burned forests; however, researchers discovered that these effects appeared to be buffered by uncut dead trees within and near the harvested areas. Following the 2007 Angora Fire near South Lake Tahoe, several clumps of standing dead trees, or snag islands, were retained for black-backed woodpeckers and other snag-associated species. Researchers systematically surveyed the postfire landscape for woodpecker nests for two years before and after salvage operations. The presence of nesting black-backed woodpeckers within snag islands and in other unlogged areas indicates that leaving dense stands of dead trees within the fire footprint may help balance the needs of wildlife and attain other management objectives.

Principal Investigator: **Angela White**

Stand productivity unaffected by logging, soil compaction

Long-term tree growth and understory revegetation were not affected by timber harvesting and related soil compaction. The results of a 20-year study showed near-complete tolerance by forest biomass to soil compaction and surface organic matter manipulation across a wide geographic range in California. The study compared results from varying soil compaction levels and varying harvest intensities, with or without postlogging control of competing vegetation. Soil compaction actually resulted in a 15-percent increase in planted tree growth, which was attributed to improved seedling survival along with reduced competition from understory vegetation. Controlling understory vegetation had the most pronounced effect in the study, with 68 percent greater tree growth in vegetation-controlled units compared to units where the understory went unmanaged.

Principal Investigator: **Jianwei Zhang**

Jianwei Zhang

Soil compaction from logging operations was found to have no long-term effects on tree growth or site revegetation, according to a 20-year study.

Getting to the root of indigenous cultivation practices

Roots were an important source of food for American Indians throughout California. Dozens of species of these geophytes were gathered across multiple plant communities, from salt marshes to deserts to chaparral to the open understories of coniferous forests and oak woodlands. Researchers have chronicled how indigenous people mastered the ecological requirements necessary for these "root foods" to flourish. Tending practices such as intentional burning, harvesting methods, and site cultivation have resulted in individual plants growing more vigorously with larger or more numerous roots, as well as growing more abundantly relative to comparable uncultivated areas.

Principal Investigator: **Frank Lake**

Frank Lake

American Indian traditional cultivation practices were found to increase productivity of root foods, such as these Indian potatoes found along the Salmon River in northern California.

Leaving clumps of dead, standing trees ("snag islands") serves as a refuge for black-backed woodpeckers during salvage logging.

Angela White

Enhanced Benefits to Communities

Building bigger fires that produce less smoke

Under favorable weather and fuel conditions, land managers can use prescribed fire in large areas of forest while keeping daily emissions below levels likely to cause harm to people in downwind communities. To better predict smoke effects from prescribed fires, Forest Service researchers have created a framework that takes advantage of smoke and air quality modeling software, as well as demographic information already used by fire, air quality, and public health managers. They demonstrated that the smoke from an uncontrolled wildfire in the central Sierra Nevada was several times greater than smoke from prescribed fires in the same area. The framework is being used in a 3-year project on the Eldorado National Forest in California's Sierra Nevada foothills that will treat 8,000 acres with prescribed fire.

Principal Investigators: **Jonathan Long, Malcolm North, and Lee Tarnay**

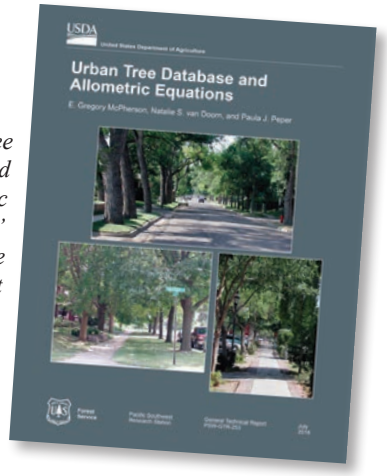
Under controlled conditions, smoke from prescribed fires can be several times less than smoke generated by uncontrolled wildfires.

Jonathon Long

Compiling the nation's largest urban tree growth database

City planners across the United States are benefiting from the largest and most precise tree growth database in the country, featuring growth models for 171 urban tree species across 16 U.S. climate zones. The Urban Tree Database is the culmination of 14 years of work in which Pacific Southwest Research Station researchers analyzed more than 14,000 trees throughout the United States. Moving beyond traditional growth models that predict a tree's height and diameter, this new database incorporates 365 sets of tree growth equations, enabling urban foresters to plan for potential carbon sequestration, crown dimensions, foliage amounts, and air pollutant absorption.

Principal Investigator: **Greg McPherson**



"Urban Tree Database and Allometric Equations" provides the largest and most precise growth database for urban trees in the United States.

Turning kids onto nature through other kids

The best way to talk to kids about nature is through other kids. Themes based on unique experiences, challenges, adventures, and social connections most resonated with Los Angeles-area youth participating in a communications workshop with Pacific Southwest Research Station researchers. Young people from underserved populations were trained to serve as peer communicators; they developed messages aimed at connecting their peers to the outdoors through photos, video, and social media messages. Researchers found that messages designed by these peer communicators were more appealing to recipients compared to messages developed by adults. Researchers developed a toolkit from the exercise to share with land managers who might be interested in adopting a youth peer communications network across social media.

Principal Investigator: **Pat Winter**

Trees ablaze during the Hunter Fire, June 2006.

U.S. Forest Service

Clean and Reliable Water Resources

Tracking landslide sediment to unearth water quality

Accurate assessments of the amount and duration of sedimentation in water after landslides help land managers better estimate the accumulative effects on water quality and aquatic organisms. Researchers found that, depending on the size of the landslide, soil and debris deposited in streams can stay suspended in the water column for up to 8 years. While the majority of displaced material from landslides remains on the hillslope or adjacent to the stream or river channel, in two large slide events, up to 15 percent of the slide volume was found in the stream. Stream sedimentation can remain affected for years after a landslide owing to bank erosion and channel incisions from wood and debris.

Principal Investigator: **Elizabeth Keppeler**

Invasive plants negatively affect Hawaiian stream species

Reduced streamflow caused by invasive plants and low precipitation can result in reduced numbers for species that filter drinking water and provide important food sources. Researchers found that decreased streamflow in Hawaiian streams correlated with smaller and fewer native shrimp, as well as an increase in brown spot disease, which is lethal to these shrimp. Researchers also found the number of eggs on female shrimp decreased along the declining streamflow gradients.

Principal Investigator: **Rich MacKenzie**

Richard MacKenzie

Reduced streamflows in Hawaii have been linked to fewer and smaller aquatic species, such as these native shrimp.

Incorporating fish behavior to improve stream restoration

Bret Harvey

A new computer model gives land managers more useful estimates of how fish will respond to restoration options for streams such as this.

Land managers can better estimate how restoration designs will affect valued fish species, such as coho salmon, with a new model called InSTREAM that offers greater insight into how fish respond to stream channel characteristics, water conditions, other fish, and predators. Models that reflect individual fish behavior can provide managers with simulations that also account for daily, seasonal and annual variations, allowing them to make projections across various time frames. Previous models only used generalized assumptions about fish populations and habitat conditions. This new model gives land managers more useful estimates of how fish will respond to various restoration strategies.

Principal Investigator: **Bret Harvey**

Elizabeth Keppler

Researchers discovered that up to 15 percent of a landslide's volume can wind up in a stream, where sediment can remain suspended in the water column for up to 8 years.

PSW Research Station Organization

Station Director
Dr. Alexander L. Friend
(510) 883-8832
afriend@fs.fed.us

Assistant Director, Business Operations
Colleen Schneider
(510) 883-8834
ckschneider@fs.fed.us

Director, Partnerships
Dr. Ricardo D. Lopez
(808) 747-4080
rdlopez@fs.fed.us

Director, Research Planning
A.J. Duggan
(510) 883-8836
aaduggan@fs.fed.us

Program Manager, Conservation of Biodiversity
Dr. Patricia Manley
(530) 621-6882
pmanley@fs.fed.us

Program Manager, Ecosystem Function and Health
Dr. Chrissy Howell
(510) 883-8839
cahowell@fs.fed.us

Program Manager, Fire and Fuels;
Urban Ecosystems and Social Dynamics
Joshua Wilson
(951) 680-1558
joshuawilson@fs.fed.us

Director, Institute of Pacific Islands Forestry
Dr. Susan Cordell
(808) 854-2601
scordell@fs.fed.us

Locations

PSW-Albany (Headquarters)
800 Buchanan Street
Albany, CA 94710-0011
Phone: (510) 883-8830
Fax: (510) 883-8858

PSW-Arcata
1700 Bayview Drive
Arcata, CA 95521-6013
Phone: (707) 825-2900
Fax: (707) 825-2901

PSW-Davis
1731 Research Park Drive
Davis, CA 95618
Phone: (530) 759-1700
Fax: (530) 747-0241

PSW-Fresno
2081 E. Sierra Avenue
Fresno, CA 93710-4639
Phone: (559) 323-3200
Fax: (559) 297-3355

PSW-Hilo, Institute of Pacific Islands Forestry
60 Nowelo Street
Hilo, HI 96720
Phone: (808) 933-8121
Fax: (808) 933-8120

PSW-Placerville, Institute of Forest Genetics
2480 Carson Road
Placerville, CA 95667
Phone: (530) 622-1225
Fax: (530) 622-2633

PSW-Redding
3644 Avtech Parkway
Redding, CA 96002
Phone: (530) 226-2530
Fax: (530) 226-5091

PSW-Riverside
4955 Canyon Crest Drive
Riverside, CA 92507
Phone: (951) 680-1500
Fax: (951) 680-1501

Credits

Editor—A.J. Duggan
Writer—Paul Meznarich
Graphic Design—Jason Blake

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